Management Theory and Studies for Rural Business and Infrastructure Development
eISSN 2345-0355. 2020. Vol. 42. No. 3: 248-258
Article DOI: https://doi.org/10.15544/mts.2020.24

COSTS OF MAINTAINING FIXED ASSETS IN AGRICULTURE – CASE OF POLAND AND LITHUANIA

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Fixed assets are the foundation of agricultural production. The efficiency of this production depends on the degree to which fixed assets are used (their productivity). The goal of this article is to analyze the fixed assets of variously specialized farms, the costs of their maintenance, and to investigate relationships between the value of tangible fixed assets and the efficiency of agricultural production. This analysis pertains to farms in Poland and Lithuania specializing in field crops and milk production based on FADN data from the years 2015-2017. The results indicate that Polish farms are better equipped with fixed assets. At the same time, considering type of production, farms specializing in milk production were technically better equipped in both countries. The costs associated with maintaining fixed assets and their depreciation are a substantial item in the total costs of agricultural production, making up 40% of all costs. In the case of Poland, farms specializing in milk production were characterized by higher effectiveness of labor, which was 35% higher than on field crop farms. As for Lithuanian farms, those specializing in field crops reached higher labor effectiveness. The positive relationship between fixed assets and the effectiveness of labor and value of production is confirmed by coefficient of determination.

Keywords: agriculture, costs, farm, fixed assets.
JEL codes: O13, Q12, Q14.

Received 28 08 2020; Accepted 01 09 2020

1. Introduction

Agricultural activity is associated with costs. Next to sale prices, production costs are the most important factor in the profitability of production. Under conditions of intensive competition, there is a need to search for methods of rationalizing production costs. As part of any cost minimization strategy, it is worth paying attention to the costs of maintaining fixed assets. Due to its nature, agricultural production requires high capital expenditures for fixed assets. This arises from the need to engage various machines and equipment in the production process, which is associated with the high costs of purchasing and operating them. In agriculture, technical means of production are the primary constituent of fixed assets on a farm. The set of these means, at the disposal of individual farms, conditions how production is organized and the economic results of production.

Farms differ in the fixed assets they hold. Fixed assets constitute the material and technical base of production capacity. Next to labor inputs, they are a fundamental factor differentiating farms. The volume of production and economic results largely depend on the degree in which fixed assets are used (Popescu and David, 2015). Differences in possession of fixed assets arise from the size of a farm, and above all, from the adopted production technology. Changes in the quality and structure of fixed assets determine production capacities and the level of production costs.

It is a natural tendency for farms to strive for ever better technical equipment. Better equipment improves labor effectiveness and contributes to improvement of production quality. Studies conducted in Brazil demonstrated that the use of safety equipment on agricultural machinery may be an effective measure preventing accidents at work, thus contributing to reduction of production costs (Gomes et al. 2015). The expected rate of return on the capital invested in the purchase of equipment is an important issue in management of fixed assets. This is important at the stage of making a decision on a planned investment.

Fixed assets are mainly discussed in the context of rational farm management (Mykolaitiene et al. 2010). Fixed assets are also considered in the context of farms' debt, in which case they are treated as collateral on long-term liabilities (Matemilola and Ahmed, 2014). Many studies have been devoted to tangible fixed assets. They generally pertain to costs of purchase (manufacture), accountancy policy and depreciation (Jackson et al. 2010; Zinkeviciene and Vaisnoraite, 2014). Tamuleviciene and Mackevicius (2019) conducted a review of the literature on tangible fixed assets in enterprises. The above authors proposed a comprehensive method of analyzing tangible fixed assets, pointing to its utilitarian significance in administrative decision-making aimed at improving the results of an enterprise's activity.

