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COST ANALYSIS OF PREPARATION AND DISCHARGE IN SELECTED TIED-UP CATTLE BARNS

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ABSTRACT

Research work was conducted in 4 tied-up cattle barns with herd size 44.85-109 LU. It covers analysis of preparation and discharge of feed using machinery and equipment involved in this treatment. It also presents specified exploitation costs of machinery and equipment in livestock buildings and components of these costs such as maintenance cost and annual utilization of the machines. Also specified labor costs during treatment of feeding were described.

Introduction

Cattle feeding is one of the most important and necessary elements of production economy and has great influence on growth and development of animals, their health and productivity (Krzyżewski and Reklewski, 1997). Desirable results can be achieved when total mixed ration of feed can be obtained from mixing of concentrate and bulky feeds with vitamin and mineral supplements. To achieve the highest level of animal production, an increasing number of farms are equipped in modern machinery and equipment, and even in whole feeding lines for discharge of concentrate and bulky feeds.

The rational feeding system must meet the following requirements (Romaniuk et al., 2011b):

– feeds should fully cover animals demand for energy, protein, vitamins and mineral salts;
– discharge feeds, with appropriate quantity, should have a good quality, corresponding to the accepted standards;
– used feed methods should provide proper reproductive processes keeping animals in good health and provide good economic effects on total farm productivity;
– feeds for dairy cattle should be discharged in the form of a complete mixture (e.g. TMR), mixed in a mixer wagon using concentrate, bulky feeds and mineral ingredients as well;
– feed production should allow application of full mechanization during plants cultivation, maintenance, storage and feeding.

In cattle feeding it is very important to have high quality roughage. Feeds rations in bulky feeds are very diverse in terms of nutritional value. When increasing animal production it is very important to choose a proper feeding and discharge method. The feed ration must have both appropriate amount of minerals and energy (Winnicki et al., 2009).

The objective and scope of study

The objective of study was to analyze the cost of preparation and discharge of feeds. Also specified exploitation costs of machinery and equipment used in the cattle feeding and labor inputs that occur in the studied livestock buildings were taken into consideration.

The scope of the study includes studies conducted in 4 tied-up cattle barns with the herd size of 44.85-109 LU, characteristics of machinery and equipment for preparation and discharge of feeds, exploitation costs and labor input parameters.

Methods

The study was conducted taking into account the guidelines included in the research carried out by (Muzalewski, 2010; Gancarz, 2007 and 2010; Romaniuk et al., 2011a, b) – for example 4 tied-up cattle barns on farms. In the feeding treatment a mobile mixing wagon or hanged feeding robots were utilized. The calculations were conducted according to the following formulas:

Exploitation cost – K_e concerning machinery and equipment utilized for the mechanization of preparation and discharge of feeds, K_e consists of maintenance cost K_{utrz} and total costs $K_{uż}$ (Muzalewski, 2010; Gazzarin and Lips, 2013):

$$K_e = K_{utrz} + K_{uż} \ (\text{PLN}\cdot\text{year}^{-1}) \tag{1}$$

K_{utrz} – maintenance cost,
$K_{uż}$ – operating costs.

The combined maintenance costs are the sum of depreciation costs K_a and insurance costs K_{ub}. Dividing the sum of costs by the equipment operating time in the year W_R, unitary cost of machines maintenance per 1 hour was obtained (Muzalewski, 2010; Gazzarin and Lips, 2013).

$$K_{utrz} = K_a + K_{ub} \ (\text{PLN}\cdot\text{year}^{-1}) \tag{2}$$

Depreciation expenses are costs of replacement in the value of a particular machine. At the time of its use by a fixed number of years T_{lat}, the depreciation costs are equal to the value of total machine market cost C_m (Muzalewski, 2010).

$$K_a = \frac{C_m}{T_{lat}} \ (\text{PLN}\cdot\text{year}^{-1}) \tag{3}$$

Insurance costs K_{ub} of machines were adopted according to the data provided by the farmers of the investgated objects.

