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## **SIZE AND EFFECTIVENESS OF FIELD CROP FARMS**

Key words: plant production, agricultural production results, effectiveness in agriculture

**ABSTRACT.** The aim of the study is the assessment of the management effectiveness of production resources on farms of various sizes focused on cultivating cereal, oil and protein crops against a background of total field-crop farms and total farms. The assessment covered farms encompassed by the FADN system in 2017 in the scope of production organization and intensity, production and economic results as well as the effective management of resources. The productivity and profitability of resources on cereal farms was found to be on a far lower level, however, as farm size increased, the productivity of land resources generally rose, too. There is a reverse tendency when compared to the tendencies observed in the total number of farms, including horticulture farms. Together with an increase in farm size, differences in profitability declined. The greatest differences were observed when it came to land resource profitability, while the least in the scope of labour profitability. Therefore, it can be assumed that by increasing the size of cereal farms, the effectiveness of managing land resources on such agricultural holdings will clearly improve.

### **INTRODUCTION**

One of the most important factors improving the way in which production resources in agriculture are made use of is increasing farm size, specializing and growing a farm's production scale. [Kołodziejczak 2015, Kuś 2012, Smędzik 2010, Vollrath 2007]. Farm size shapes its effectiveness level. The possibilities of investing, introducing technological progress, increasing production efficiency as well as reaching a level of economies of scale and growth effectiveness of resource management vary depending on how big a farm is. [Grochowska, Mańko 2014, Sobczyński 2013, Wicki 2019].

Farm specialization is determined by many factors, both internal and external, and is a long-term process requiring much investment expenditure. [Czyżewski, Smędzik-Ambroży 2013]. According to Poland's Central Statistical Office, Polish agriculture is becoming ever more specialized, concentrated, more production intensified and regionally differentiated in the scope of production type [GUS 2019]. There are more and more farms specializing, among others, in plant production. In 2013, there were 702,959 farms specializing in field crops, constituting 49% of all farms (1,429,006), while in 2016 this number increased to 797,409 farms, amounting to 57% of all farms (1,410,704) [GUS 2017].

The increase in the share of specialist plant farms is a result of certain processes which have been adapted to meet the demands of a market economy. It is quite certain that this group of farms shall find a permanent spot in Polish agriculture [Ziętara, Zieliński 2012]. Agricultural holdings specializing in plant production are usually of a non-inventory character. As a result, there is a risk that the level of soil humus may drop, thus resulting in poor soil fertility [Kuś 2013]. This risk grows together with greater farm intensity combined with a prevalence of cereal crops [Krasowicz 2009]. The appropriate management of natural resources entails the maintenance of a balanced level of soil organic material. This condition forms the basis of maintaining or even improving soil fertility [Grzelak 2010], which may prove hard to implement on plant farms. Furthermore, what is particularly threatening to the effectiveness of such agricultural holdings, especially in regions characterized by light soils, are more frequent water shortages and droughts associated with such shortages [Zieliński 2015].

## RESEARCH MATERIALS AND METHODS

The aim of the study is the assessment of the effectiveness of production resource management on farms of different sizes focused on cultivating cereal, oil and protein crops against a background of the total number of farms focused on general field cropping as well as the total number of farms. Farms considered for this study were those encompassed by the FADN<sup>1</sup> system in 2017. To simplify matters, this study uses the term cereal farms for agricultural holdings specializing in cultivating cereal, oil and protein crops. Farms specializing in general field cropping of various plant species, however, are referred to as plant farms. In accordance with the adopted assumptions of the agricultural accounting system, the survey only covered commercial farms [Goraj, Mańko 2009]. Due to this fact, the FADN system fails to incorporate cereal agricultural holdings below 5 ha of ULA, therefore the study only includes agricultural holdings exceeding 5 hectares and groups land size into the following categories: UAA: 5-10 ha (small), 10-20 and 20-30 ha (medium), 30-50 ha (large) and above 50 ha (extremely large).

In the study analyses, the potential of production resources, production organisation, production results, productivity of input, revenue and resource profitability of agricultural holdings covered by the study were examined. In accordance with the FADN methodology, the category of total production was used to measure production results, and economic results: income from a family farm, called farm income in the study. The effectiveness of managing production resources of agricultural holdings is measured by relating the value of production effects and the economic results of agricultural holdings to the input of production factors involved in achieving output [Józwiak 1998, Kapusta 2012]. Relating the production results appropriately allows to assess the production effectiveness (land productivity, economic work efficiency, capital productivity), while relating economic results gives an understanding of economic effectiveness (profitability of land resources, labour input and invested capital).