These observations can also be carried over to agriculture. Farms constitute the primary component of this sector of the national economy and are an important entity on the market. The subject matter of farms' possession of fixed assets is present in studies. Some articles are dedicated to the effectiveness of using fixed assets (Zwolak, 2008; Popescu i David 2015; Nabieva and Davletshina, 2015; Koloszko-Chomentowska i Sieczko 2016). It seems that the problem of the costs of maintaining tangible fixed assets has seen little study. The cost of energy consumption in production has not been included in previous studies. Energy consumption is associated with the operation of fixed assets. Farms possessing more machines and equipment, modern farm buildings, better equipped with fixed assets than farms without such technical equipment, consume more energy for production purposes. It also seems that the problem is significant, particularly in the situation of continuous increase prices on the energy market. The present article fills that gap. Fixed assets determine the production potential and competitive capacity of farms. They are treated as one of the more important elements of farms' modernization and innovation, contributing to improved labor effectiveness in agriculture.

The goal of this paper is a comparative assessment of the costs of maintaining fixed assets on farms in Poland and Lithuania and to investigate relationships between the value of tangible fixed assets and the efficiency of agricultural production.

2. Materials and methods

The research problem was addressed based on data from Polish and Lithuanian farms in the FADN system (European …2015). The data pertains to the years 2015-2017. According to this methodology, production costs include: (1) total specific costs (SE281), (2) total farming overheads (SE336), (3) depreciation (SE360) and (4) total external factors (SE365). Total specific costs and total farming overheads are jointly considered as total intermediate consumption (SE275). This classification also related to such economic categories as: gross farm income (SE410), farm net value added (SE425), and family farm income (SE430).

Fixed asset maintenance costs are classified as total farming overheads and designated as machinery and building current costs (SE340). They include the costs of current maintenance of equipment, current maintenance of buildings and irrigation devices, insurance on buildings. According to FADN methodology, costs associated with general overhaul of fixed assets are accounted as investment activity.

Expenditures associated with the purchase of fixed property, which cannot be accounted for as deductible expenses at the time of purchase, are counted as costs of agricultural production gradually

throughout the entire period of the given asset's use. Depreciation (SE360) is an expression of the wear of fixed property over the course of the production process. Hence, it is the cost arising from maintenance of tangible fixed assets, spread out over time.

Moreover, energy consumption is associated with the operation of fixed assets. Farms possessing more machines and equipment, modern farm buildings, better equipped with fixed assets than farms without such technical equipment, consume more energy for production purposes. Therefore, energy consumption (SE345) should be included in the costs of maintaining fixed assets, as was adopted in the present article.

Such an approach to classification of costs was adopted for the purposes of this work and allows for realization of the accepted goal of the article.

The production profitability index, being the ratio of total output (SE131) to total inputs (SE270), was taken as the measure of the efficiency of agricultural production. Since fixed assets indicate the level of technological advancement and serve as the basis for production assets, the effectiveness of use of this property was evaluated. Hence, the productivity of fixed assets (value of production per PLN 1 in fixed assets) was calculated along with the reproduction rate of fixed assets, according to the formula: net investment on fixed assets (SE521)/total fixed assets (SE441) (Gabrusewicz, 2007). It was calculated according to the formula: *(net investment on fixed assets/total fixed assets)x100%*, which, according to FADN, takes on the form: (SE521/SE441)x 100%. For the purposes of calculating this index, the value of land was excluded from the value of fixed assets. This approach arises from the fact that land is not subject to depreciation according to the rules applicable to other fixed assets. The rate of reproduction of fixed assets provides information on the type of reproduction occurring in a farm (simple, expanded, narrowed). The effectiveness of labor on farms was also calculated. This index is related to the technical means of labor and is generally recognized as one of the most important indices characterizing development processes in the economy. The labor effectiveness index was accepted to be the net value added per work unit in farm (SE415/SE010).

The analysis takes into consideration farms specializing in field crops (plant production) and dairy cattle (livestock production). These are the types of production most frequently adopted by family-owned farms in Poland and Lithuania. Requirements relating to production technology have a large impact on the fixed assets farms are equipped with, and hence on the level of costs associated with maintenance of these fixed assets and the effectiveness of their use. The dependency between the value of fixed assets and value of production, and between the value of fixed assets and labor effectiveness, was investigated using the coefficient of determination. In this case, data from the years 2008-2017 was used.