The operating costs of equipment were as follows (Muzalewski, 2010):

$$K_{uż} = K_r + K_{ee} + K_{em} + K_n \quad (PLN \cdot year^{-1}) \tag{4}$$

K_r – labor inputs costs, (PLN·year^{-1})
K_{ee} – cost of the electricity consumed by machinery and equipment, (PLN·year^{-1})
K_{em} – mechanical energy costs, (PLN·year^{-1})
K_n – repair costs, (PLN·year^{-1})

Labor costs (Muzalewski, 2010):

$$K_r = N_r \cdot N_{DJP} \cdot C_j \quad (PLN \cdot year^{-1}) \tag{5}$$

$$N_r = n'_r \cdot 200\,days + n''_r \cdot 165\,days \quad (man\text{-}hour \cdot year^{-1}) \tag{6}$$

N_r – labor inputs costs, (man-hour·year^{-1})
n'_r – unitary labor inputs in the winter, (man-hour ·LU^{-1}·day^{-1})
n''_r – unitary labor inputs in the summer, (man-hour ·LU^{-1}·day^{-1})
C_j – labor cost, (PLN·h^{-1})
n'_r i n''_r = 60 minutes = working hour
N_{DJP} – number of animals based on the LU

Costs of repair (Muzalewski, 2010):

$$K_n = \sum_{i=1}^{n} S \cdot \left(\frac{C_m}{T_{lat}} \right) \quad (PLN \cdot year^{-1}) \tag{7}$$

S=0.6-1.1 factor of the repair costs depending on the machinery or equipment (based on data from the System of Agriculture Machinery IBMER *[Institute for Construction, Mechanization and Electrification in Agriculture]* (SMR).

$$k_e = \frac{\sum_{i=1}^{n} K_{utrz} + \sum_{i=1}^{n} K_{uż}}{N_{DJP}} \quad (PLN \cdot year^{-1} \cdot LU^{-1}) \tag{8}$$

k_e – unitary cost of exploitation for feed preparation and discharge
N_{DJP} – number of animals based on the LU

Research results

Characteristics of the investigated cattle barns were presented in Table 1. Characteristics of the machines and equipment used in the feeding treatment and their annual use were presented in Table 2 and Table 3: cumulative results of research with different feed discharge systems, machinery and equipment purchase costs, exploitation costs of equipment involved in feed preparation and discharge. Table 4 presents labor input for cows feeding treatment in the investigated barns.

Table 1
Characteristics of investigated barns

No. barn	Cattle maintenance system	Herd size (LU)	Length of feeding corridor (cm)	Width of feeding corridor (cm)
1	tied-up	44.85	3100	450
2	tied-up	54.4	2400	180
3	tied-up	100	3800	278
4	tied-up	109	6200	330

Table 2
Machinery and equipment utilized for mechanization of feeding in investigated farms

No. barn	Utilized machinery	Type	Yearly utilization ($h \cdot year^{-1}$)	Amount (pcs.)	Replacement value (PLN)
1	Tractor	Fendt 62 kW	400	1	120 000
	Front loader	T210	200	1	4 000
	Silage cutter	TU 115	185	1	6 000
	Feeding fences	-	3000	set	10 000
	Water bowls	-	1500	31	3100
	Silo	Michał 8t	4000	2	10 000
	Total outfit (PLN)				153 100
2	Tractor	DeutzFahr 66 kW	300	1	190 000
	Front loader	T210	100	1	4 800
	Silage cutter	-	100	1	11 000
	Feeding fences	-	3000	set	10 000
	Water bowls	-	1500	19	100
	Silo	Michał 10 t	4000	1	8 000
	Feeding robot	Pellon	730	1	37 000
	Mixer for feed concentrates 2 t	-	100	1	12 000
	Total outfit (PLN)				274 700
3	Tractor	John Deere 80 kW	700	1	150 000
	Telescopic loader	Deutz Fahr 66 kW	540	1	220 000
	Robot of bulky feeds	Pellon	800	1	140 000
	Stationary feeder of bulky feeds	Pellon 10 m^3	120	1	58 000
	Front loader	T261	120	1	5 500
	Water bowls	-	1500	13	1 300
	Feeding fences	-	3000	set	19 000
	Silo	Michał 10 t	4000	1	8 000
	Silo	Michał 2 t	4000	1	4 000
	Total outfit (PLN)				610 300
4	Tractor	Ursus 1634; 114 kW	600	1	230 000
	Front loader	T210	150	1	10 000
	Silage cutter	-	120	1	8 000
	Feeding fences	-	3000	set	12 000
	Water bowls	-	1500	54	5 400
	Silo	Pellon 14 m^3	4000	1	7 000
	Robot of concentrate feeds	Pellon	700	1	37 000
	Mixing wagon	Strautman 9 m^3	550	1	40 000
	Total outfit (PLN)				349 400

