AgEng Oslo 98 — EurAgEng

Paper no: **98 - A - 131**

PORTUGAL

"Tractor Performance Monitors optimizing tractor and implement dynamics in tillage operations - one year of field tests"

(Project sponsored by the Programme supporting the modernizing of portuguese agriculture and forestry - PAMAF)

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ABSTRACT

The relative weight of the variables present in the dynamics of tractor-soil-trailed disc harrow is studied under real agricultural conditions. Input parameters (tractor ballast; implement size; transmission gear) are made variable, within limits accepted by farmers. The results are analysed in terms of fuel consumption per unit area in two sand based soils at moisture content accepted for disc harrowing.

OBJECTIVES

-Evaluation of different paired relations of tractor weight/implement width, building up a matched set;
-The effect of "gear-up, throttle down" on fuel consumption per hectare.

INTRODUCTION

Most of the research all over the world, with engines, tyres and fully instrumented tractors has been building up a package of valuable information. However, the practical impact of some of these results is difficult to assess due to the particular input conditions of the experiment. On the other hand, Tractor Performance Monitors (TPM), are increasingly being supplied as standard equipment, or factory-fitted option, and they can provide an excellent base to perform experiments in real working conditions and to use the gathered data to validate the real importance of the different variables present in the dynamics of tractor-soil-agricultural implement.
TPM have the fundamental advantage of being an equipment also used by the end user of the research results, making possible, inclusively, to perform demonstration experiments at the farmer's own premises.

MATERIAL AND METHODS

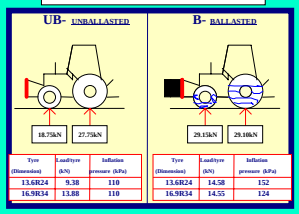
TRACTOR

A four-wheel-drive (4WD), 59kW (DIN), Massey-Ferguson 3060 Datatronic tractor, was used. This tractor is factory equipped with a tractor-performance-monitor (TPM), which, among other functions, provide relevant information such as: engine speed, actual forward speed, slip and fuel consumption per hour.

Data Acquisition System -DAS

Information provided by the TPM is volatile. To overcome this limitation a portable computer based record system was developed, which deviates the signals from the tractor TPM sensors and also collects the information from a load cell based pull measuring system.
The adopted solution consists on a portable computer equipped with a data acquisition board and a terminal board providing the appropriate connection and the voltage excitation for the 50 kN capacity load cell.

TRACTOR BALLAST



Tyre (Dimension)	Load/tyre (kN)	Inflation pressure (kPa)
13.6R24	9.38	110
16.9R34	13.88	110

Tyre (Dimension)	Load/tyre (kN)	Inflation pressure (kPa)
13.6R24	14.58	152
16.9R34	14.55	124

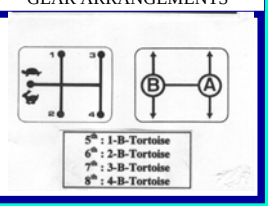
IMPLEMENTS: Trailed disc harrows

Harrow	Diameter disc (mm)	Number of discs	Static weight per disc (daN/disc)	Disc spacing (mm)	Max. Working width (mm)
H1	610 (24")	20	65	230	2350
H2	610 (24")	24	61	230	2750

TEST PROCEDURE

The combinations of gear and throttle used were:
-in the first combination an engine speed of 1750 r.p.m. (80% of the rated speed) was imposed, and the operator was asked to choose the highest gear that could pull the implement with no risk to his safety and comfort, and with no significant decrease in engine speed;
-in the second combination the operator was asked to shift to the immediate lower gear speed and at the same time speeding up the engine (approximately 90% of the rated speed) in order to keep the same tractor actual forward speed.
Even though in reverse order, these two combinations will show the "gear-up/throttle down" effect.

GEAR ARRANGEMENTS



RESULTS AND DISCUSSION

SÍTIMA - SANDY LOAM

Undisturbed
Mc =9.7% (d.b.)

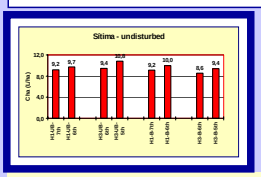
Disturbed (Cultivated at 20cm depth)
Mc =10.5% (d.b.)

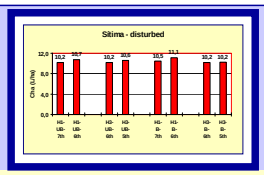
LAGOA - TRANSITION OF SANDY CLAY LOAM TO LOAMY SAND

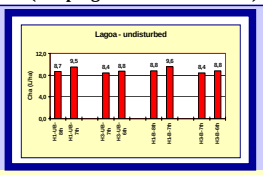
Undisturbed
Mc =9.7% (d.b.)

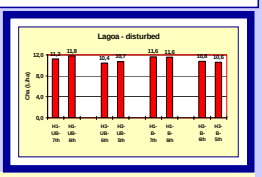
Disturbed (Ploughed at 30cm depth)
Mc =15.7% (d.b.)

The effect of GUTD on Fuel consumption per hectare (Keeping the same work rate)



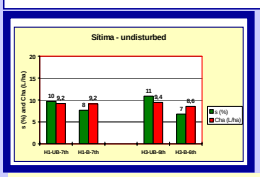


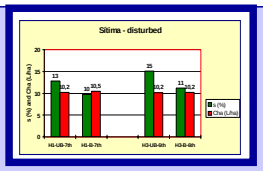


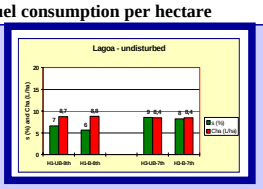


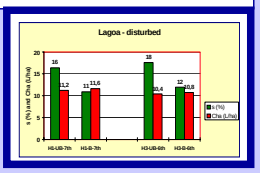
Figures show that the effect GUTD alone in the Cha, however small, is within the expected trend of reducing the fuel consumption per unit area. This is a consequence of the engine being operated in the vicinity of maximum power and at high speed, where the variations in terms of fuel efficiency are relatively small.

The effect of tractor ballast on slip and on fuel consumption per hectare









The green plots show the expected effect of ballast on reducing tyre slip. The general low values of slip, confirm that traction conditions in all the experiments were good. In a typical slip/tractive efficiency curve, these conditions correspond to the top flattest part, where tractive efficiency is relatively constant and unaffected by slip. With small variations in the values of tractive efficiency, it is reasonable to expect, also a small variation in the values of Cha, as shown by the red plots.

CONCLUSIONS

To reflect situations feasible to common agricultural practice, the input conditions imposed (ballast; soil type and soil condition, gear, implement size), only cover a narrow range of values. This resulted in small variations of the working rate and fuel consumption per hectare, however in the expected trend. Within a realistic value of work rate, two possible combinations of engine speed and gear ratio could be used. Between the two, the effect of GUTD, however small, could be noticed in the right trend, providing a small save in fuel consumed per hectare.
Due to the good traction conditions found, the presence of ballast was found to be of no worth.
The 24 disc implement performed better both in terms of work rate and fuel consumption per unit of worked area, however by a small difference, relative to the 20 disc harrow, making the larger implement a better choice.