3. Results

Costs of agricultural production vary according to, among other things, the direction of the production, which is linked to the technology adopted. In the case of Polish farms, a small drop in the production costs of field crop farms was observed in the years 2015-2017, by 4.15% (tab. 1). Total specific costs made up the largest share (from 40.95% in 2015 to 39.40% in 2017). The share of total farming overheads was at the level of 25-26%. Costs of energy consumption for the purposes of agricultural production made up the largest share of total overheads. Certain changes in the structure of total farming overheads were observed during the studied period. Energy costs decreased by 4.66 EUR per 1ha of farmland, which contributed to a reduced share of this component in total overheads, by 2.58%. The increase in costs of services amounted to 54 EUR per farm, which amounts to 0.79% of the structure of total farming overheads. The largest changes were noted in machinery and building maintenance costs. In 2017, they amounted to 74.26 EUR·ha^{-1}, corresponding to growth by 6.2% (2.18% in the structure) compared to 2015. Changes were small in the “other costs” group, which includes, among other things, telephone fees, decreasing by 0.54 EUR·ha^{-1}.

Depreciation of fixed assets is an important part of production costs. In this case, its value was 207.26 EUR·ha^{-1} on average, making up 22.28% to 23.15% of total costs depending on the year. If depreciation is accounted for together with current maintenance costs of machinery, equipment and buildings, as well as with energy, it turns out that the costs associated with maintenance of tangible fixed assets rise to 376.61 EUR·ha^{-1}, which is equal to 41.27% on average. This is a significant item in the costs of field crop production.

In the case of Lithuanian farms, production costs in fieldcrop farms were, on average during the studied period, 695 EUR·ha^{-1}, 23.8% lower than in Polish farms of the same type. Meanwhile, the structure of production costs was similar. Specific costs had the largest share. In the years 2015-2017, they remained at nearly the same level, but their share in the structure changed (43.13-45.59%) because of changes in other components of total specific costs. Particularly large changes are observed in the level of total farming overheads and depreciation. In 2016, total overheads were slightly lower than in 2015, but in 2017, they increased by nearly 19 EUR·ha^{-1}. These changes were primarily caused by the increase in machinery and building maintenance costs by 27.88% compared to 2015 (5% growth of share in the cost structure). It should be noted that, during this same period, the value of depreciation also grew by 21.52 EUR·ha^{-1}. This shows that, during the studied period, these farms could have enriched themselves with additional technical equipment, and so analyses should be considered in the context of changes in available fixed assets. The data presented in table 3 shows that such a phenomenon occurred. In Lithuanian field crop farms, during the years 2015-2017, the increase in the value of machinery and equipment amounted to 15.74%, and in the value of buildings by as much as 44.78%, whereas in the case of Polish farms of the same type, these increases were 4.63% and 7.29%, accordingly. It should be noted that, in Poland, a relatively high increase in the level of fixed assets on farms occurred in earlier years. This is the result of facilitated access to investment resources from EU funds for financing the purchase of equipment (Grzelak, 2013). However, growth effects were not seen in all farms (Koloszko-Chomentowska, 2018; Toro-Mujica et al. 2015). The most active reproduction of fixed assets occurred in larger, economically strong farms. In reference to the data from the years 2015-2017, it should be stated that the tempo of acquisition of fixed assets by farms in Poland was probably slower in recent years. Meanwhile, Lithuanian farms were characterized by a relatively high rate of acquisition of fixed assets, precisely in recent years. Increased values of fixed assets are associated with higher costs of their maintenance, hence there are differences in the value and structure of production costs.

Table 1. Value and structure of production costs - fieldcrops

Specification	Poland			Lithuania		
	2015	**2016**	**2017**	**2015**	**2016**	**2017**
Direct costs (EUR·ha^{-1})	389.02	354.99	358.65	308.68	310.96	308.71
(%)	40.95	40.44	39.40	45.59	44.81	43.13
Total farming overheads (EUR·ha^{-1})	242.65	224.14	239.42	140.80	136.03	154.82
(%)	25.54	25.54	26.29	20.79	19.60	21.63
including: (%)						
machinery and building current costs	28.83	31.00	31.01	30.53	32.99	35.53
energy	43.32	40.89	40.74	45.14	41.94	40.32
services	15.92	16.40	16.71	7.31	6.21	6.81
other costs	11.93	11.71	11.54	17.02	18.86	17.34
Depreciation (EUR·ha^{-1})	211.66	199.32	210.81	150.01	164.17	171.53
(%)	22.28	22.71	23.15	22.16	23.66	23.97
Total external factors (EUR·ha^{-1})	106.64	99.27	101.66	77.56	82.74	80.67
(%)	11.23	11.31	11.16	11.46	11.93	11.27
Total costs (EUR·ha^{-1})	949.98	877.72	910.54	677.05	693.91	715.72
(%)	100.00	100.00	100.00	100.00	100.00	100.00
Utilised agricultural area (ha)	21.69	21.95	22.30	78.94	80.92	78.88