Table 3
Methods of feeding systems, evaluation of maintenance and exploitation costs

No of barn	Herd size (LU)	Method of feed discharge	Replacement value of machinery and equipment		Maintenance costs $K_{utrz.}$		Exploitation costs	
			(PLN)	(PLN·LU^{-1})	(PLN·year^{-1})	(PLN·year^{-1}·LU^{-1})	(PLN·year^{-1})	(PLN·year^{-1}·LU^{-1})
1	44.85	Manually	153 100	3 413.6	12 134.68	270.56	32 946.34	734.59
2	54.4	Robot for concentrate feeds + manual discharge of bulky feeds	274 700	5 049.63	21 041.35	386.79	41 461.51	762.16
3	100	Robot for bulky feeds	610 300	6 103	54 507.4	545.07	62 250.5	640.29
4	109	Mixing wagon + robot for concentrate feeds	349 400	3 205.50	29 532.01	270.93	69 302.01	635.79

Table 4
Daily labour input for preparation and discharge of feed in investigated farms

No. barn	Operation	Utilization of machinery and equipment	Numbers of workers	Operation time (min)	Days of labour input (work min)
1	Silage cutting	Fendt tractor with silage cutter TU 115	2	30	30
	Feed transportation to barn	Fendt tractor with front loader		20	20
	Feed discharge	Hand work		180	180
Total (work min)			2	230	230
Total (work min LU^{-1})			2	5.12	5.12
2	Silage cutting	Deutz Fahr tractor with silage cutter	1	20	20
	Feed transportation to barn	Deutz Fahr tractor with front loader		5	5
	Refilling of feed in silo	Screw conveyor		6	6
	Batching of bulky feed	Hand work		40	40
Total			1	71	71
Total (work min LU^{-1})			1	1.30	1.30
3	Silage cutting	Telescopic front loader	1	60	60
	Loading stationary feeder Pellon with bulky feeds	Telescopic front loader		30	30
	Refilling of concentrate feed in silo	Screw conveyor		5	5
	Loading of liquid feed	Circulation pump		3	3
	Downloading feed ingredients by robot (automatically)	Screw conveyor		20	0
	Mixing feeds (automatically)	Robot Pellon for bulky feeds		40	0
	Feed discharge (automatically)	Robot Pellon for bulky feeds		120	0
Total			1	278	98
Total (work min LU^{-1})			1	2.78	0.98

No. barn	Operation	Utilization of machinery and equipment	Numbers of workers	Operation time (min)	Days of labour input (work min)
4	Silage cutting	Tractor with silage cutter	1	25	25
	Loading of feed wagon	Tractor with front loader		20	20
	Mixing of bulky feeds	Tractor with mixing wagon		35	35
	Discharge of bulky feeds	Tractor with mixing wagon		25	25
	Loading of concentrate feeds into silo	Screw conveyor		5	5
	Loading of concentrate feed components into robot (automatically)	Screw conveyor		20	0
	Discharge of concentrate feeds by robot (automatically)	Robot Pellon for concentrate feeds		90	0
Total			1	220	110
Total (work min LU^{-1})			1	2.01	1

Figure 1 presents daily labor input depending on the herd size on the farms under research. Comparative evaluation of investment costs of machinery and equipment for feeding mechanization is shown in figure 2. Summary of the comparative exploitation costs of machines and equipment for preparation and discharge of feeds in the tested farms is presented in figure 3.

