Influence of technical infrastructure on economic efficiency of farms with various production trends

U. Malaga-Toboła

Institute of Agriculture Engineering and Informatics; University of Agriculture (Uniwersytet Rolniczy) in Cracow;
e-mail: urszula.malaga-tobola@ur.krakow.pl

Abstract. The study presents how farms are equipped with technical means of production. Moreover, it gives the number of equipment per one farm and the reproductive value. The technical infrastructure index of farms as well as the standard gross margin value per a field area unit was also determined.

The researched facilities were divided into three groups, which differed with a trend of performed activities, for the purpose of comparative analysis. Therefore, farms, which carried out plant, animal and mixed production, were compared.

The statistical analysis was carried out and on its basis, differences in the value of the above mentioned indexes were determined between the production trends as well as the influence of the technical infrastructure on the standard gross margin.

Key words: reproductive value of a machinery park, technical infrastructure index, standard gross margin, production trend

INTRODUCTION

As a part of Common Agricultural Politics (Polish: WPR) most of our commodity family farms are subject to technological and ecological modernisation based on the change of farm infrastructure into fixed assets, since it is difficult to increase plant crops and animal productivity with decreasing production costs at the same time, without modern technical equipment [7, 21, 11]. Only modern technical means, which are selected adequately to the production trend and which are necessary for implementation of new highly productive and energy saving technologies, will provide for products of better quality [18, 3, 22, 10]. Therefore, capital-intensive modernisation, from which high economic effectiveness is required, guarantees both high quality and high cost of commodity production [8]. Substitution of man labour with machine work and increase of work efficiency should constitute notable effects of modernisation. However, as [17] emphasises, increase of the substitution index and increase of work productivity at the same time is possible only if the technical means of production are rationally used. Increased need for machinery and devices which increase productivity and facilitate physical work on a farm results from the growth of production intensity. According to [14] and [20], such farms must be adjusted to the new technologies, which result from the requirements of the sustainable agriculture and from a multifunctional model of a Polish country. The agricultural requirements for machinery and devices are very diverse. This situation results from both the structure of existing agricultural farms as well as from the production trends, which are carried out, since rational machinery selection and operation is closely related to the trend of production activity. Except high quality commodity production, a rational selection must include economic aspects of the machinery park operation.

PURPOSE, SCOPE AND METHODOLOGY OF RESEARCH

The purpose of the study was to determine interdependence of the reproductive value of a machinery park, the technical infrastructure index of farms and the standard gross margin obtained on farms.

The research covered 116 developing agricultural farms located on the territory of Małopolskie province. Data for calculation was collected from applications for investment, which farmers submitted to The Agency for Restructuring and Modernisation of Agriculture – the Cracow Branch, as a part of UE aid programmes. Collected information concerned managing conditions of, among others, land utilization, a machinery park, material inputs, production size, and the trend of the production processes performed on farms.

Calculation of the standard gross margin (SGM) was applied with the method of its calculation in order to determine economic efficiency of farms:

$$SGM = \mathrm{FP}\mathit{gross} - DC,$$

where:
FPgross – gross value of final production
DC – direct costs incurred on production [1].

Whereas, the technical equipment index *(WT)* expressed in [PLN /man-hour[1]] was described as a ratio of the reproductive value of a machinery park *(WO)* and the input of labour *(SR)* [6]:

$$WT = \frac{WO}{SR}\mathit{[zł \cdot rbh^{-1}]}.$$

The reproductive value of a machinery park was estimated as the value of new, fully efficient machines, without considering the degree of their physical and economic wear.

For the purpose of the comparative analysis, the researched facilities were divided into three groups, which differ with a production trend. The farms, where contribution of the particular activity was above 2/3 of the total value, were qualified as single-trend farms, specialist farms (plant and animal farms) while the rest were qualified as mixed farms.

DESCRIPTION OF THE RESEARCHED FARMS

116 farms located in few Małopolska communes were accepted for the research. Straight majority, that is 90 farms (78%) were qualified as the plant production oriented. 35 facilities in this group performed the plant cultivation activity and did not possess any animals.

