

INVESTIGATIONS OF THE POWER RATING POTENTIAL OF AGRICULTURAL TRACTORS IN CONDITIONS OF AGRICULTURAL FARMS IN THE REGION OF WIELKOPOLSKA

Summary

The aim of the study was to assess the level of equipment in agricultural tractors of selected agricultural farms in Wielkopolska. The assessment of the level of farm equipment was based on the power rating saturation index calculated per area unit of arable land (AL). Depending on the farm area group, the value of the determined tractor power rating potential in conditions of the examined farms ranged from 1.4 to 6.2 kW·ha⁻¹. The most correct trend was observed in agricultural farms whose area exceeded 100 ha of arable land because in the case of those farms, the tractor power rating saturation index reached 1.4 kW·ha⁻¹ confirming rational level of equipment of those farms in tractors and their proper utilisation.

BADANIA POTENCJAŁU MOCY NOMINALNEJ CIĄGNIKÓW ROLNICZYCH W WARUNKACH GOSPODARSTW ROLNYCH W REGIONIE WIELKOPOLSKI

Streszczenie

Celem pracy była ocena stanu wyposażenia w ciągniki rolnicze wybranych gospodarstw rolnych w regionie Wielkopolski. Miarą oceny wyposażenia gospodarstw w ciągniki jest wskaźnik nasycenia nominalnej mocy ciągników w przeliczeniu na jednostkę powierzchni użytków rolnych (UR). W warunkach badanych gospodarstw wartość wyznaczonego potencjału mocy ciągników wynosiła od 1,4 do 6,2 kW·ha⁻¹, w zależności od grupy obszarowej gospodarstw. Najbardziej prawidłowa tendencja wystąpiła w gospodarstwach powyżej 100 ha UR, ponieważ wskaźnik nasycenia mocy ciągników wyniósł 1,4 kW·ha⁻¹. Świadczy to o racjonalnym wyposażeniu gospodarstw w ciągniki i dobrym ich wykorzystaniu.

1. Introduction

The principal source of mechanical tractive force in domestic farming is agricultural tractors. According to the 2007 survey, the total number of tractors in Polish agriculture amounted to 1 543 000 [1]. One of the measures of the qualitative equipment of agriculture in tractors is mean tractor horsepower rating. Similarly to trends observed in developed countries, also in Poland we can observe an increase of the mean tractor horsepower rating [4]. It was estimated on the basis of literature data that in years 2000-2007, the mean tractor horsepower rating increased by 25.2% and, at present, it stands at 39.8 kW [1].

Contemporary agricultural tractors frequently transfer most of their power by means of the power-take-off shaft and hydraulic system of power transmission rather than by the coupling system. Therefore, the working capability of a tractor should be assessed on the basis of its power rating and power should be considered as its main "size" or "magnitude" parameter. In addition, for economic reasons, the power of an agricultural tractor to be purchased for a given farm should be selected taking into account its area as well as the type and conditions of work to be performed by the tractor during the whole year at appropriate agrotechnical dates. The above-mentioned problems are crucial because - in the result of maladjustment of the power structure of the type of series of agricultural tractors to farmers' requirements - operational costs of tractors increase and, consequently, specific economic losses are incurred leading to increased costs of agricultural production. That is why, when assessing the state of farm equipment in agricultural tractors, one of important parameters to be taken into consideration is the horsepower potentials of tractors used in a given farm in relation to the area of arable land.

2. Research objective

The main aim of the investigations was to assess horsepower rating potentials of agricultural tractors used in conditions of agricultural farms situated in the region of Wielkopolska. In addition, the obtained empirical results were compared with appropriate data connected with the saturation tractor power in Polish agriculture.

3. Research methods

Investigations on tractor horsepower potentials were carried out in 2008 in 16 agricultural farms situated in various administrative districts of Wielkopolska Voivodeship. Farms for investigations were selected purposefully because they guaranteed the most comprehensive collection of the required data. In addition, the selected farms fulfilled the criterion of availability of sample elements [3].

