INFRASTRUKTURA I EKOLOGIA TERENÓW WIEJSKICH
INFRASTRUCTURE AND ECOLOGY OF RURAL AREAS

Nr IV/1/2016, POLSKA AKADEMIA NAUK, Oddział w Krakowie, s. 1209–1216
Komisja Technicznej Infrastruktury Wsi

DOI: http://dx.medra.org/10.14597/infraeco.2016.4.1.088

THE EFFECT OF LOADING WORKS MECHANIZATION IN FARM TRANSPORT ON THEIR EFFICIENCY

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Abstract

Assessment of the coefficient of mechanization level of loading and unloading works was conducted in the paper. It was established that mechanization of loading activities affects the transport efficiency. The coefficient of mechanization index of loading works obtained for small load capacity aggregates (particularly tractor + cart aggregates) is unsatisfactory (e.g. for loose loads 3.71%). In all load groups and for all transport aggregates a higher mechanization index occurs at unloading works, (e.g. loose loads – loading 53.04, unloading 56.85%).

The working time expenditure of transport aggregates is decreasing with increasing efficiency of loading and unloading, which is growing with increasing mechanization of these works. At mechanization index 0% loading works efficiency is 6.55 Mg, whereas at the index 100% – 29.19Mg.

Keywords: mechanization, level of mechanization, index, loading, unloading

INTRODUCTION

Agricultural production, like any other production process involves a necessity to move various loads. At the same time, marketability of agricultural production progressively increasing over the recent years causes, that a farm involuntarily becomes also a transport enterprise. Loading and unloading works are indispensable element of the transport process, thus the amount of transloaded loads is twice bigger than the quantity of transported loads. (Bielejec 1994, Kokoszka et al. 2002b). According to Kokoszka (1986) and Wolszczan (1988)

loading activities consume even 60-70% of labour and 40-50% of traction force working time in transport (Kokoszka et al. 2002b, Kokoszka 1981).

The research conducted so far indicates a deficiency of means and loading devices on farms. The lack of loading and unloading equipment is particularly arduous at the centres for agronomic inputs supply. According to the investigations of Ignatiuk and Pasyniuk (1988) the index of loading works mechanization in agriculture is on average 28.0%, whereas according to Kokoszka et al. (2002a) – 25.7%. The authors of the investigations indicate also a declining tendency in mechanization of loading works over the recent years. Transport efficiency may be achieved among others by ensuring appropriate work organization and increase in the efficiency of loading works. A better efficiency of loading and unloading works is strictly connected with shortening the time of these activities, leading to proportional increase in a means of transport efficiency. For instance the index of load capacity 0.5, gives a decrease in the time of loading activities by 10% and average increase in its hourly output by 10% (Kunczyński 1983). On the other hand, research by Kokoszka and Kuboń (2003) demonstrate that the 10% increase in the index of loading works mechanization leads to a decrease in the means of transport working time expenditure by 3.71% and labour expenditure on average by 6.65%.

AIM AND SCOPE OF WORK

Following the remarks above, the aim of the paper was determining the mechanization index for loading and unloading works and its effect upon the efficiency of loading works. On the basis of former research it was assumed that the efficiency of loading works directly influences their duration time and therefore the whole transport process (Sęk 2005). Because mechanization of loading works results from the kind of transported loads, technical parameters and means of transport equipment, the analysis was conducted regarding the kind of load (loose, bulk and other load with individual characteristics) and the kind of means of transport used for the haulage (tractor + cart, tractor + manure spreader, tractor + trailer, tractor + 2 trailers, truck, truck + trailer). The investigations were conducted on 51 agricultural farms situated in 6 districts of the Małopolska region (Sęk 2005).

METHODS

The investigations were conducted for two years on selected agricultural farms on the basis on the daily snapshots of transport means working activity.

