TEKA Kom. Mot. Energ. Roln. – OL PAN, 2007, 7, 122–128

BALANCING OF WORKING INDICATORS OF AGRICULTURAL TRACTOR AS THE WAY TO IMPROVE THE EFFICIENCY OF FARMING

Adam Koniuszy

Basic Technique Department, Agricultural Academy in Szczecin,
Papieża Pawła VI Str. 1, 71-459 Szczecin, Poland, e-mail: adamkoniuszy@agro.ar.szczecin.pl

Summary. In this article we show the results of the exploitation research of the agricultural tractor U 912. The selected indicators of the exploited agricultural tractor were balanced and compared in two one-month agricultural periods. During the first research period the tractor worked as a transport vehicle, and during the second period – took part in post-harvest crops. The results were shown in the form of time courses of chosen parameters as well as one- and two-dimensional frequency characteristics. Essential participation of idle running working time of the engine was found, which matched the distribution of power and showed that it is not optimally utilized while the tractor is working on the studied farm.

Key words: agricultural tractor, exploiting, working indicators, balancing

INTRODUCTION

Agricultural tractors empirical tests in conditions of real exploitation bring on the ability of achieving a certain amount of important pieces of information, which after the proper interpretation, can effect in improvement of farming effectiveness. Analysis of the acquired tractor's working indicators allows to show the efficiency of its use in farming, which helps to optimize the fleet of tractors and machines.

Another important reason to achieve the information, especially on the fuel consumption, is the evaluation of the engine working economics and exhaust gases emission, whose main source in agriculture are tractors. As the research indicates, the statistic data in this field are really scarce [Hansson *et al.* 1999, 2001].

Current measuring technique allows to decrease the amount of work in the field research which results in more and more frequent use of foreseeing and modelling of the processes taking place during the exploitation of the tractor.

The main target of the research was balancing and comparing of the chosen working indicators of the tractor U 912 exploited in two different agricultural periods.

RESEARCH METHODS

A two-month exploitation period of a tractor U 912 in one of the agricultural farms in West Pomeranian Region was the subject of the research. The tractor worked for 1819 minutes as the means of transport during the first month and for 1685 minutes in post harvest crops, during the second month of investigation. During this period the effective time of work of the tractor, fuel consumption, engine load, rotational velocity of the crankshaft and the position of the tractor were registered. A TRS – 1 (Tractor Recording System) device, designed and made by the Basic Technique Department of the Agricultural Academy in Szczecin, was used. TRS – 1 measures and registers the above mentioned parameters in real time without any maintenance of the tractor user. Properly installed module of the registering device activates itself automatically as the engine starts and turns itself off when the engine stops. Registered quantities can be saved on some data recording device or sent directly to a computer base by some transmitting device. The number of possible data collected on this data carrier corresponds with 2000 working hours that is ca 4 years of intensive exploitation of the tractor. With the direct transmitting of data to the computer the time of work of the device is unlimited. There is also possibility of registering and monitoring the data measured from more than one device at a time. Thorough specification together with the description of the device can be found in the patent application in The Polish Patent Office.

RESEARCH RESULTS

Registered indicators of the agricultural tractor have been presented and compared in the form of changes of chosen parameters in time and one- and two-dimensional frequency characteristics.

The velocity of the tractor was the first of the analysed factors. Fig. 1 and 2 present changes of velocity of the tractor under research.

Big variation of the tractor's speed working as transportation vehicle (Fig. 1) was the result of roads infrastructure on the agricultural farm which resulted in frequent changes of the speed, accelerating and breaking.

During the work in post harvest crops, in a longer, compared to Fig. 1, time, stable ranges of velocity were being kept, especially in the intervals 4–6 km/h (Fig. 2). Those were the velocities most frequently used in field works in most cultivation technology measures.

Analysis of velocity distribution shown in Fig. 3a and 3b allows to state that in both kinds of work the essential participating part is in characterized by the range 0–5 km/h. Participation of this range of velocity in post harvest crops was the highest and took 52% of the exploitation time. As it was said earlier this fact results in the first place from cultivation technology factors, but also from the arrangement of fields under cultivation on the farm and in consequence the need to do many u-turns and aggregation of numerous equipment [Banasiak *et al*. 2002].

