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# Fuel Consumption in Agricultural Transport Activities

*The influence of load and driving speed on fuel consumption, while transporting 16.5 t of rapeseed with an all-wheel-drive tractor and two two-axle tipping trailers, was investigated. The fuel consumption rises [l/h] disproportionally with the driving speed. An optimal engine operation point, which could be reached with a high engine load, reduces the fuel consumption intensity [g/(t•km)].*

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**Keywords**

Agricultural transport, fuel consumption

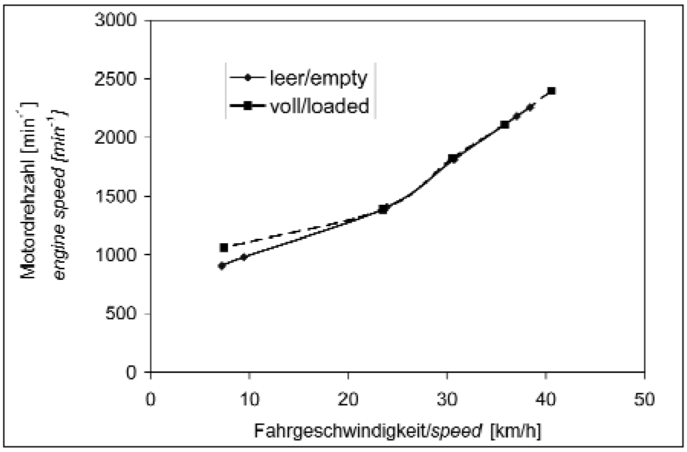


*Fig. 1: Engine speed versus driving speed and load*

Agriculture is an economic sector with high amounts of transport activities for inputs of agricultural products. For the most transport activities, tractors are used as drawing vehicles. Besides that transport with lorries becomes more important. According to BERNHARDT transport activities with lorris are cheaper alternatives, if the annual transport performance is more than 10.000 km [1]. Due to increasing transport costs, agricultural transport activities are subject in many research areas regarding optimisation of logistic concepts [2].

Besides the fuel consumption, the transport duration as well as the transport speed is of big economic relevance. This study was therefore initiated to investigate the influence of the transport speed and the loading condition on fuel consumption with tractor-drawn tipping trailers.

*Table 1: Masses moved for the transport drives (empty and loaded)*

| | load [kg] |
|---|---|
| Allradtraktor (92 kW)/ Four wheel driven tractor | 6.580 |
| 2-Achskipper 12 to/ 2-axle tipper 12 to | 3.700 |
| 2-Achskipper 10 to/ 2-axle tipper 10 to | 3.250 |
| Gesamtmasse leer/ total weight - empty | 13.530 |
| Transportierte Nutzmasse/ transported payload | 16.530 |
| Gesamtmasse beladen/ total weight - loaded | 30.060 |

## Material and Method

In summer 2007 the fuel consumption for the transport of 16.5 t rapeseed with two tractor-drawn two-axle tippers (*Table 1*) was measured on a flat road. The four-wheel driven tractor has a power shift transmission.

For the measuring of 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). Additionally the frequency signal of the engine speed was recorded.

The recorded data for one transport drive (empty and loaded) was separated in four (loaded transport drive) and five (empty transport drive) data sets and analysed. Each single data set represents a certain engine operating point and is characterised with a constant transport speed, constant engine speed and constant fuel consumption. Acceleration- and braking phases during the drive were therefore eliminated. As seen in *Figure 2, 3 and 4*, fuel consumption is the energy amount needed for overcoming the rolling resistance and in small portion the aerodynamic resistance. The unloaded and loaded transport drives were done for a certain transport speed with the same engine speed (Fig. 1) in order to determine the influence of the engine load on the fuel consumption.

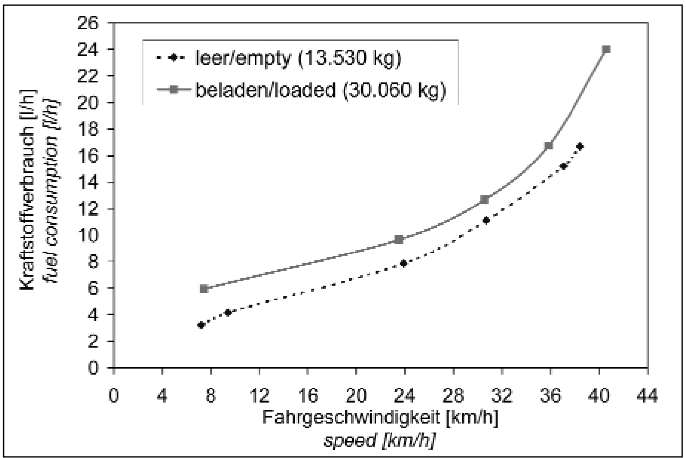


*Fig. 2: Fuel-consumption during transport of 16.530 kg rapeseed with two two-axle tipping trailers on a flat road, depending on speed and load*