All transport activities realized on the studied farms were recorded in special study forms. Regarding the loading and unloading tasks the records comprised:

- the volume of load,
- working time of a means of transport (driving time with and without cargo, the loading and unloading time, time of technical and organizational stopovers),
- the way of loading and unloading,
- the kind of loading or unloading device,
- working time of loading and unloading equipment,
- number of people employed for the loading and unloading tasks.

7158 cycles – transport events were registered during the investigations, comprising all transport activities conducted on the farms (Sęk 2005).

The efficiency was computed according to generally applicable rules, i.e. the ratio of the carried load to the time of its transfer, whereas the index of loading and unloading works mechanization was determined according to the formula:

$$P_m = Q_m/(Q_m+Q_v)*100\ [\%]$$

Where:
P_m – index of loading works mechanization [%],
Q_m – the scope of loading works done mechanically [Mg],
Q_v – scope of loading works done manually [Mg].

RESULTS

The number of loading and unloading equipment on farms to a considerable degree affects the efficiency of performed transport tasks. At the same time the quantity of the above mentioned means depends on transport needs, and these in turn are dependent on the farm size. Therefore, their analysis was conducted for identified area groups. The results are presented in Table 1.

Table 1. Loading and unloading equipment on farms

	Mean	Area group (ha AL)			
		below 10.00	10.01-20.00	20.01-50.00	over 50.01
Pieces per farm	1.04	0.65	1.31	2.00	0.83
Pieces per 100ha AL	4.11	11.02	10.23	7.47	1.42

Source: own studies

Mean number of loading and unloading pieces of equipment is 1.04 pieces per farm and is strongly diversified depending on the farm size (0.65 to 2.00).

Farms with the areas between 20.01 and 50.00 ha AL possess the highest number of loading and unloading devices per farm. In this group on average 2

loading devices fall per farm, which in conversion to 100ha AL gives 7.47 pcs. In comparison, in the objects with the smallest areas the same index is 11.02 pieces per 100 ha AL. Stationary and front end tractor loaders, conveyor belts and pneumatic conveyors were the most common in the structure of possessed loading and unloading devices.

Table 2. Mechanization index and loading works efficiency for the studied aggregates

Specification		Transport aggregate							
		T+C*	T+M*	T+T*	T+2T*	T*	T*	T+T*	Mean
LOOSE LOADS									
Mechanization index [%]	loading	9.45	90.07	61.06	53.42	0.00	88.89	68.42	**53.04**
	unloading	12.94	92.20	63.34	69.18	0.00	89.33	71.05	**56.86**
	mean	*11.19*	*91.13*	*62.20*	*61.30*	*0.00*	*89.11*	*69.74*	***54.95***
Efficiency of loading works [Mg·h^{-1}]	loading	3.59	13.94	9.92	13.20	2.94	28.55	15.24	**12.48**
	unloading	3.84	11.09	23.84	37.75	2.88	78.60	24.40	**26.06**
	mean	*3.71*	*12.51*	*16.88*	*25.47*	*2.91*	*53.57*	*19.82*	***19.27***
BULK LOADS									
Mechanization index [%]	loading	6.17	76.51	17.34	61.29	-	90.38	-	**50.34**
	unloading	5.29	83.96	27.97	61.29	-	90.38	-	**53.78**
	mean	*5.73*	*80.23*	*22.66*	*61.29*	-	*90.38*	-	***52.06***
Efficiency of loading works [Mg·h^{-1}]	loading	2.06	12.83	4.31	9.39	-	18.41	-	**9.40**
	unloading	2.96	12.42	7.43	18.12	-	22.90	-	**12.77**
	mean	*2.51*	*12.63*	*5.87*	*13.76*	-	*20.66*	-	***11.09***
OTHER LOADS									
Mechanization index [%]	loading	10.91	36.36	26.14	0.00	4.38	95.51	18.03	**27.33**
	unloading	11.46	81.82	20.40	12.50	1.17	95.51	22.95	**35.12**
	mean	*11.19*	*59.09*	*23.27*	*6.25*	*2.77*	*95.51*	*20.49*	***31.22***
Efficiency of loading works [Mg·h^{-1}]	loading	2.78	3.91	4.63	14.68	1.65	9.26	7.84	**6.39**
	unloading	3.32	8.73	9.47	23.25	1.88	9.48	10.95	**9.58**
	mean	*3.05*	*6.32*	*7.05*	*18.96*	*1.77*	*9.37*	*9.40*	***7.99***