Distribution of fields under cultivation where the agro-technical measures are being taken on the farm shows the registered trajectory of the tractor movement (Fig. 4).

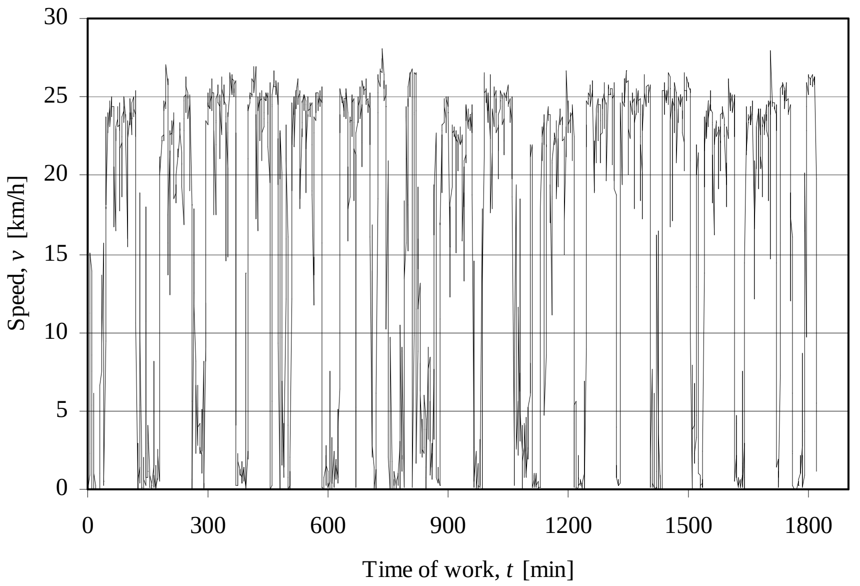

Fig. 1. Changes of the tractor velocity in time during transportation works

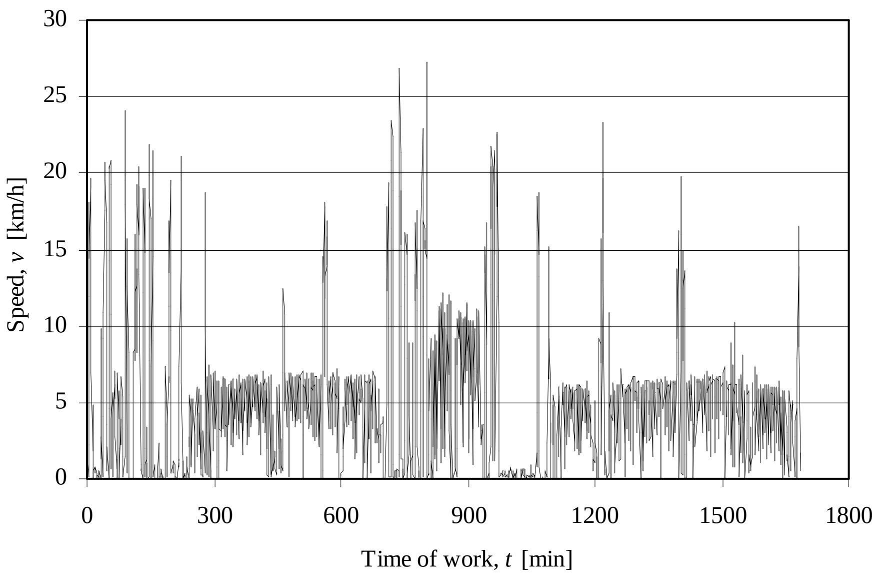

Fig. 2. Changes of tractor velocity during the post-harvest crops

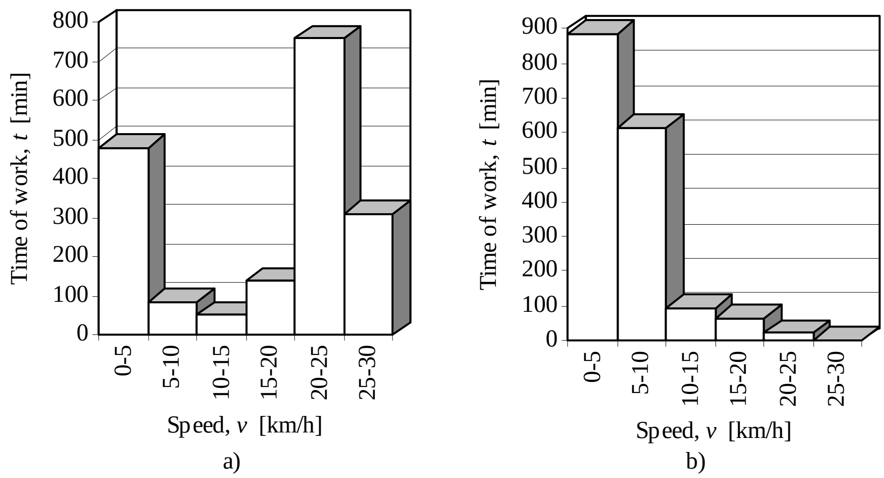

Fig. 3. Velocity distribution of the tractor during; a) transportation works, b) post harvest crops

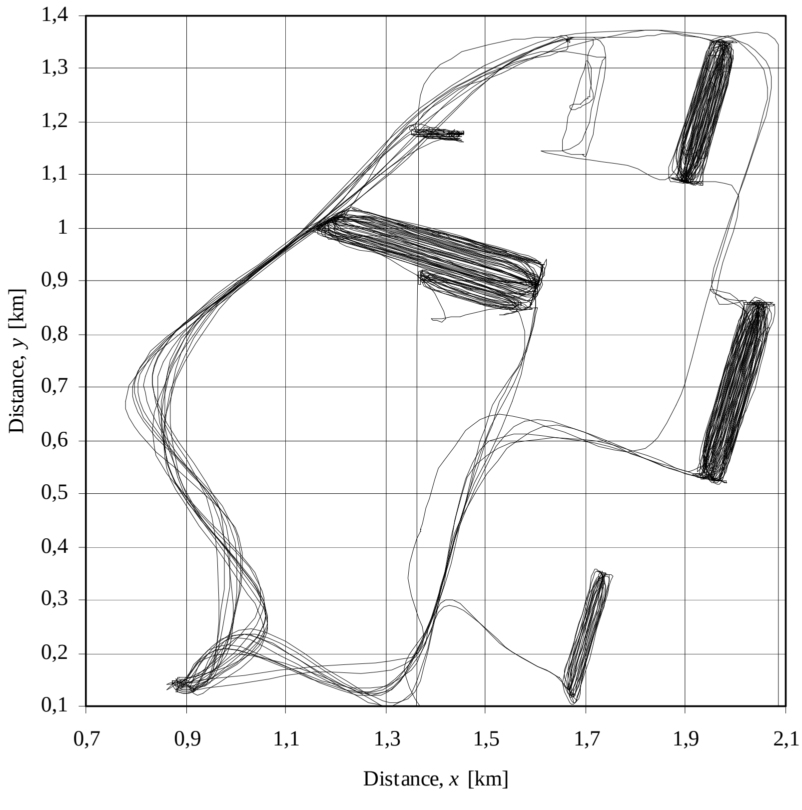

Fig. 4. Trajectory of movement of the tractor under research in the period of post harvest crops

The trajectory of tractor U 912 movement, shown in Fig. 4 complicated organization of works in which it took part. That might have led to the decrease in farming effects [Yule *et al.* 1999].

A second variable, identifying the rotational speed of crankshaft was introduced in order to balance the information about the power development of the tractor under observation. This allows us to achieve a two dimensional power distribution dependant on the most frequently used rotational speed of the crankshaft.

