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IMPACT OF TRANSPORT INFRASTRUCTURE ON TRANSPORT ACCESSIBILITY OF FARMS

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Abstract

The paper analyses potential applications of modern car transport on farms with area over 20 ha agricultural land (AL). A vast majority of farms are capable of using transport by means of truck with load capacity between 8 and 10 tons. The greatest difficulty is a possibility of performing a safe 360° turn. In this respect only 45.90% of farms have this option, however their percentage is growing with increasing farm area. On the other hand, in case of on average 21.31% of the analyzed farms the entrance may be hindered at some times due to the access from a field track. The width of the entrance gate and the culvert bridge bearing capacity (in 8.20% it was too low) have only slight influence on the discussed issues.

Keywords: farm transport accessibility, transport, truck, kind of the road surface, entrance

INTRODUCTION

Agricultural transport, due to various conditions in which it is performed, diversity of carried loads and different techniques and technologies of transportation has a marked influence on the expenditure on agricultural farms. Results of research on the rate of use and connected expenditure level presented by many authors clearly indicate that the scope of transport works, available means and their use differ considerably (Kokoszka, Tabor 2006; Lotencowicz 2007; Paraf-

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iniuk 2006). Some tendencies to reduce the expenditure visible in the performance of transport techniques are also perceivable in the agricultural transport. In the first place they include increasing the means of transport load capacity and increasing the speed of their movement (Kokoszka 2007).

At the same time, application of modern transport techniques – heavy goods vehicles is determined by the working conditions resulting from the transport infrastructure in rural areas and agricultural farms as such (Myczko et al. 2012; Wójcicki 2009). All elements of transport infrastructure, both linear (roads) and point ones, so called transport hubs (loading and unloading sites and places of generating transport weigh) basically affect the expenditure, but also the selection of means of transport (Kokoszka 1995; Kokoszka 1996). Simultaneously, these elements determine so called transport accessibility – applicability of a given technique – the means of transport.

AIM AND SCOPE OF WORK

Because of the changes which occur in agriculture concerning the farm area and farm commercial character, the paper aims to analyze potential application of modern transport techniques regarding the farms accessibility. Transport accessibility is understood as the possibility for heavy goods vehicles to enter the farm premises. The analysis was conducted for selected farms. The analysis covered 61 farms located in the Malopolskie province, with area over 20ha AL. The selection was determined by the fact that only such farms generate the transport weight to guarantee the adequate use of the means of transport. At the same time, regarding the rate of load capacity use, they allow for efficient utilization of means of transport with assumed load capacity, since about 48% of one-time carried loads weigh over 5 tons (Parafiniuk 2006).

Car transport by means of vehicles with 8-10 Mg load capacity was considered as a modern transport technique. The elements of infrastructure directly determining potential applicability of assumed transportation technique were used for the analyses.

The farms owners' children, students of agricultural colleges declare taking over the family farms after completing their education. Therefore, it may be supposed that these farms are or will be developing. Due to a considerable diversity of the basic type of agricultural production – the arable land area, the analyzed farms were divided into three area groups (which represent the agricultural structure of huge farms in the Malopolskie province):

- 20.00 – 50.00 ha AL 41 farms – 67.21%
- 50.01 – 100.00 ha AL 15 farms – 24.59%
- Over 100.00 ha AL 5 farms – 8.20%.

MTERIAL AND METHODS

The research was conducted on the basis of guided interview and direct assessment of the state of analyzed parameters. Objects of analysis were selected purposefully, basing on the stated willingness to conduct agricultural production on the same level, or often declared increasing it. One of the main questions of the interview concerned the current state of transport infrastructure. In case of linear infrastructure it referred to the distance and quality of access roads to the fields, supply and sales markets. Regarding the point infrastructure, analyzed were the sizes and accessibility of fields and farm facilities, the size of buildings generating transport weight, farm accessibility and the size of its yard – as the maneuvering area for the means of transport, which would enable using a given vehicle.

Analysis of transport roads (particularly for inland transport) was conducted according to the methodology suggested by Hopfer (Hopfer et al. 1980). The methodology was applied to determine an average class of road assuming the following conversion factors:

a) average asphalt road – class 2 (medium quality asphalt surface or gravel)
b) hard-surfaced road (road-metal, gravel, unpaved reinforced road – on average class 3.5 (medium quality gravel surface or reinforced unsurfaced road),
c) unpaved (dirt) road, on average class 6.6 (from dry unpaved to very poor quality dirt road).