Source: own calculation based on FADN data

In terms of production costs in dairy cattle farms, they were 40.56% higher, on average, in the case of Poland, and 20.04% higher in the case of Lithuania compared to production costs in fieldcrop farms. Total specific costs occupy the dominant position in the cost structure. In the case of Polish farms, the share of these costs is over 49% (49.04-49.46%). Total farming overheads are the second most important group. In Poland, during the years 2015-2017, their value grew by 8.5%, and their share in the structure of total costs increased by 1.34%.

In this group of costs, the costs of energy for agricultural production purposes make up the highest share (40.45% on average during the studied period). In terms of value, this corresponds to 124.51 EUR·ha^{-1} against 98.12 EUR·ha^{-1} in farms specializing in field crops. Relatively high energy consumption costs are linked to the technology applied in dairy cattle farms.

These farms apply modern technologies by which production processes are completely mechanized, and very often automated, thus increasing demand for electricity. Building and machinery maintenance costs are also higher than in field crop farms. This is since animal production requires larger investment in buildings and their equipment than plant production does.

During the studied period, current maintenance costs of buildings and machinery amounted to 106.37 EUR·ha^{-1} and were nearly 50% higher than in field crop farms. Small changes occurred in the costs of depreciation of fixed assets (7.5%). The average value of depreciation during the years 2015-2017 was EUR·ha^{-1}, and its share in the structure of total costs was steady at about 22%.

Table 2. Value and structure of production costs - milk

Specification	Poland			Lithuania		
	2015	2016	2017	2015	2016	2017
Direct costs (EUR·ha^{-1})	638.20	608.21	653.52	368.60	347.48	384.35
(%)	49.57	49.04	49.46	46.26	41.74	43.45
Total farming overheads (EUR·ha^{-1})	301.51	295.80	327.12	178.36	174.01	191.41
(%)	23.42	23.82	24.76	22.38	20.90	21.64
including: (%)						
machinery and building current costs	32.21	34.78	36.45	30.83	33.52	37.97
energy	42.14	39.80	39.40	39.45	37.21	35.41
services	15.70	16.35	15.17	7.87	4.78	4.79
other costs	9.95	9.07	8.98	21.85	24.49	21.83
Depreciation (EUR·ha^{-1})	292.33	285.02	286.85	194.35	247.06	240.63
(%)	22.71	22.98	21.71	24.39	29.69	27.20
Total external factors (EUR·ha^{-1})	55.45	51.53	53.85	55.56	63.88	68.13
(%)	4.30	4.16	4.07	6.97	7.67	7.71
Total costs (EUR·ha^{-1})	1287.49	1 240.12	1 321.34	796.87	823.43	884.52
%	100.00	100.00	100.00	100.00	100.00	100.00
Utilised agricultural area (ha	21.91	20.96	20.76	27.77	30.43	29.46

Source: own calculation based on FADN data

It is worth paying attention to the value of assets in farms' possession. Available assets indicate that farms are equipped with production property. The data shown in table 3 shows that Polish farms are better equipped with fixed assets (tab. 3). This pertains to farms specializing in plant and animal production alike. At the same time, differences in current assets are small, and it can be acknowledged that farms from both countries are similar in this respect.