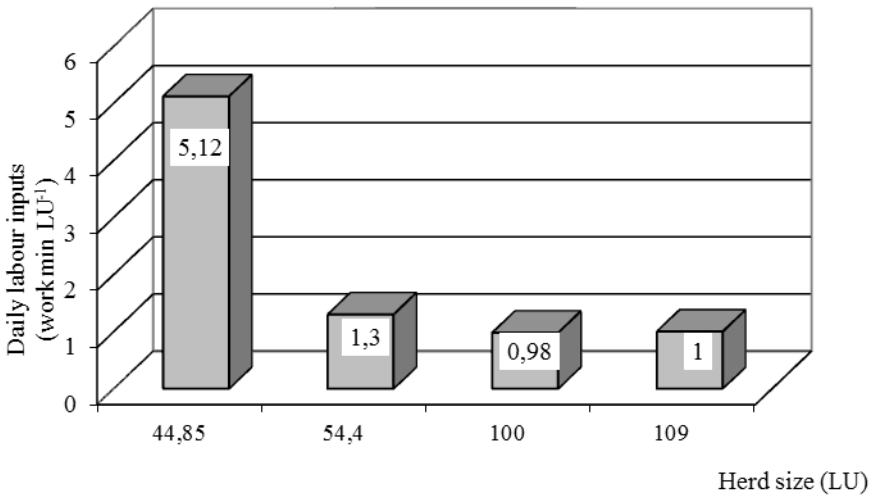

Figure 1. Combined daily labor input per LU in investigated farms

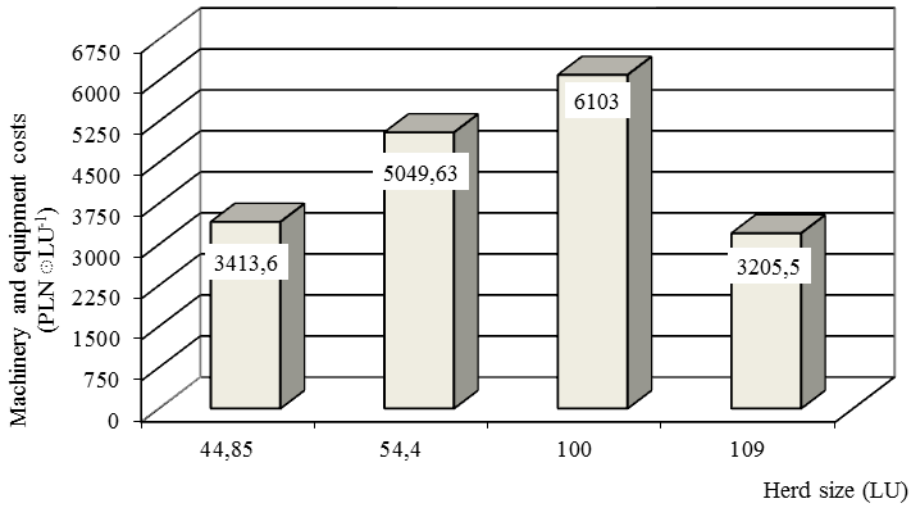

Figure 2. Combined comparative investment costs of machinery and equipment of feeding in farms tested

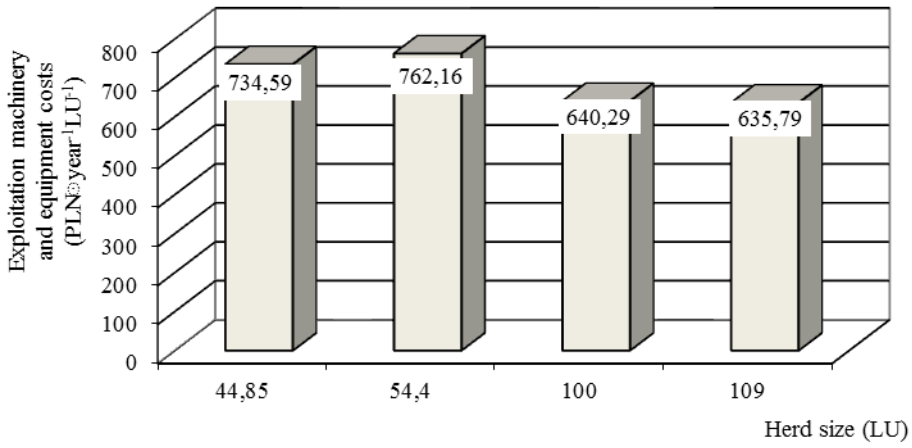

Figure 3. Combined comparative exploitation costs of machinery and equipment for feeding in investigated farms

Conclusion

The study proves that the use of modern machinery and equipment for feeding leads to savings in daily labor input and in the cost involved despite the high herd size.