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<sup>1</sup> FADN is the EU system for collecting accounting data from farms in all member countries.

## RESEARCH RESULTS

The average UAA of the analyzed agricultural holdings within the following specified group sizes did not differ substantially: 5-10, 10-20, 20-30 and 30-50 ha of UAA, however in agricultural holdings exceeding 50 ha of UAA, it was found to be greater on farms specializing in plant production (by 13%), in particular on cereal farms (by almost 20%) in comparison with farms in total (Table 1). The compared farms used land resources, which were partially leased. The area of leased land grew visibly together with farm size and fluctuated in the range of around 10% on small farms and up to 50% on very large farms.

Table 1. Production resources in comparison with farms grouped according to UAA size

Farms	Group sizes [ha UAA]				
	5-10 (small)	10-20 (medium)	20-30 (medium large)	30-50 (large)	over 50 (very large)
Number of farms					
Total	1,170	3,485	2,431	2,492	2,205
Plant	305	944	675	827	1,169
Cereal	91	443	352	478	811
Average UAA [ha]					
Total	8.0	15.0	24.8	38.9	92.7
Plant	8.2	14.9	24.7	39.2	105.0
Cereal	8.6	15.0	24.8	39.7	110.4
Total labour input [AWU]					
Total	1.61	1.70	1.80	1.90	2.23
Plant	1.50	1.58	1.64	1.67	2.04
Cereal	1.04	1.16	1.26	1.43	1.85
Share of paid labour [%]					
Total	11.8	7.6	6.7	8.0	18.4
Plant	10.0	13.9	13.4	10.8	20.1
Cereal	0.0	0.9	0.8	4.2	14.1
Total labour input per 100 ha UAA [AWU]					
Total	20.1	11.3	7.3	4.9	2.4
Plant	18.3	10.6	6.6	4.3	1.9
Cereal	12.1	7.7	5.1	2.8	1.7
Total assets per 1 ha UAA [thousand PLN]					
Total	61.4	50.1	44.1	40.2	32.5
Plant	56.8	43.2	37.8	35.1	30.0
Cereal	50.7	39.9	35.3	33.1	28.6

Source: own elaboration based on [FADN 2018, 2019]

On the basis of accountancy data, it can be inferred that total annual labour input when expressed in full-time, annual labourer (in AWU<sup>2</sup>) was far lower on farms specialising in cultivating cereal, oil and protein crops, especially against a background of total farms (Table 1). The labour input was found to be much lower across all groups, which results from the fact that production is far less labour intensive on such farms (measured as labour input per 100 ha of UAA). On small cereal farms, production labour intensity was 40% lower compared with total farms and 34% lower in comparison with plant farms, while 30% and 11% lower on very large farms. As a result, the share of paid labour on cereal farms was also relatively low – on small and medium-sized cereal farms it did not exceed 1%. The share of paid labour was the greatest on plant farms – in the group of farms exceeding 50 ha of UAA and constituted over 20% (total farms – 18.4%, cereal farms 14.1%).

The potential of capital resources of agricultural holdings is based on fixed and circulating production, the value of which chart the total assets of a holding. Their value in terms of 1 ha of UAA, constituting capital intensity of production, was relatively smaller in all farm group sizes specializing in plant production, in particular the cultivation of cereal, oil and protein crops (Table 1). The greatest differences were observed in average and large agricultural holdings. The capital-intensity of production on medium and large horticulture farms was relatively lower by 18-20% when compared with total farms.

The input of production resources in methods of production of the studied agricultural holdings shaped, among others, production organisation. Production organisation in the analysed holdings was characterised by the following indicators: share of cereal, oil crops, legumes, potatoes, sugar beet and vegetables in field crop as well as livestock in LU<sup>3</sup> per 100 ha UAA (Table 2).

On agricultural holdings specialising in cultivating cereal, oil and protein crops, the share of cereal in the structure of field crop fell within the range of 53-67%, reaching higher levels on average sized farms. The second group of crops with a high share was oil crops. Their share increased together with an increase in farm size area – from 16% on small farms, to 27% on very large farms. The third group of crops with a high share were protein crops cultivated for seeds. Their share decreased together with an increase in farm size area – from 8.5% on small farms to 5.5% on very large holdings. The share of other crops in the structure of field crops of particular farm size was insignificant. The share of potatoes did not exceed 1%, the share of sugar beet reached 2% on very large holdings, while vegetables accounted for 0.1%.