While the vegetable cultivation activity was the main branch, on 66 farms, the orchards cultivation activity - on 7 farms and the general plant activity - on 17 farms. Such intensification of the vegetable production is the only source of income for the fragmented Małopolska agriculture.

The mixed type of production, that is, the plant and the animal production and in some cases the service production was carried out on 18 farms in total. While, 8 farms specialising in livestock husbandry constituted the least numerous group; 2 of them specialised in the milk production, 5 of them in pig fattening and 1 in sheep breeding.

Mean area of arable land was 13,71 ha, out of which 82% constituted cropland, 14% - grasslands, and 3% - orchards and perennial plantations (table 1). Similar situation was on the plant farms and the mixed production farms, while contribution of grasslands in the structure of land utilization on the animal farms increased and it was 43%. It shall be stressed, that almost 34 % of arable land was leased. Almost half of arable lands were intended for grain cultivation. This structure of sowing was diverse because of the production trend. On farms specialising in the animal and the mixed production, grain growing predominated and constituted adequately 69 and 65 % of arable land area, while vegetables predominated on the plant production farms (42% of cultivated area).

Mean livestock density per a field area unit was 0, 47 LSU. While, on the animal farms it was 1, 56 LSU·ha^{-1} and it was also comparatively high on the mixed production farms – 0, 92 LSU·ha^{-1} (table 2). Pigs constituted almost a half (56%) in one structure.

Table 1. Land utilization [ha]

Specification	Average	Production trend		
		Plant production	Animal production	Mixed production
Arable land [ha]	**13,71**	**10,62**	**24,26**	**24,44**
including: own	8,98	8,07	11,03	12,49
leased	4,73	2,53	13,23	11,95
Cropland [ha]	**11,29**	**9,54**	**13,57**	**19,04**
grain	5,55	3,85	9,40	12,39
root crops	1,45	1,33	0,75	2,33
industrial	0,28	0,17	1,00	0,52
fodder	0,49	0,14	1,86	1,63
vegetables	3,52	4,05	0,56	2,18
Grasslands	**1,97**	**0,55**	**10,34**	**5,27**
Orchards and perennial plantations	**0,45**	**0,53**	**0,36**	**0,13**

Source: own study

RESULTS OF THE RESEARCH

Organization of the work process must be adjusted to the conditions and the factors of production. However, first, it requires effective application of agricultural technique in the process of management [15].

The researched farms were quite well equipped in technical infrastructure. 126 farm tractors, 107 sidecars, 62 delivery trucks were recorded in the analysed objects but 410 machines and cultivation devices as well as 405 harvesting machines constituted the majority. There were not many machines and devices for animal production on the farms. There were only 46 units, including 22 machines for feed preparation such as feed mills, feed mixers, and shredders.

19 machines, tools, and technical devices averaged out per one farm, and 1, 37 per 1 ha of arable land. There were about 2 farm tractors, 1 sidecar, 4 cultivation machines and devices and 3 fertilization and plant protection machines on every farm, irrespective of the production trend (Fig.1). While the number of the remaining groups was diverse in relation to the type of the activity. Differences were also noticed in the number of machines per field area unit, which constituted 1,73, 0,78 and 0,82 unit/ha[-1] of arable land respectively for farms specialising in the plant, the animal and the mixed production. Whereas, arable land per 1 farm tractor averaged out at 7, 23 ha, therefore it was considerably less than the mean of the country (10, 6 ha, according to PSR (*Polish Agricultural Census)* 2010). The index was very diverse in the analysed core groups, because it was only 5, 79 ha per a farm tractor[1] in the farms specialising in the plant production, however it was higher than the mean throughout Poland on the animal production farms and on the mixed farms and it was respectively 12, 94 i 11, 58-ha·farm tractor[1].

Mean reproductive value of a machinery park was 44, 40 thousand PLN·ha^{-1} of arable area (Table 3). Farms, which owned a machinery park of the highest value of 48,43 thousand PLN·ha-1, were plant production oriented.