Analogously to the adopted road classification, conversion factors were assumed for the distances covered on various class roads in relation to the asphalt surface in good quality, excluding the road slope (assuming a horizontal course of the road): a = 1.5000, b= 2.8125, c= 10.2830 (Hopfer et al. 1980).

The assessment of the yard as a maneuvering area, on which most loading activities are performed, was based on its dimensions enabling a truck with load capacity over 5 tons a 360 degree turn. This area should be a square with a side 17 m (8m radius and 1m safety zone) (Siwulec 2008; www.Katalog.wp2012). If dimensions of the square (meaning yard dimensions) are smaller than a double turning radius such a yard was considered as inaccessible for the given mean of transport.

RESULTS

Average size of the investigated farms was 51.95 ha AL (Table 1), however a considerable diversification (from 29.46 to 190.20 ha) was observed among the determined area groups and within the appointed groups. It was found a high

proportion of land under lease – on average 38.86%. It evidences that farms owners regard agricultural production as their future. The analysis of available traction – installed power 4.35kW ·1ha^{-1}AL reveals a definitely declining trend with growing farm area, which is the right tendency. The number of load box trailers per 100ha AL at the average number of 9.84 reveals a marked decreasing tendency. At the same time, the number of means of transport expressed by the unit load capacity from 3.54 to 4.65 Mg per vehicle shows a 35% growth. Taking into consideration a higher efficiency of means of transport with higher load capacity, it may be regarded a positive phenomenon. It should be added that the analyzed farms also possessed special means of transport, such as silage transporters, load box trailers or platform trailers.

Table 1. Characteristics of the analyzed farms

Specification	Unit	Farm area ha AL.			
		On average	20.00-50.00	50,01-100.00	over 100.01
Area AL.	(ha)	51.95	29.46	67.36	190.20
Per cent of leased arable land	(%)	38.86	33.05	52.23	46.44
Installed power	(kW·1ha^{-1} AL)	4.34	5.21	2.87	1.61
Means of transport					
Pieces per 100 ha AL*	(pcs. /100ha^{-1} AL)	9.84	12.23	5.86	2.23
Percent of farms owning a truck	(%)	6.56	2.44	13.33	20.00
Ton per 100 ha AL	(Mg·100ha^{-1} AL)	33.00	46.00	9.00	1.00
Average means of transport load capacity	(Mg)	3.79	3.54	4.16	4.65

* delivery vans, trucks, load box trailers and tow tractors.
Source: Author's own studies

Currently only 4 farms in the analyzed sample – on average 6.56% possess trucks (3 have cars with load capacity 8 Mg and 1 with 5 Mg capacity). However, about 30% of the interviewed farmers saw the necessity to replace the tractor aggregates with car transport, particularly in the external transport.

One of the basic elements – components of transport infrastructure influencing the potential applications of modern car transport techniques is the linear infrastructure, i.e. roads. The road surface in some seasons of the year determines the use of means of transport with higher load capacity (considering its so called bearing capacity), but also possible passage. Therefore, characteristics of roads on the investigated farms were presented in Table 2.

As evidenced by data presented in Table 2, the distances between field and farm facilities are considerable. They range from 3.30 for the smallest farms to 6.29 in case of the largest ones, with the average of 3.89 km, which shows that a 6.45-fold increase in the farm area extends the distance by 1.91 times. Assuming that the presented distances result from the expanse of farm fields, it may be stated that the analyzed objects have a most inconvenient expanse, i.e. field arrangement in relation to the farm. However, considering potential applications of car transport techniques, the distance (within the presented boundaries) is not the main element determining their potential use.

Table 2. Characteristics of roads in the farm internal transport

Specification	Unit	Farm size			
		On average	20.00-50.00	50.01-100.00	over 100.01
Length of access roads to the fields	(km)	3.89	3.30	4.72	6.29
In which percent of road surface kinds					
Asphalt	(%)	52.19	50.30	59.53	44.04
Hard surfaced road – improved	(%)	32.39	31.82	26.48	47.54
Unpaded (dirt) road	(%)	15.42	17.88	13.99	8.42
Farm entrance – field track	(%)	21.31	17.07	26.67	40.00
Average road passability class	(---)	3.18	3.28	3.04	3.09
Conversion distance – in relation to asphalt surface	(km)	14.82	14.62	17.79	18.74