The discussed investigations comprised 16 farms of different areas. The most numerous group - 7 farms - represented farms from the group of 50 to 100 ha of arable land, whereas the remaining farms fell into one of the following area groups: 15 - 20 ha - 3 farms, 20 - 50 ha - 2 farms and the group of farms exceeding 100 ha - 4 farms. The mean farm area of the examined farms amounted to 66.6 ha.

In the course of the performed experiments, the author collected information about the number of tractors operating in a given farm as well as the horsepower rating of all the tractors used in individual farms [5]. On the basis of the obtained set of data, the tractor potential horsepower rating index was determined and calculated per unit area of arable land (AL).

4. Research results and discussion

The collected set of data was used to elaborate Table 1 which presents the state of equipment of individual farms in agricultural tractors as well as the potential horsepower rating of tractors operating in farms under investigations.

The total of 39 tractors worked in the examined agricultural farms with the number of tractors operating in individual farms ranging from 1 to 4 and their horsepower – from 22.4 to 106.6 kW. The area of land that fell to one tractor amounted to 27.3 ha and was considerably higher in comparison with average Polish agriculture. According to the data from the National Census of 2002, one tractor serviced 12.4 ha [2], so the above figure of 27.3 ha indicates a considerable degree of tractor operational intensity in the examined farms.

Mean horsepower rating of tractors in individual farms ranged from 45.8 to 106.6 kW, whereas in the entire population of the examined tractors - the power rating amounted to 73.3 kW. The determined considerable high mean value of the mean horsepower rating was the result of purchase by farmers of tractors of high power – usually over 60 kW. Tractors with rated power exceeding 60 kW made up 66% of all the tractors used on the examined agricultural farms.

Table 2 presents the distribution of the tractor horsepower rating potentials depending on area groups to which the examined agricultural farms were assigned. The highest

resources of tractor horsepower rating were found in the group of farms with areas ranging from 50 to 100 ha. These resources amounted to 1401.8 kW and constituted more (53%) than half of the total potential of the rated power of the examined tractors. Figure 1 shows percentage structure of the tractor horsepower potential in individual area groups of arable land in the farms under investigations.

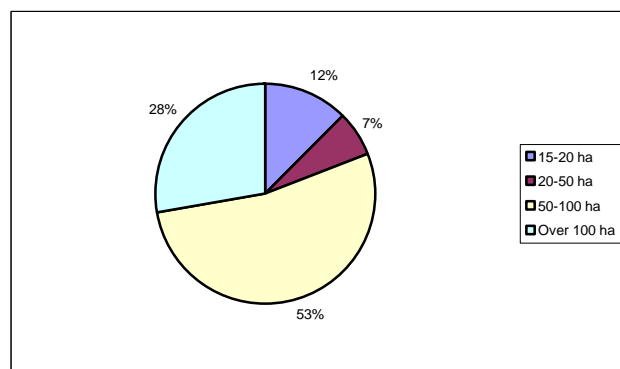


Figure 1. Percentage structure of the tractor power rating potential in individual area groups of arable land in the farms submitted to the investigations (Source: Author's own investigations)

Table 1. Potential power rating of agricultural tractors operating in the examined farms

No. of examined farm	Area of farm arable land [ha]	Number of tractors [pcs.]	Tractor power rating potential [kW]	Mean tractor power in a given farm [kW]
1	120	4	272.4	68.0
2	160	2	194.4	97.4
3	60	3	225.7	75.2
4	72	2	150.7	75.4
5	58	3	203.7	67.9
6	18	2	114.0	57.0
7	29	2	125.0	62.5
8	55	3	155.9	52.0
9	15	3	137.5	45.8
10	65	2	172.8	86.4
11	70	2	172.8	86.4
12	69	4	316.2	79.0
13	20	1	72.2	72.2
14	130	4	198.5	49.6
15	100	1	106.6	106.6
16	25	1	51.5	51.5

Source: Author's own investigations

Table 2. Tractor power rating potential in individual area groups of the examined farms

Area group of farms [ha]	Number of farms in group [pcs.]	Area of arable land [ha]	Tractor power potential in area group	Number of tractors [pcs.]	Mean tractor power potential in area group [kW]
15 – 20	3	53	328.7	6	54.8
20 – 50	2	54	176.5	3	58.8
50 – 100	7	444	1401.8	19	73.8
Over 100	4	510	730.1	11	66.4

Source: Author's own investigations

Using data from Table 2, values of the horsepower rating saturation index were determined in individual area groups of the examined farms. The results of the performed calculations are presented below in a graphic form (Fig. 2).