Table 2. Livestock density [LSU·ha^{-1} of arable area]

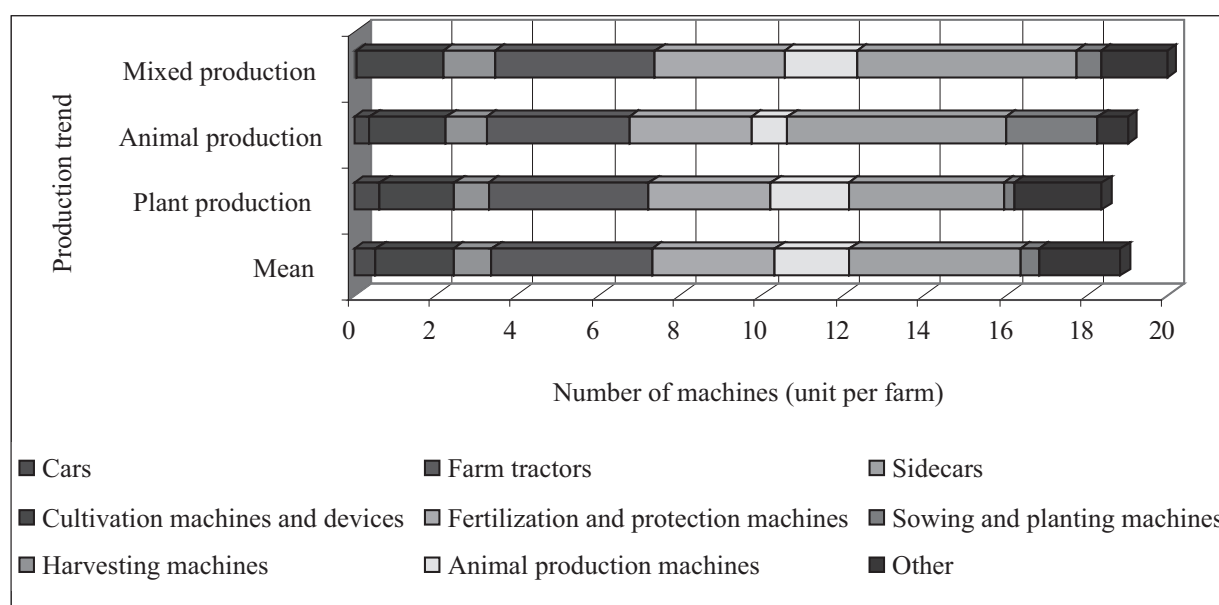| Specification	Average	Production trend		
		Plant production	**Animal production**	**Mixed production**
Dairy cattle	0,10	0,05	0,33	0,24
Beef cattle	0,10	0,07	0,01	0,30
Pigs	0,26	0,15	1,20	0,38
Horses	0,01	0,01	0,00	0,00
Sheep	0,00	0,00	0,02	0,00
Total	**0,47**	**0,28**	**1,56**	**0,92**

Source: own study

Fig. 1. Number of machines per one farm

Source: own study

In the remaining core groups, it was 33,23 thousand PLN·ha⁻¹ and 29,23 thousand PLN·ha⁻¹ respectively for the animal and the mixed production farms.

Harvesting machines and farm tractors had the biggest contribution in the core groups in the technical value structure of the production means. They averaged out at 34, 7% and 26, 8% respectively for harvesting machines and farm tractors. Reproductive value of the remaining groups of machines does not exceed 10% of the total technical values of the production means.

Mean value of the technical equipment index on the examined farms was 100,38 PLN·man-hour⁻¹ (Fig. 2). Both the lowest and the highest value was noticed on

the plant production farms, while the smallest technical infrastructure was 3,81 PLN·man-hour⁻¹ and it concerned the farms specialising in the general plant production and the biggest of 348,93 PLN·man-hour⁻¹ – concerned the farms which specialised in vegetable growing. While, the differences of the mean values between the core groups were considerable. Basing on [5], it may be stated, that the most capital-intensive process of production was performed by the livestock farms since the technical equipment index was the highest there and the less capital-intesive process of production was performed by the mixed production farms.