* first letters of the transport aggregate
Source: own studies

Table 2 presents the indices of mechanization and efficiency of loading works for the studied transport aggregates at the haulage of three main identified load groups (loose, bulk and other loads). Identification of the load groups was decided by the fact that the shape of load or its packaging determine the choice of the loading equipment, therefore it influences the results of loading works

mechanization. The kind of means and its construction (particularly its body) also affects possible mechanization of loading works (Bielejec 1994, Ławicki, Golka 1988).

The highest index of loading work mechanization, on average 54.95% (53.04 loading and 56.86 unloading) was registered at the loose materials transport, whereas the lowest at the transport of loads from the "other" group (31.22%). It is worth emphasizing that the obtained mechanization index is on average by 70-75% higher in comparison with previous research in this area (Kokoszka et al. 2002b, Ławicki, Golka 1988).

Irrespective of the kind of load, the lowest index was noted for the loading activities when the transport was done by a light commercial vehicle and by tractor with cart.

In the group of loose loads, all loading and unloading activities were done manually, whereas considering the transport in this group by means of manure spreader, on average 91.13% of loading activities were mechanized (loading 90.07% and unloading 92.20%).

In the group of car aggregates, a truck was characterized by a definitely highest index of loading works mechanization for all load groups. High values of loading mechanization index for a truck (loose material 88.89%, bulk loads 90.38% and other 95.51%) result mainly from the fact that the car mainly cooperated with the machinery having its own unloading appliances or the loading was conducted by means of front end or grapple loaders or forklifts. The necessity for manual loading or unloading the construction of the trailer box cause that the mechanization index for loading activities obtained for the haulage using this means of transport ranges from 5.73 to 11.19%.

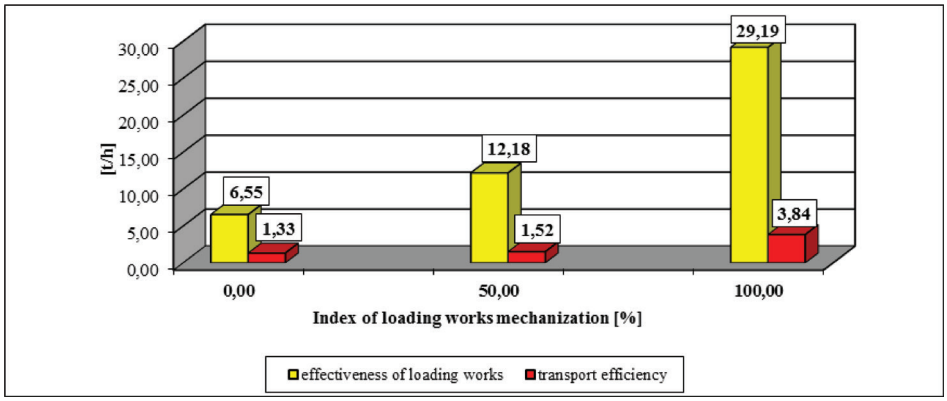
On the basis of the data in the Table it may be stated that in all load groups and for all transport aggregates the highest mechanization index occurs at the unloading works, e.g. for loose loads: loading 53.04 and unloading 56.86%).

Mechanization index for the loading activities remains strictly connected with the efficiency of both loading and unloading and in result with the performance capacity reached by these transport aggregates. It was confirmed by the analysis of loading and unloading efficiency for individual transport aggregates.