- The cost of machinery and equipment in the investigated cattle barns was varied was within the range from 3200 to 6100 PLN·LU^{-1}, but they dependent on the herd size and applied mechanization for feed preparation and discharge.
- The highest daily labor input occurred in the cattle barn no. 1 and contained over 5 min·LU^{-1}. This was due to the fact that the feeding system in this barn was performed manually and provided by two service persons. The lowest labor input occurred in the cattle barn no. 3, where, thanks to the use of modern machinery and equipment managed to get the result below 1 man-hour/min·LU^{-1} with the herd size equal to 100 LU.
- The lowest exploitation costs of machinery and equipment were present in barn no. 4 with a result over 635 PLN·year^{-1}·LU^{-1}, which was the most optimal concerning the treatment of preparation and discharge of feed in cattle breeding systems.

References

Gncarz, F. (2007). Analiza kosztów mechanizacji procesu żywienia w oborach wolnostanowiskowych o zróżnicowanej obsadzie krów. *Problemy Inżynierii Rolniczej, Vol. 2,* 153-158.

Garncarz, F. (2010). Koszty wyposażenia i eksploatacji do przygotowywania i zadawania pasz w różnych systemach żywienia krów. *Problemy Inżynierii Rolniczej, Vol. 3*, 85-93.

Gazzarin, C.; Lips, M. (2013). *Maschinenkosten, ART-Bericht vol. 767*, ISBN 1661-756.

Krzyżewski, J.; Reklewski, Z. (1997). *Chów i hodowla zwierząt gospodarskich*. Warszawa. SGGW. ISBN 83-86980-47-8, 284.

Muzalewski, A. (2010). *Koszty eksploatacji maszyn, Vol. 25*. Falenty ITP. ISBN 978-83-62416-05-9.

Romaniuk, W.; Biskupska, K.; Pierednia, V.; Romanovich, A. (2011a). Dobór wozu paszowego mieszającego w zależności od koncentracji bydła w gospodarstwie. *Problemy Inżynierii Rolniczej, Vol. 3*, 121-130.

Romaniuk, W.; Fiedorowicz, G.; Biskupska, K. (2011b). *Analiza standardów technologicznych obór dla krów mlecznych w gospodarstwach rodzinnych i farmerskich*. Monografia. Falenty-Warszawa. ITP. ISBN 978-83-62416-21-9, 66.

Winnicki, S.; Domagalski, Z.; Pleskot, R. (2009). *Technika w zakresie konserwacji, przechowywania i zadawania pasz dla bydła*. Ekspertyza. Poznań. IBMER, 15.

ANALIZA KOSZTÓW PRZYGOTOWANIA I ZADAWANIA PASZ W WYBRANYCH OBORACH STANOWISKOWYCH

Streszczenie. W pracy przeprowadzono badania w 4 oborach stanowiskowych o obsadzie 44.85-109 DJP. Przeanalizowano sposoby przygotowania i zadawania pasz w oborach przy wykorzystaniu maszyn i urządzeń biorących udział w zabiegu żywienia. Dokonano analizy kosztów przygotowania i zadawania pasz dla bydła mlecznego. Określono koszty eksploatacji maszyn i urządzeń w obiektach inwentarskich oraz składowe tych kosztów: koszty utrzymania i koszty użytkowania, wykorzystanie roczne maszyn. Określono również nakłady robocizny, występujące w badanych obiektach inwentarskich w zabiegu żywieniu bydła.

Słowa kluczowe: zabieg żywienia, koszty eksploatacji, nakłady robocizny