Table 3. Reproductive value of machinery park [thousand. PLN·ha⁻¹ of arable area]

Specification	Average	Production trend		
		Plant production	Animal production	Mixed production
Cars	6,88	8,41	4,64	0,25
Farm tractors	11,89	12,97	8,25	8,11
Side cars	1,68	1,81	0,91	1,35
Cultivation machines and tools	1,49	1,68	0,78	0,81
Fertilization and protection machines	3,21	3,59	1,78	1,92
Sowing and planting machines	1,56	1,78	0,45	0,9
Harvesting machines	15,42	15,67	14,68	14,48
Animal production machines	0,22	0,16	0,95	0,19
Others	2,06	2,34	0,80	1,2
Total	**44,40**	**48,43**	**33,23**	**29,23**

Source: own study
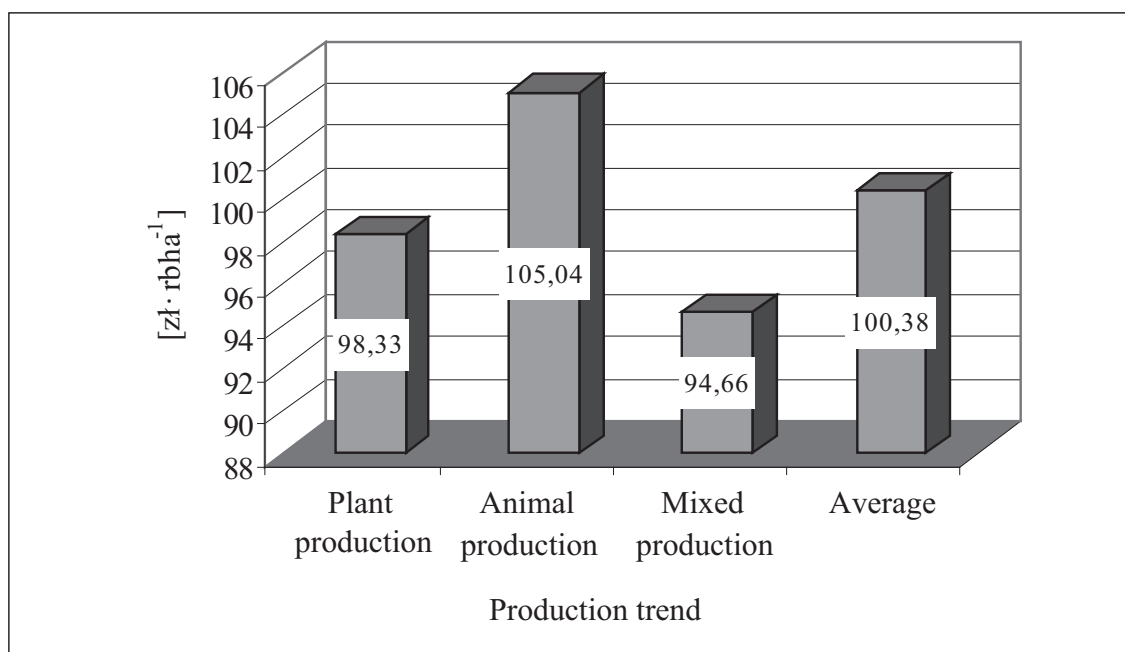
Fig. 2. Technical infrastructure index of farms

Source: own study

The technical infrastructure index is calculated as a quotient of the technical values of the production means and labour force. Then, the labour force resources, as one of the most active factors of production, essentially influence the production process on agricultural farms. Numerous publications which analyse the labour resources [3, 13, 23, 24, 19, 9] prove a significant role of this factor in the management process as well as in the farm organization. The plant production turned out to be decisively the most labour-intensive among the examined core groups, especially vegetable cultivation, which took 587 man-hour/ha^{-1} of arable land. Work input on these farms was almost two times higher than in the two remaining core groups.

The standard gross margin value is one of the measures, which allows for estimation of the production economic efficiency [16]. According to [4], it depends more on the human labour input than on the technical infrastructure of farms, what proves that a man performs a large amount of work.