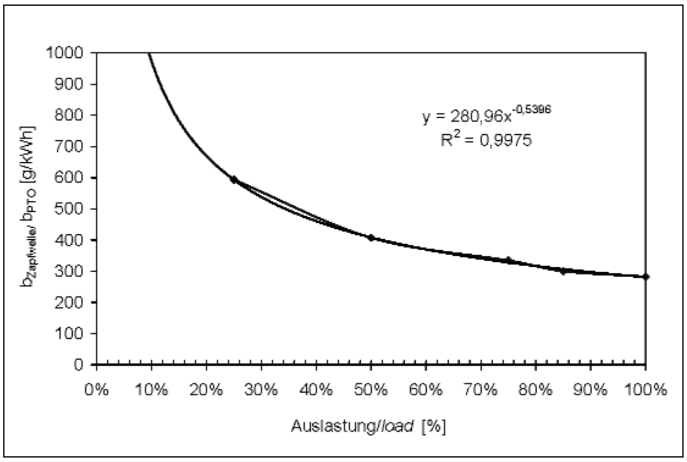


*Fig. 3: Specific fuel consumption of the engine ($b_{PTO}$) at different loads in the nominal rotation speed range (OECD-Test-Report [3])*

#### Influence of the load condition and transport speed

The fuel consumption increases in the loaded transport drive from approx. 6 l/h at 8 km/h to approx. 24 l/h at 40 km/h. In the unloaded transport drive, the fuel consumption is between 10 % (in the transport speed of 30 km/h) and 30 % (in the lowest and highest transport speed) lower than in the loaded transport drive (*Fig. 2*).

The fuel consumption of a tractor depends on the engine load under else equal circumstances [4]. With decreasing engine load, the fuel consumption rises (*Fig. 3*).

According to calculation of REHRL the transport of small loads is very inefficient and could not be compensated with a high transport speed [4]. This results from an unfavourable engine operating point, in which the specific fuel consumption is higher than in favourable operating points.

#### Fuel intensity at the transport

A parameter for the evaluation of the transport-energy intensity is the fuel consumption based on the transported payload and route with the unit l/(t•km). This parameter is as smaller the better the acceptable tipper load is used [4]. In the presented trial (*Fig. 4*) the fuel intensity has its minimum 20.9 g/(t•km) in the speed range between 25 and 30 km/h. From 30 km/h the fuel intensity increased due to the suboptimal engine load (*Fig. 4*).

#### Conclusion

Fuel saving transport with tractor drawn tippers requires the operation of the engine in an optimal engine operation point, which can be achieved with a high engine load.

Via the tractor transmission, the driving speed and consequently the engine load can be controlles. A practical indicator for fuel-saving engine operation is the engine speed which is for the most engines at 70 to 80 % of the nominal engine speed.

## Literature

Books are marked by •


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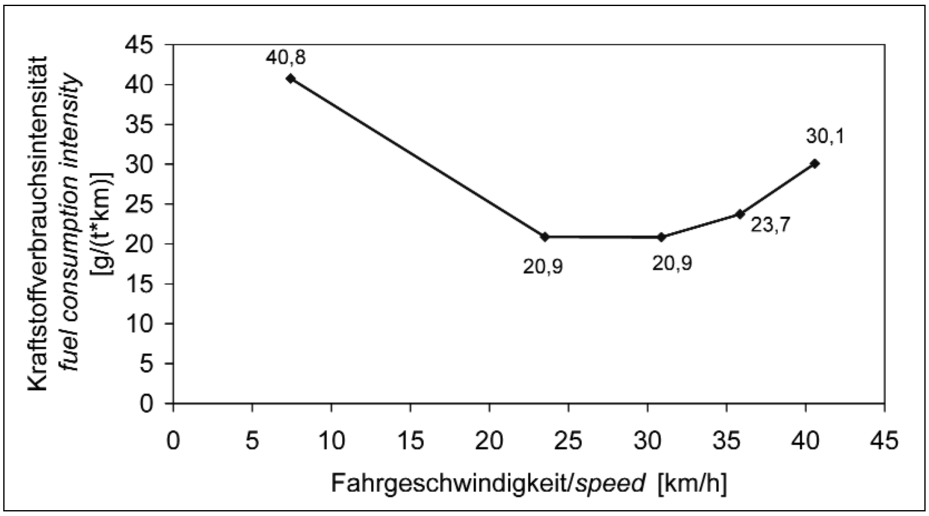


*Fig. 4: Fuel consumption intensity during transport of 16,530 kg rapeseed with two two-axle tipping trailers on a flat road, depending on driving speed*