On farms specialising in field crops of differing plant species, the area of cereal in the field structure was relatively smaller and was found to be around 51-59%. The second group of crops with a meaningful share was oil crops. The share of oil crops increased together with farm size – from 8% on small farms to 25% on very large ones. Further groups of crops with a significant share were protein crops, potatoes, sugar beet and vegetables. The share of protein crops fluctuated in the range of 5-6.5%, potatoes 2-8%, sugar beet 1-4% and vegetables 1-7%. The share of potatoes and vegetables decreased as the area size of a farm increased, whilst the share of sugar beet – increased.

<sup>2</sup> AWU – the unit of measurement of labour input pursuant to FADN methodology: 1 AWU is equivalent to 2200 hours of work/year. Labour input charts the labour input of the farmer and the farmer's family (FWU) as well as paid labour input (AWU).

<sup>3</sup> LU – the unit of livestock pursuant to FADN methodology equal to 1 dairy cow or cull dairy cow or bull aged 2+.

Table 2. The organization of production intensity of compared farm groups according to UAA

Farms	Farm size group [ha UAA]				
	5-10 (small)	10-20 (medium)	20-30 (medium large)	30-50 (large)	over 50 (very large)
Cereal share in field crop area [%]					
Total	65.6	64.3	59.4	57.5	52.0
Plant	53.7	58.8	56.6	55.7	50.8
Cereal	60.0	66.7	63.3	60.2	53.4
Oil crop share [%]					
Total	3.93	5.1	7.3	10.6	19.6
Plant	8.34	10.6	14.4	18.4	24.5
Cereal	15.9	16.0	18.9	21.7	26.6
Legume share [%]					
Total	3.7	3.9	4.5	4.7	4.8
Plant	6.4	6.1	6.5	6.2	5.0
Cereal	8.5	7.5	7.2	7.0	5.5
Potato share [%]					
Total	4.3	2.7	2.3	1.9	1.5
Plant	8.1	4.3	3.9	2.9	1.9
Cereal	0.7	0.7	0.5	0.4	0.2
Sugar beet share [%]					
Total	0.7	2.0	2.7	3.1	3.6
Plant	1.3	2.7	3.8	4.2	4.2
Cereal	0.0	0.6	0.8	1.2	2.0
Vegetable share [%]					
Total	3.0	1.7	1.2	1.0	0.7
Plant	7.3	4.6	3.4	2.3	1.0
Cereal	0.1	0.1	0.1	0.1	0.0
Livestock per 100 ha of UAA [LU]					
Total	81.5	98.6	99.8	89.4	52.2
Plant	9.1	7.2	6.1	6.2	4.3
Cereal	4.6	3.6	3.4	2.9	2.7
Total costs per 1 ha of UAA [thousand PLN]					
Total	3.93	3.26	3.21	3.34	3.37
Plant	5.84	4.33	3.98	3.78	3.69
Cereal	8.70	6.08	5.84	5.69	4.85

Source: as in Table 1

The livestock on analysed farms was very low and did not exceed 10 LU/100 ha of UAA. On cereal farms, it did not even exceed 5 LU/100 ha of UAA. As the farm size area increased, the number of livestock decreased and on the very large farms, the number equaled 4.3 LU/100 ha, while on the very large cereal farms, this number constituted 2.7 LU/100 ha of UAA, which is extremely disadvantageous to the maintenance of soil fertility [Krasowicz 2009].

The level of production costs expressed per agricultural holding UAA charts the production intensity level [Goraj, Mańko 2009, Ziętara 2017]. The most intensive production on the analysed agricultural holdings was observed on farms specializing in cultivating cereal crops, oil and protein crops. Following close behind were farms specializing in field crops of various plant species. The level of production intensity of plant and cereal farms decreased with the increase of farm size, especially on cereal farms. Analogous tendencies were not observed on total farms (Table 2).