The final production, which constituted the output value for calculation of this measure, average out at 14, 36 thousand zl·ha^{-1} of arable land. After reducing this production category of costs value incurred on the purchase of mineral fertilizers, plant protection products and sowable material, the standard gross margin value was obtained on the level of 11, 03 thousand PLN/ha^{-1} of arable land Table 4). Meanwhile, its value on the plant production farms was 68%, and over 100% higher than on the animal and the mixed production farms. It is confirmed by the variable analysis carried out in a single classification, which presented how essential were the differences between the standard gross margin value in the core groups. Based on the variable analysis we may reject a zero hypothesis that the standard gross margin average value is equal to 0,000319 (table 5). Considerable deviation of the standard gross margin value on the plant production farms was noticed in the list of the mean values in comparison to the animal and the mixed production farms. Therefore, Duncan test was conducted and on its basis it may be stated, that the plant production farms obtained the highest standard gross margin mean

value (12, 36 thousand PLN·ha^{-1} of arable land and it was statistically different from the mean value obtained in the remaining two core groups.

Duncan Test; variable: Standard gross margin (variable analysis). Marked differences are essential with $p < ,05000$

Standard Gross Margin	{1} M=5,96	{2} M=12,36	{3} M=7,36
Mixed production{1}		*0,009352*	0,547213
Plant production{2}	*0,009352*		*0,033492*
Animal production {3}	0,547213	*0,033492*	

Source: own study

The variable analysis was also carried out in order to compare mean reproductive values of a machinery park and the technical infrastructure index for the production trends, which were mentioned. However, it cannot be stated, based on the conducted research, that no essential differences in mean values of the examined features occurred.

Correlation and regression analysis was conducted in order to check if there was a relation between the reproductive value of a machinery park, the technical infrastructure index and the standard gross margin value. This analysis was conducted for all examined farms, as well as for the selected core groups. Statistically essential positive relation (r = 0, 75) between the reproductive value of a machinery park and the technical infrastructure index occurred only in the animal production farms. Other correlations were irrelevant from the statistical point of view.

CONCLUSIONS

19 machines, tools, and technical devices averaged out per one farm. No essential differences in quantitative equipment of farms with the technical means of the production were noticed in the core groups. Arable land per one farm tractor averaged out at 7, 23 ha. Essential

Table 4. Standard gross margin in selected production branches [thousand PLN/ ha^{-1} of arable land]

Specification	Average	Production trend		
		Plant production	Animal production	Mixed production
Gross final production	14,36	15,55	13,92	8,59
Direct costs	3,33	3,18	6,56	2,63
Standard gross margin	11,03	12,36	7,36	5,96

Source: own study

Table 5. Variable analysis and Duncan test in a single classification. Standard gross margin in relation to production trend.

Variable	SS	df	MS	SS	df	MS	F	p
SGM	729,49	2	364,74	4763,97	113	42,16	8,65	0,000319

differences were visible in the core groups since, on the animal and the mixed production farms the area was about two times bigger than on the plant production farms.

It may be stated, based on the technical infrastructure index that one man-hour was potentially balanced by 93, 33 PLN of the capital invested in a machinery park. The farms specialising in livestock husbandry were the most capital-intensive because the technical infrastructure index was the highest there and it amounted to 105, 04 PLN man-hour[1]. It is worth noticing that the lowest labour input was noticed on these farms.

The plant production farms carried out the most economically efficient activity, since the standard gross margin value, which is its measure, considerably exceeded the value obtained in the remaining core groups. Those differences turned out to be statistically essential.

However, the statistical analysis did not prove any essential relation with the technical equipment, which was determined with the reproductive value of machinery park, with the technical infrastructure index and the standard gross margin value.