Table 3. Assets value in 2015-2017 years

Specification	Poland			Lithuania		
	2015	2016	2017	2015	2016	2017
fieldcrops						
Total assets (EUR ha^{-1})	7 679.39	7 328.61	7 929.28	2 186.12	2 233.72	2 377.37
Fixed assets (EUR ha^{-1})	6 929.55	6 608.25	7 153.05	1 354.43	1 513.18	1 602.26
including:						
land (EUR·ha^{-1})	4 601.94	4 394.44	4 754.93	644.43	698.12	753.08
buildings (EUR·ha^{-1})	1 193.22	1 132.76	1 245.16	120.26	128.94	174.24
machinery (EUR·ha^{-1})	1 117.80	1 059.91	1 137.53	577.93	671.22	667.19
breeding livestock (EUR·ha^{-1})	16.60	21.14	15.43	11.81	14.90	7.52
Total current assets (EUR·ha^{-1})	749.84	720.36	776.23	831.68	720.54	775.10
milk						
Total assets (EUR ha^{-1})	10 428.94	10 461.26	10 854.48	2 699.50	2 988.92	2 947.11
Fixed assets (EUR ha^{-1})	9 561.72	9 499.19	9 794.99	1 969.76	2 100.85	2 089.00
including:						
land (EUR·ha^{-1})	4 807.35	4 841.51	5 063.20	655.13	652.58	657.98
buildings (EUR·ha^{-1})	2 094.98	2 162.36	2 134.58	314.73	301.64	294.13
machinery (EUR·ha^{-1})	1 939.11	1 783.39	1 834.97	716.89	881.73	872.40
breeding livestock (EUR·ha^{-1})	720.31	711.93	762.24	282.99	264.90	264.49
Total current assets (EUR·ha^{-1})	862.89	962.07	1 059.54	729.74	888.07	858.08

Source: own calculation based on FADN data

Management of agricultural production costs is always considered in the context of the efficiency of this production. In reference to plant production, it should be noted that, during the studied period, the profitability index was greater than 1 (except for 2016, in Lithuania), which means that the value of production covered production costs. (tab. 4). However, it is difficult to acknowledge such an index as satisfactory, as it was only minimally greater than 1. It would be more accurate to speak of a profitability threshold, particularly about Polish farms. Milk production had relatively high profitability in Poland. The productivity of fixed assets was higher in the case of Lithuania, for farms of both types. In the case of farms specializing in plant production, the difference was 3- to 4-fold, and 2- to 3-fold in the case of farms specializing in milk production, depending on the year. Such a large difference between farms from both countries arises from the different ratios of the value of production to the value of fixed assets. In Poland, a lower value of production is coupled with a higher value of fixed assets, while the opposite is true in Lithuania: a higher value of production is coupled with a lower value of fixed assets.

Table 4. Economic results

Specification	Poland			Lithuania		
	2015	2016	2017	2015	2016	2017
fieldcrops						
Total output (EUR·ha^{-1})	1 042.87	921.02	984.80	774.07	633.06	761.46
Profitability ratio	1.098	1.049	1.082	1.143	0.912	1.064
Productivity of fixed (EUR)	0.15	0.14	0.14	0.57	0.42	0.47
The rate of reproduction of fixed assets	-0.014	-0.048	-0.034	0.075	0.173	0.104
Farm net value added (EUR·AWU $^{-1}$)	6368	6027	7075	15 401	9 308	14 392
milk						
Total output (EUR·ha^{-1})	1 519.03	1 504.15	1 883.38	763.63	719.62	891.07
Profitability ratio	1.179	1.213	1.425	0.958	0.864	1.007
Productivity of fixed (EUR	0.16	0.16	0.19	0.39	0.34	0.43
The rate of reproduction of fixed assets	-0.013	-0.020	0.010	0.054	0.118	0.028
Farm net value added (EUR·AWU $^{-1}$)	7 373	7 862	11 246	4 719	4 966	6 256

Source: own calculation based on FADN data

Possibilities of reproducing fixed assets are determined by the rate of reproduction of these assets. The presented data shows that, during the studied period, Polish farms did not have the capacity to reproduce assets, as indicated by the negative reproduction rate of fixed assets, except for dairy cattle farms in 2017. This situation is indicative of decapitalization of fixed assets. This trend has been going on for many years. Research conducted by Zwolak (2008) has shown the diminishing impact of the productivity of fixed assets and the decreasing productive efficiency of Polish agriculture from 2002-2005. This situation was caused by the relative stability in the generic structure of fixed assets. The efficiency of fixed assets in other sectors of the economy is similarly low (Beyer and Hinke, 2018).