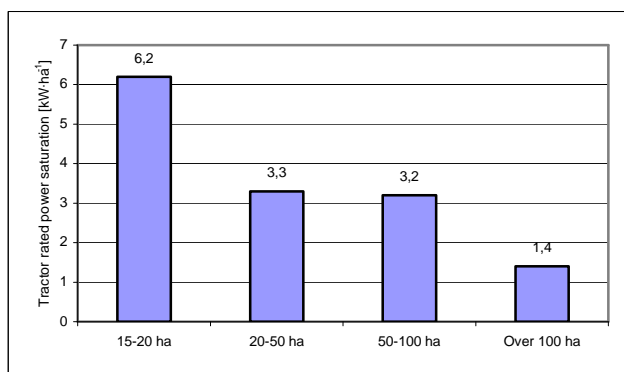


Figure 2. Value of the power rating saturation index in individual area groups of the examined farms (Source: Author's own investigations)

The determined mean values of tractor rated power saturation index presented in Figure 2 ranged from 1.4 to 6.2 kW·ha⁻¹ and they were found to decrease together with the increase in the surface of area groups to which the examined farms were allocated. According to appropriate literature, the value of tractor horsepower rating potential should not exceed 4 kW·ha⁻¹. It is commonly assumed that if the above value is exceeded, we observe excess of tractors in a given farm and costs of tractor operations increase [2]. Therefore, it can be said that the best relationship occurred in the group of the biggest farms (over 100 ha) because the tractor rated power saturation index in those farms amounted to 1.4 kW·ha⁻¹. This value indicates good tractor utilisation and testifies to farm rational management practices. On the other hand, the least desirable tendency was recorded in the group of farms with the area of 15-20 ha because the tractor horsepower rating potential calculated per unit areas of arable land amounted to 6.2 kW·ha⁻¹. A considerable value of the power rating saturation index resulted from maladjustment of the tractor power structure to the needs of the examined farms.

5. Conclusions

On the basis of the performed empirical investigations as well as the analysis of the obtained results, the following conclusions were drawn:

1. The area of arable land per one tractor can be treated as a measure of quantitative equipment of tractors in agriculture. However, differing power ratings of tractors make comprehensive comparison of farms regarding their equipment in tractors impossible. Therefore, determination of the power potential on the basis of tractor horsepower rating as well as the number of tractors of a given power appears to be a more objective parameter for the assessment of the state of agriculture of individual farm equipment in mechanical tractive force.

2. In conditions of the examined farms, the value of the determined tractor power potentials ranged from 1.4 to 6.2 kW·ha⁻¹, depending on the area group of farms. The obtained values decreased with the increase of the arable land area. From the point of view of machine work economics in agriculture, the most desirable tendency was recorded in farms more than 100 ha in arable land area because in such situation the tractor horsepower rating saturation index reached 1.4 kW·ha⁻¹. This confirmed rational equipment of some farms in tractors and their appropriate utilisation.

3. Tractor horsepower rating saturation in the group of the smallest farms (15-20 ha AL) exceeded 4 kW·ha⁻¹ indicating excess of tractors and low level of their utilisation. Further increase in tractor numbers in those farms results in excessive cost increases of machine work involving tractor use. It seems more appropriate to replace the existing tractors by ones with more rationally selected horsepower ratings. This refers, in particular, to those tractors which have already exceeded their recommended period of utilisation but are still used in conditions of the examined farms.

6. Literature

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