The engine under observation worked in transportation for the longest period, that is 19% of exploitation time, at the rotational speed of engine crankshaft in the range of 2000–2200 r.p.m. and corresponding power range of 10–15 kW. That is mere 17–26% of the rated power in this range of rotational speed of the engine.

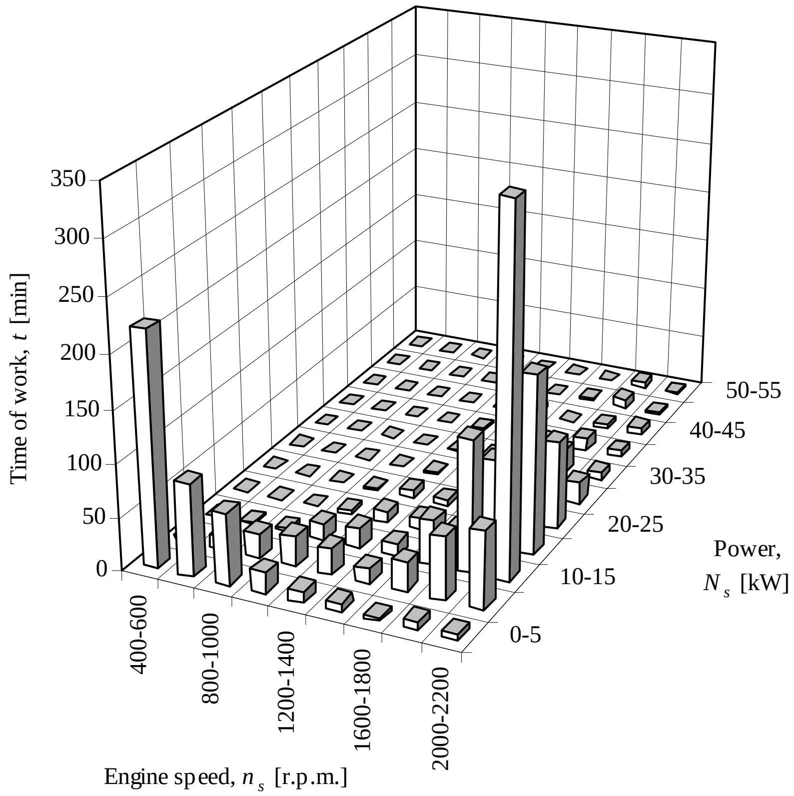

Fig. 5. Two-dimensional power distribution of an engine as a function of rotational speed of the crankshaft during transportation works

The engine under observation worked in post harvest crops for the longest period, that is 16% of exploitation time at the rotational speed of engine crankshaft in the range of 400–600 r.p.m. and power range of 0–5 kW (Fig. 6).