REFERENCES

1. **Augustyńska-Grzybek I. i in. 1999.** Metodyka liczenia nadwyżki bezpośredniej dla działalności produkcji rolniczej. IERiGR, Warszawa. 8-10.
2. **Baer-Nawrocka A. 2008.** Zasoby pracy jako przesłanka konkurencyjności rolnictwa nowych krajów członkowskich Unii Europejskiej. Roczniki Naukowe SERiA, Tom X. Zeszyt 1. 16-22.
3. **Golka W. and Wójcicki Z. 2006.** Ekologiczna modernizacja gospodarstwa rolniczego. Monografia, Wydawnictwo IBMER, Warszawa
4. **Kocira S. 2008.** Wpływ technicznego uzbrojenia procesu pracy na nadwyżkę bezpośrednią w gospodarstwach rodzinnych. Inżynieria Rolnicza. Nr 4 (102). 375-380
5. **Kowalski J. 2006.** Wiek właścicieli gospodarstw a wskaźnik technicznego uzbrojenia w warunkach gminy górskiej. Problemy Inżynierii Rolniczej. Nr 4. 51-56
6. **Kowalski J. i in. 2002.** Postęp naukowo-techniczny a racjonalna gospodarka energią w produkcji rolniczej. PTIR, Kraków, ISBN 83-905219-9-7.
7. **Kuboń M. and Kwaśniewski D. 2006.** Prace transportowe a postęp techniczny w wybranych gospodarstwach rolniczych.. Inżynieria Rolnicza. Nr 11(86). Kraków. 233-239.
8. **Malaga-Toboła U. 2007.** Kierunek produkcji a efektywność technicznej modernizacji gospodarstw rolniczych. Inżynieria Rolnicza. Nr 7 (95). 129-136
9. **Malaga-Toboła U. 2008.** Wskaźnik technicznego uzbrojenia a wydajność pracy w aspekcie uproszczenia produkcji roślinnej. Inżynieria Rolnicza. Nr 2 (100). 195-202
10. **Marczuk A., 2010.** Dobór środków technicznych do zadawania pasz w obiektach inwentarskich dla bydła. Inżynieria Rolnicza. Nr 3 (121). 119-125.
11. **Marczuk A. and Misztal W., 2011.** Optimum planning of connections between suppliers and receivers under circumstances of demand-supply imbalance and existing restraints. Journal of KONES Powertrain and Transport, Vol. 18, No. 3 2011. 237-243.
12. Powszechny Spis Rolny. 2010.
13. **Radwan A. 2008.** zasoby pracy w rolnictwie polskim (analiza przestrzenno-czasowa). Roczniki Naukowe SERiA. Tom X. Zeszyt 2. 216-222.
14. **Roszkowski A. 1998.** Aktualne problemy technologii produkcji roślinnej. W: Kierunki prac naukowych w inżynierii rolniczej u progu XXI wieku. Wydawnictwo IBMER. Warszawa. 85-95.
15. **Sawa J. 2000.** Efektywność mechanizacji produkcji rolniczej w różnych warunkach gospodarowania. Problemy Inżynierii Rolniczej. Nr 3. Warszawa. 85-94.
16. **Szeląg-Sikora A. and Kowalski J. 2009.** Warunki gospodarowania w wybranych gospodarstwach w woj. małopolskim o korzystnej strukturze agrarnej. Inżynieria Rolnicza. Nr 9 (118). 283-290
17. **Tabor S. 1998.** Poziom nakładów technicznych środków produkcji a efektywność pracy w rolnictwie. Inżynieria Rolnicza. Nr 5(6). 169-175.
18. **Tabor S. 2004.** Kierunek gospodarowania a wyposażenie techniczne i koszty mechanizacji produkcji rolniczej. Inżynieria Rolnicza, nr 4.
19. **Tabor S. and Prusak A. 2008.** Wykorzystanie zasobów pracy ludzkiej w wybranych gospodarstwach rolnych małopolski. Inżynieria Rolnicza. Nr 10 (108). 253-259.
20. **Wójcicki Z. 2003.** Metody oceny działalności modernizowanych gospodarstw rodzinnych. Inżynieria Rolnicza. Nr 9(51). 49-59.
21. **Wójcicki Z. 2008.** Metodyka badań postępu technologicznego w gospodarstwach rodzinnych. IBMER. Warszawa. ISBN 978-83-89806-22-3.
22. **Wójcicki Z. 2009.** Potrzeby i możliwości inwestycyjne rozwojowych gospodarstw rodzinnych. Problemy Inżynierii Rolniczej nr 3. 5-12
23. **Wyrzykowska B. 2008.** Kapitał ludzki jako czynnik konkurencyjności. Roczniki Naukowe SERiA. Tom X. Zeszyt 1. 464-468.
24. **Wysocki F. and Kołodziejczyk W. 2008.** Zasoby pracy i ich jakość na wsi polskiej. Roczniki Naukowe SERiA. Tom X. Zeszyt 1. 469-476.