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Fuel consumption at subsoiling

With increasing wheel load of agricultural vehicles, subsoiling as mechanical repair measurement became more important. In a field trial the influence of different soil tillage systems on fuel consumption at subsoiling was done. With two different driving strategies the fuel consumption was measured. The results show, that the driving strategy has more influence on fuel consumption (l/h) than the soil tillage system. In a second trial it was shown, that the heavy self-propelled potato harvester results to small additional fuel consumption at subsoiling.

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Keywords

Subsoiling, fuel consumption, soil tillage systems

The increasing of wheel-load of the farm machinery used could result in deformation of the subsoil [3]. Mechanical subsoiling is an energy-intensive mechanical repair approach for removing harmful compaction. The fuel consumption for subsoiling depends on soil condition, working depth, kind of subsoiler (rigid or moving tines) and ranges between 11 and 32 l/ha [2].

At the experimental farm in Groß Enzersdorf of the University of Natural Resources and Applied Life Sciences the fuel consumption at subsoiling was measured in different soil tillage systems. The long-term trial with large plots (60 • 24 m) allows soil tillage with conventional working widths and was established in 1996. In a second experiment the effect of two different potato-harvesting-systems on fuel consumption at subsoiling was measured.

Technical description and method

For measuring the fuel-consumption, a high-performance flow-meter (PLU 116H) was integrated into the fuel-system of the tractor (Steyr 9125a with 92 kW). The digital signal from the flow-meter (error rate 1 %) and the frequency-signal of the radar-sensor for speed measurement was continuously recorded with a data-logger (scan rate 1 Hz). The cultiplow-subsoiler (*Fig. 1*) has a working width of 3 m and was equipped with four rigid tines (share width: 34 cm). The working depth of 40 cm was adjusted with a cage roller.

The fuel consumption at subsoiling was measured on 17th August 2004 in the first replication of the established soil-tillage trial (*Fig. 2*). Thereby two cross-drives with two different driving strategies were carried out.

Influence of the soil tillage systems and driving-strategy

Since 1996 the soil tillage has been set constant for the different systems (*Fig. 2*). Soil tillage systems with reduced soil tillage intensity result in a higher bulk density. The consequence is that draft power and fuel consumption at subsoiling is higher (*Fig. 3*). Especially the variants “No tillage with direct drilling” and “Mulch drilling – shallow loosening” have an additional fuel consumption between 1.6 and 3.6 l/h in comparison to conventional tillage with plough.

The factor „driving-strategy“ has much more influence on fuel consumption than the soil-tillage systems. The drive with the adapted gear shifting (2. gear; 1. powershift) and mean engine speed of 1700 rpm results in an average fuel consumption of 17.2 l/h. In comparison, the “high engine speed” drive (1. gear; 4. powershift) with a mean engine speed of 2300 rpm showed a 43 % higher fuel consumption, which is 7.4 l/h. The fuel consumption per hectare, without consideration of the fuel consumption of the turning at the headland, is 17.4 l respectively 12.3 l. This fuel-saving effect at same field capacity is based on the optimal engine operating point, which is realised at 70 % of the rated engine speed.

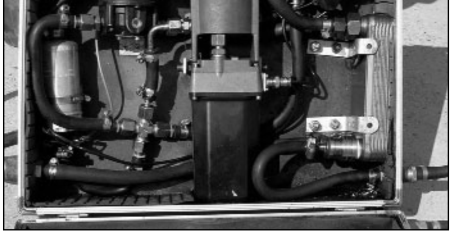

Fig. 1: Subsoiler (left) and fuel-flowmeter PLU 116 H (right)