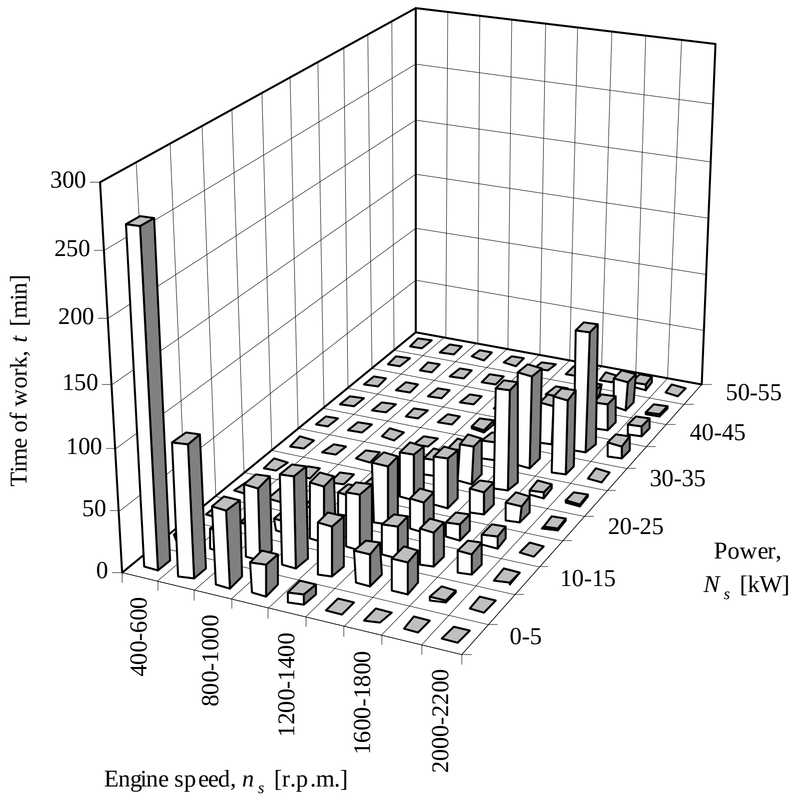

Fig. 6. Two-dimensional power distribution of an engine as a function of rotational speed of the crankshaft during post harvest crops

In both cases of the analysed works, no matter what kind of work the tractor was doing, essential participation of rotational speed and characteristic loads of idle run of the engine has been confirmed. It came out as a result of the tests that the tractor under research was not effectively exploited during the essential part of the work time. Similar distribution of rotational speed of the crankshaft, without measuring the load, was achieved during the exploitation survey of the engine 359 M which is being used in the STAR 1142 vehicle. The author's conclusions also confirmed essential participation of the idle run of the engine in the general time of exploitation [Czarnigowski *et al.* 2002].

Based on the conducted research I would like to state that drawing attention to the ranges of some utility indicators characteristic of a certain type of a tractor is justified. Such indicators as: driving speed, rotational speed of the crankshaft, power of the engine, etc, can be a valuable source of information in official certification research, durability tests or in optimization procedures of the tractor or engine at the production stage [Ambroziak and Piasta 1988, Wisłocki 1989].

The presented analysis is based on one example of agricultural farm. Still, it allows to draw conclusions important for the optimization of work of an agricultural tractor on this farm.

CONCLUSIONS

1. Distribution of driving velocity of the agricultural tractor under research points out at essential participation of intermediate activities, especially in the post harvest crops, that is aggregating of equipment, u-turns, etc.
2. Participation of rotational speed and loads characteristic of idle run of the engine is essential, and this shows that the agricultural tractor under research was not effectively exploited during substantial part of the work time.
3. Distribution of engine load during work in transportation and post harvest crops, in the field of power supply, indicates clearly to its not full and not optimal usage.
4. To improve the efficiency of utilization of agricultural tractors, its work in light field works should be limited, increase or consolidation of fragmented soil areas of field crops should be done and in this way favourable for mechanization agricultural farm infrastructure could be achieved.

REFERENCES

Ambrozik A., Piasta Z. 1988: Ocena pracy silnika spalinowego w oparciu o uogólnioną użyteczność jego wskaźników. Silniki Spalinowe 4, 33–36.

Banasiak J., Bieniek J., Detyna J. 2002: Aktualne problemy użytkowania maszyn rolniczych. Eksploatacja i Niezawodność 2 (14), 63–72.

Czarnigowski J., Droździel P., Kordos P. 2002: Charakterystyczne zakresy prędkości obrotowych wału korbowego podczas pracy silnika spalinowego w warunkach eksploatacji samochodu. Eksploatacja i Niezawodność 2 (14), 55–62.

Hansson P.-A., Lindgren M., Noren O. 2001: A comparison between different of calculating average engine emissions for agricultural tractors. J. Agr. Eng. Res. 1 (80), 37–43.

Hansson P.-A., Noren O., Bohm M. 1999: Effects of specific operational weighting factors on standardized measurements of tractor engine emissions. J. Agr. Eng. Res. 74, 347–353.

Wisłocki K. 1989: Rozkład warunków pracy w optymalizacji silnika spalinowego i pojazdu. Silniki Spalinowe 4, 26–33.

Yule I. J., Kohnen G., Nowak M. 1999: A tractor performance monitor with DGPS Capability. Computers and Electronics in Agriculture 23, 155–174.