The lowest loading efficiency in the tractor aggregate group was noted for the tractor + cart aggregate and the highest for tractor + 2 trailers. The outcome of low mechanization index for loading of tractor cart carrying bulk materials is the loading efficiency, the lowest in this group of materials and generally for this aggregate (2.06 $Mg \cdot h^{-1}$). Depending on the kind of load, the efficiency of the loading of the tractor + 2 trailers aggregate in on the level 9.39-14.68 t/h and for unloading 18.12-37.75 $Mg \cdot h^{-1}$.

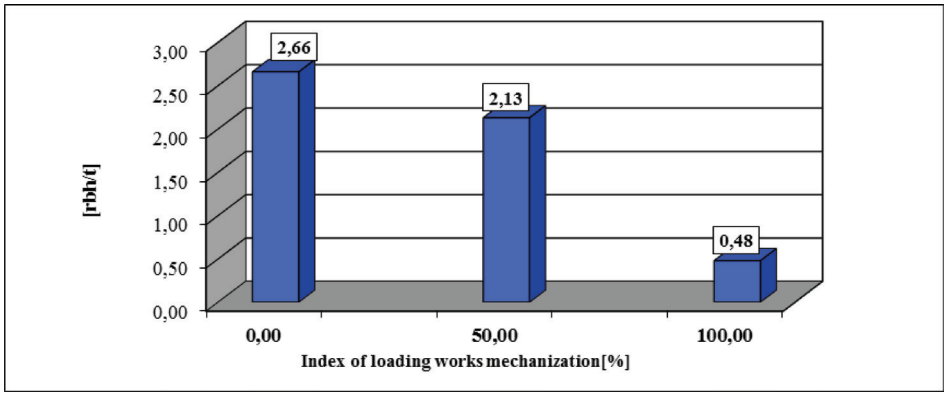
In the group of car aggregates the loading and unloading was performed fastest in case of truck carrying loose materials (loading 28.55 $Mg \cdot h^{-1}$, unloading 78.60 $Mg \cdot h^{-1}$).

Load pickup directly from the harvesters equipped in their own unloading devices (cereal and potato combine harvesters), trailer with big loading capacity and unloading by dumping cause a considerable shortening of the transport cycle and increase its efficiency.



Source: own studies

Figure 1. Index of loading works mechanization versus mean effectiveness of loading works and transport efficiency on an example of loose loads



Source: own studies

Figure 2. Index of loading works mechanization versus mean labour expenditures on an example of loose loads

Figures 1 and 2 present the effect of mechanization index, determined on the basis of the research, transport efficiency and labour expenditure on an example of loose loads as the dominant in the cargo of the load group. The analysis

was conducted for three variants of mechanization index: manual loading and unloading – index 0%, index 50% and full mechanization – index 100%.

Increase in loading works mechanization leads to increased efficiency of loading works and transport effectiveness but a decrease in labour expenditure. For example, the increase in the discussed index from 0% to 50% causes an improvement of loading works efficiency by 86%, transport effectiveness by 14% and a decrease in labour consumption by transport by 20%.

SUMMARY AND CONCLUSIONS

Summing up, it should be stated that mechanization of loading activities significantly impacts the efficiency of transport, particularly regarding the aggregates of big loading capacity, which enables the use of high transport effectiveness. The index of loading works mechanization obtained on the investigated objects reveals a growth trend as compared to previous studies. However, regarding the aggregates of low loading capacity (especially tractor + cart), the index is unsatisfactory. It has been reflected in a low effectiveness of loading and unloading and in consequence in low efficiency of transport and labour expenditure. Possible mechanization of loading and fast emptying of a trailer by means of dumping lead to a considerable improvement of the labour efficiency indices of the studied means of transport. Working time expenditure of transport aggregates is decreasing with increasing efficiency of loading and unloading which is growing with improving mechanization of these works.

ACKNOWLEDGMENTS

This research and publication was financed by the Ministry of Science and Higher Education of the Republic of Poland: DS-3600/WIPIE

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Received: 1.07.2016
Accepted: 22.09.2016