During the studied period, although Lithuanian farms were characterized by a positive reproduction rate of fixed assets, it had very low values. One may surmise that investments were small, but opportunities to reproduce property appeared.

In agriculture, expenditures are substituted in the production process. The most encountered form of substitution is replacement of labor with capital, and the goal of this substitution is to increase labor effectiveness. Labor effectiveness (net value added) was therefore accepted as an indicator of economic effects in the studied farms.

The data presented shows that labor effectiveness varied and is difficult to interpret unambiguously. In the case of field crop farms, Lithuanian farms were characterized by higher labor effectiveness, and the difference was two-fold. At the same time, in the case of farms specializing in milk production, higher labor effectiveness was noted in Poland, and the difference was 66% in comparison to Lithuanian farms. The dependence between the value of fixed assets and work effectiveness is confirmed by the coefficient of determination. In Polish farms specializing in milk production, the coefficient of determination amounts to R^2=0.2565, whereas in the case of Lithuanian farms, it is R^2=0.2301 (fig. 2 and 4). In reference to Lithuanian farms specializing in field crops, this dependence is much weaker. In the case of Lithuania, the dependence between the value of assets and labor effectiveness is only explained in 11% (R^2=0.1130), and in Polish farms, this dependence was not observed (fig. 1 and 3). This is probably because plant production (fieldcrops) requires the engagement of machinery only during the vegetative season and not for the entire year and can also be conducted basing on services. Therefore, the decision to invest in fixed assets for farms specializing in plant production will, in many cases, be considered against the backdrop of prices of services, as an alternative solution to purchase of machinery.

Meanwhile, animal production is more demanding in terms of availability of fixed assets, which are used year-round. Furthermore, animal production is more burdensome and requires higher labor inputs, which is why farms with this profile are more eager to invest in equipment and machinery reducing this burden. When analyzing fixed assets on farms, it is worth noting that the value of machinery and equipment per 1 ha of farmland is higher in farms specializing in milk production, which would confirm the validity of the adopted hypothesis. About the relationships between fixed assets and the value of production, a dependence was observed at a level from 27.48% to 29.97% depending on the type of production, with the exception of Lithuanian farms specializing in milk production, where this dependence amounts to 20.81%.

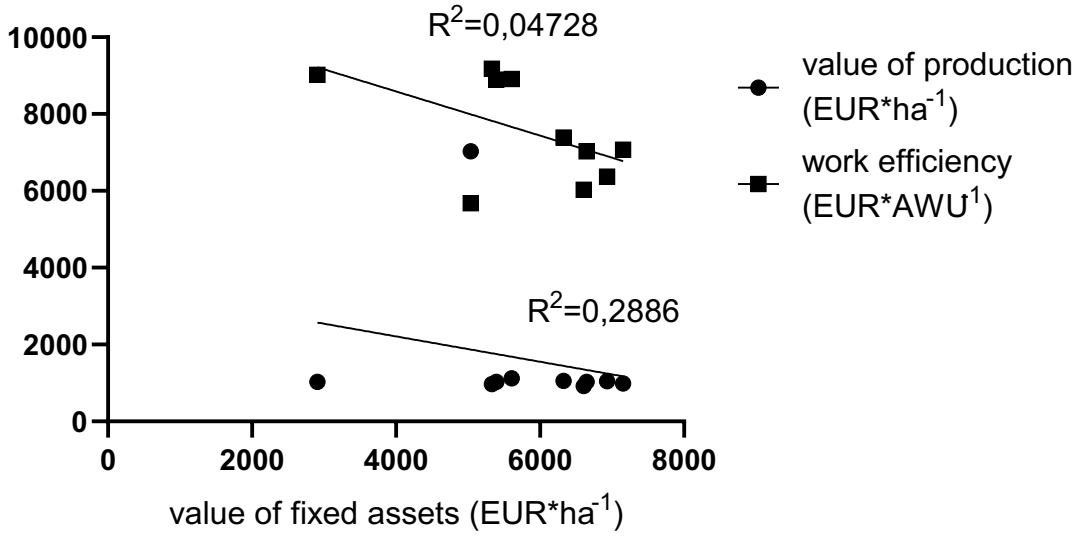

Fig. 1. Correlation between the value of fixed assets and the value of production and work efficiency - Polish farms specializing in fieldcrops
Source: own calculations