Source: Author's own studies

The kind and quality of road surface are more important elements, because they usually determine potential use of a given means of transport (e.g. car), and in some unfavourable periods also the possibility of transporting – reaching the field. In order to reach on average 15.42% of fields one must drive along an unpaved road. The situation in this respect is most favourable for the largest farms. According to their owners, in each case they have access to their fields in at least two but often in many points. Nevertheless, in practical terms 17.88% of the smallest farms and 8.42% of the largest ones must use tractor aggregates. The outcome of the above mentioned fact is average road passability class 3.18, i.e. on average a road with partially gravel surface, in medium condition and partially reinforced dirt road. Regarding the expenditure, the actual distance (length), on average 3.89 km, taking into consideration the road conditions (rolling resistance), corresponds to the 14.82 km distance covered on the asphalt surface in good condition.

As regards potential use of modern transport techniques (cars) the most important factor is possible access to the farm, which is determined by the road section with the poorest surface and connected width of the access road. On average 21.31% of the investigated farms had restricted access for car transport – entrance from a field track along unpaved surface. In some seasons of the year it made impossible entrance to the farm for a heavy goods vehicle. Entrance to the farm is on average 0.15km distant from the main road, however both the width of this section and its surface, in 84.58% asphalt or paved one, do not limit the car access.

Another element determining transport accessibility is the farm facility itself, which is usually a load transfer point or a destination for transported crops or supplied means of production. Table 3 shows the characteristics of an object – the yard. The dimensions of a yard as a maneuvering area for the means of transport determine not only the time of e.g. performing a reversing but also the possible entrance for a given means of transport.

Table 3. Transport accessibility of a farm facility

Specification	Unit	Farm size			
		On average	20.00-50.00	50.01-100.00	over 100.01
Yard dimensions length x width	(m)	21.30x16.97	20.95x16.63	21.20x17.20	24.40x19.00
Percent of farms where U-turn by 17 x 17 truck is possible	(%)	45.90	41.46	46.67	80.00
Width of entrance gate	(m)	4.52	4.56	4.60	4.30
Culvert bridge bearing capacity	(Mg)	19.05	20.17	15.73	19.80

Source: Author's own studiem

Generally – usually 100% of farms do not fulfil the criterion – safe turn by 360°. However, due to a considerable changeability of farming conditions, detailed analysis revealed that on average 45.90% of farms meet the criterion. Increasing number of farms complies with the criterion of a safe U-turn with growing farm area. It ranges from 41.46% of the smallest to 80.00% of the largest.

At this point it should be added that farm buildings are the oldest on the smallest farms and the youngest on the largest ones. It may evidence that both farm organization and its facilities become increasingly more adjusted to modern techniques, including transport. The width of entrance gate (minimum 3m) on average – 4.52 m is not a restriction to the use of car transport technique.

In agricultural areas rainwater is usually drained by open ditches, therefore the entrance to a farm – the culvert bridge bearing capacity may limit application of a car with analyzed load capacity. As results from the producers' data average gross weight rating permitted for vehicles with 8-10 Mg load capacity is about

16.4 Mg (including the vehicle weight c.a. 6.6 Mg). Assuming the weight distribution suggested by car producers (on average about 35% on the front and 65% on the rear), we obtain the load of c.a. 10.7 Mg on rear axle. Theoretically, the culvert should bear such load depending on the number of rear wheels.

Generally, all investigated farms meet the above mentioned criteria. However, a detailed analysis allowed to state that 5 farms (8.20%) of the analyzed sample did not fulfill the assumed criterion. In the group of farms with smallest area, it is 4.88%, in the medium sized group 20.00%, whereas all largest area farms meet the assumed criterion.

CONCLUSION

As results from the presented investigations and analyses, a majority of the researched farms provide a potential for the use of modern transport technique, i.e. heavy goods vehicle. Regarding the main factor limiting the use of the above mentioned technique, on average in 21.31% of the analyzed cases access to farm may be difficult during some periods because of the entrance from a field track. Unfortunately, the percentage is growing with increasing farm area. This is usually a 0.15km long section, so its improvement should not prove difficult. The greatest hindrance is a possible safe turn by 360°. In this respect, on average only 45.90% of the investigated farms have such possibility but the percentage is growing with increasing farm area. Width of the entrance gate does not pose any limitations for the entrance by car, whereas bridge culvert bearing capacity does not allow using the assumed transportation technique only in 8.20% of the investigated objects.

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