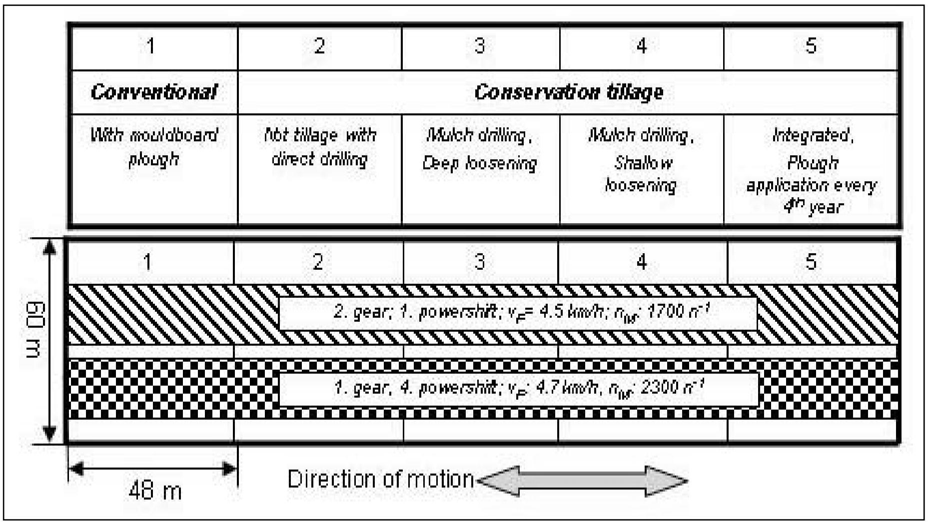

Fig. 2: Soil-tillage systems (above) with experimental design for subsoiling (below)

Effects of different potato-harvesting-systems

In a second trial, which was carried out October 6th 2005 on two adjacent potato fields (à 0.68 ha), the effect of two potato-harvesting-systems on the fuel consumption at subsoiling with the cultiplow was measured. The tractor (CLAAS - Ares, rated power; 104 kW) was equipped with an additional fuel tank-system, which allows measuring the fuel consumption with a precise scale. For slip-calculation the digital signals of parameters "theoretical velocity" (v_transmission sensor) and the „real velocity" (v_radar) were recorded with a scan rate of 1 Hz on a datalogger. One week before subsoiling the harvest was carried out with two different potato-harvesting-systems (*Tab. 1*).

The *Table 1* shows that the average fuel consumption in field 1 was marginally higher than in field 2. With a penetration sensor it was tested, that in field 1 the penetration resistance was in the topsoil (5 to 10 cm).

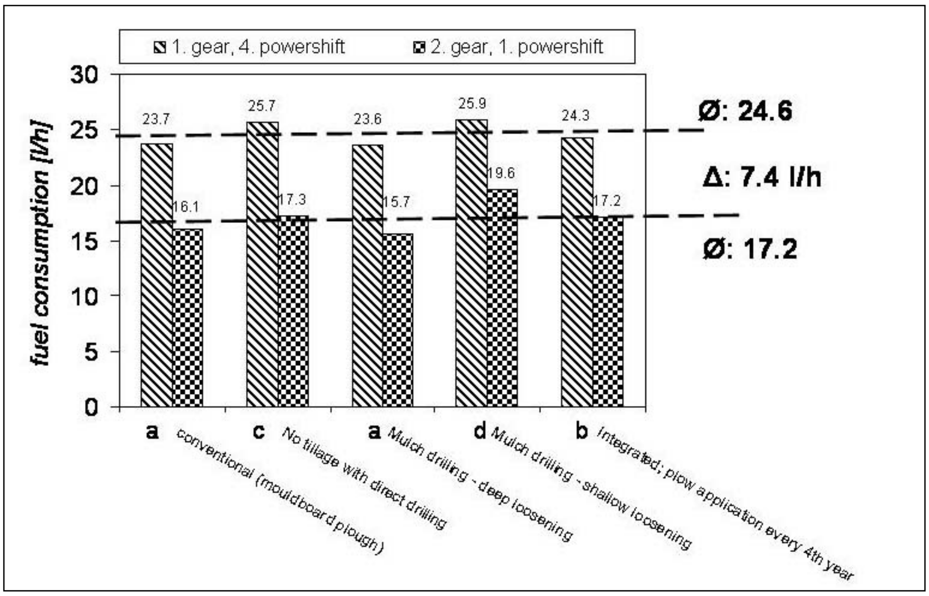

Fig. 3: Fuel consumption at subsoiling in different soil-tillage systems for two driving strategies. Miniscules indicate significant difference (Student-Newmann-Keuls-test; α=0.05) in fuel consumption in dependence of the soil-tillage system

Conclusion

Fuel consumption in crop production is an important cost factor. The competitiveness of plant production depends also on the utilization of fuel saving effects. A very efficient way for fuel consumption is the choice of driving-strategy, in which the optimal engine operating point should be realized.

Subsoil is a fuel-consuming repair measurement for harmfully compacted soils, which could be avoided by soil protection machinery operations.

	Field 1 sp 4-row harvester 4-row with rubber belt (f.) tank volume: 15 t Net weight: 29.5 t	Field 2 harvester 1-row tank volume: 4 t Net weight: 4.5 t
v_radar [km/h]	8.1	8.2
v_transmission sensor [km/h]	8.3	8.5
Slip [%]	2.6	3.0
Theor. field performance [ha/h]	2.4	2.5
Fuel consumption [l/ha]	7.6	7.1

Table 1: Mean process parameters at subsoiling on two adjacent potato-fields with different harvesting methods

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