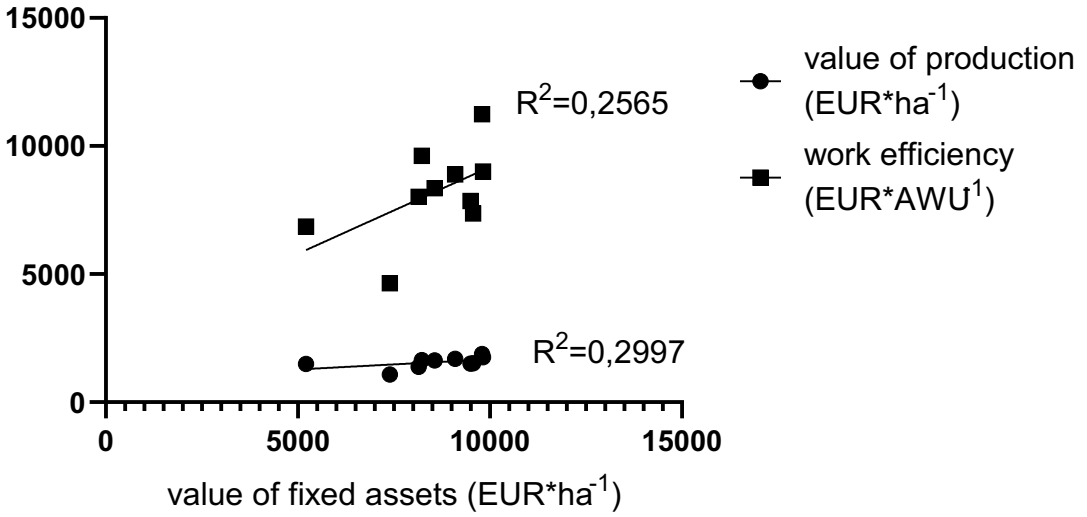

Fig. 2. Correlation between the value of fixed assets and the value of production and work efficiency - Polish farms specializing in milk
Source: own calculation

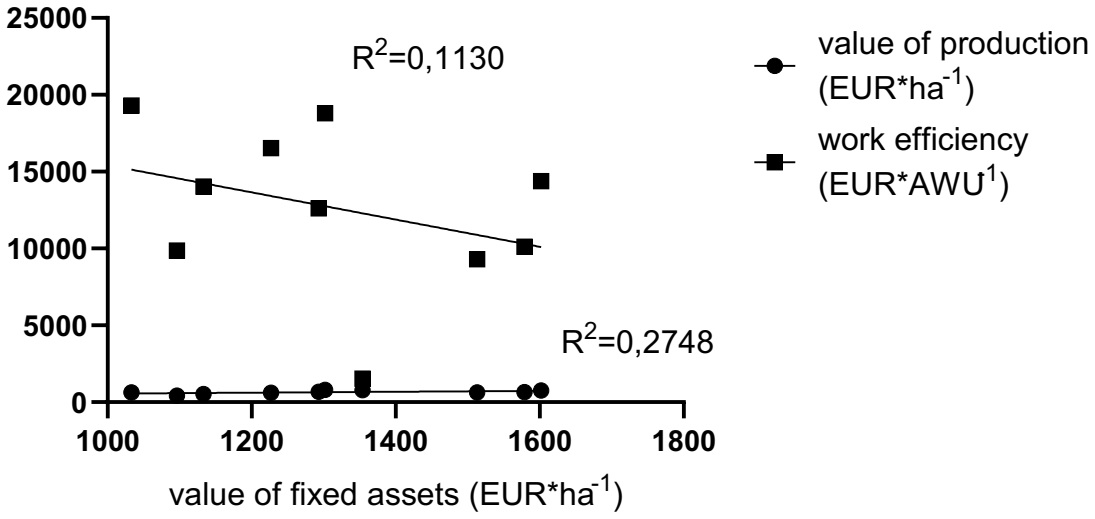

Fig. 3. Correlation between the value of fixed assets and the value of production and work efficiency - Lithuanian farms specializing in fieldcrops
Source: own calculation

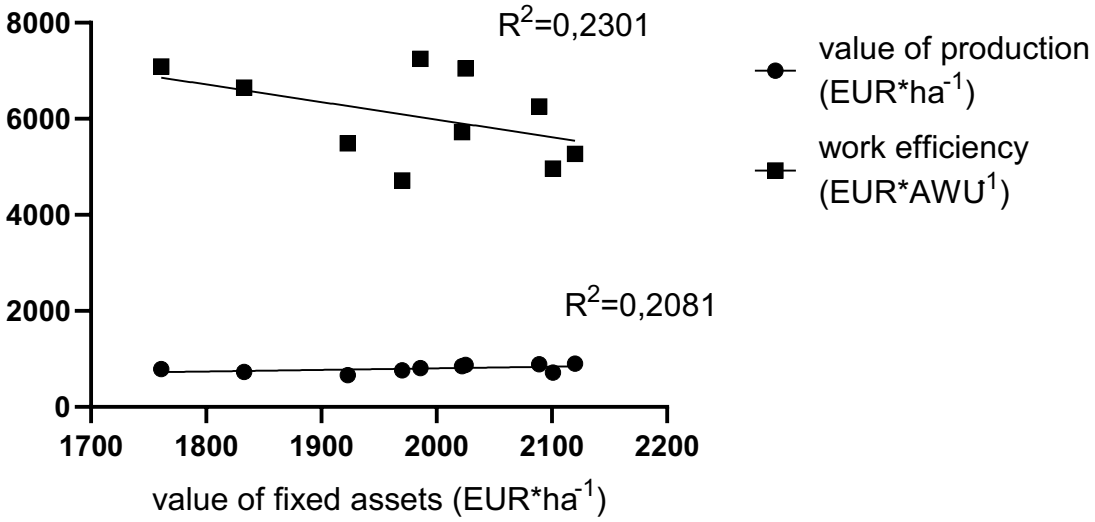

Fig. 4. Correlation between the value of fixed assets and the value of production and work efficiency - Lithuanian farms specializing in milk
Source: own calculation

4. Conclusions

Fixed assets are the foundation of agricultural production. Comparing the farms of Lithuania and Poland, Polish farms are better equipped with fixed assets. At the same time, considering type of production, farms specializing in milk production were technically better-equipped in both countries. This most likely arises from technological differences between the compared farm types.

The availability of fixed assets on farms is of great significance to farming efficiency. Farms better-equipped with fixed assets are characterized by higher labor effectiveness, although it too depends on the type of production conducted on the farm. In the case of Poland, farms specializing in milk production were characterized by higher labor effectiveness, which was 35% higher than on

fieldcrop farms. As for Lithuanian farms, those specializing in fieldcrops reached higher labor effectiveness than those specializing in milk production (by more than two-fold). In this case, the difference is the result of the larger scale of production, as plant production is conducted on an area of farmland that is approximately three times larger, which yields higher labor effectiveness for relatively similar employment. During the studied period, Polish farms did not have the capacity to reproduce their property, and with respect to Lithuanian farms, it can be said that such opportunities arose.

The efficiency of agricultural production is also determined by the ratio of the value of production to costs incurred. The productivity of fixed assets was higher in Lithuanian farms. During the studied period, the value of production covered the costs of production in fieldcrop farms. However, only Polish milk-producing farms can boast profitability.

The costs of maintaining fixed assets and their depreciation are a substantial item in the total costs of agricultural production, making up 40% of all costs. It would seem justified to verify tangible fixed assets in farms' possession and identify farms' real needs for mechanization. On many farms, the scale of agricultural production is too small, and technical and operational capabilities of machines are not used to their full potential, reducing farming efficiency. In such a case, the decision to purchase own fixed assets in the form of machines and equipment should be considered in the context of prices of services offered by external entities.

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