The production results measured by the total level of production value on the studied farms were the highest in the total number of farms, followed by plant farms. The lowest level was observed on cereal farms (Table 3). In total farms, a significant role in the results observed was played by livestock production, which constituted more than half of total production value on average. However, on plant farms, except for cereal cultivation (50% on average) and oil crops (around 20%), the results of the production value

Table 3. Production value and resource productivity of compared farm groups according to UAA

Farms	Farm size groups [ha UAA]				
	5-10 (small)	10-20 (medium)	20-30 (medium large)	30-50 (large)	over 50 (very large)
Total production [thousand PLN]					
Total	83.97	114.65	184.23	283.09	557.32
Plant	56.85	75.48	114.96	175.60	454.94
Cereal	31.29	50.25	86.13	147.53	437.77
Soil productivity [PLN/ha]					
Total	10 513	7 636	7 436	7 279	6 015
Plant	6 932	5 083	4 654	4 478	4 334
Cereal	3 645	3 348	3 469	3 721	3 960
Economic labour efficiency [thousand PLN/AWU]					
Total	52.26	67.58	102.11	148.72	250.46
Plant	37.82	47.73	70.16	105.33	223.50
Cereal	30.00	43.48	68.51	102.83	236.86
Productivity per PLN 100 of total assets [PLN]					
Total	17.1	15.3	16.8	18.1	18.5
Plant	12.5	11.8	12.3	12.6	14.5
Cereal	7.2	8.4	9.8	11.3	13.9

Source: see Table 1

level were greatly influenced by vegetable production (8%), fruit production (7%), potato production (7%) and sugar beet (5%).

The productivity of resources, similarly to production results, was found to be at a much higher level when it came to total farms, followed by plant farms and then the lowest being found on cereal farms. On cereal farms, the total productivity of land resources increased together with an increase in farm size, which is a reverse trend when it comes to the observed total farm number as well as on farms specializing in field crops of various plant species (Table 3). This is a result of the organisation of cereal farm production, mainly due to a growing share of oil plants in the field crop area as farm size increases. On farms specializing in field crops of various plant species, declining land productivity was connected to a decreasing share of vegetable, potato and protein plant cultivation.

Economic labour efficiency increased together with farm size, which is a commonly known trend. On farms specializing in cereal production, oil and protein crops, efficiency grew faster than on farms specializing in field crops of various plant species. On the largest cereal farms it was higher than on the largest plant farms. The production efficiency of invested capital was significantly lower on plant farms, especially cereal farms, than on total farms. This was observed despite lower capital-intensity (Table 1) and higher production costs on these farms (Table 2).

The economic results of the analysed farms measured by farm income have been presented in table 4. Horticulture farm income, similarly to production results, was found to be at a lower level, while on cereal farms at a much lower level in relation to the total number of farms. Bigger differences were observed on smaller farms, especially cereal farms in relation to total farms: 70% on small farms, and 15% on the largest farms.

Both in the case of farms specialising in plant production, especially cereal production, oil and protein crops, and total farms, the level of final results was shaped, to a large extent, by subsidies obtained by agricultural holdings. They have a significant share in the income of all farms in Poland and other EU countries. In 2009, the share of payments in the income of EU-15 farms exceeded 100% of income [Runowski 2014]. In Poland, their highest share was recorded in the income of multidimensional farms and those specialising in field crops [Goraj, Mańko 2013]. In the years 2013-2016, the share in subsidies of total farms equaled 70%, while on farms specialising in field crops – more than 80% [Komorowska 2018].

The share of subsidies in the total number of studied farms in 2017 was around 50%. On plant farms it was higher and more differentiated depending on farm size and ranged between: 61% on farms with 5-10 ha to 79% on farms with 20-30 ha of UAA. On cereal farms with an area size of 5-10 ha and 10-20 ha of UAA, the subsidies partially covered production costs and shaped the positive final result, however, on farms exceeding 50 ha of UAA, the subsidy share in income was the lowest and constituted 68% (Table 4).

Due to the fact that the level of income achieved on farms specializing in horticulture production, especially cereal crops, oil and protein crops was relatively lower, resource profitability was also lower on such holdings. Bigger differences were observed on smaller farms, especially cereal farms in relation to total farms. When it comes to land resource profitability, differences on such farms were as follows: small farms by 74% and on the largest farms by 28%. In the case of own labour profitability – 62% and 2%, respectively, while in the case of capital profitability – by 70% and 19%, respectively.

Table 4. Income and resource profitability of compared farm groups according to UAA

Farms	Farm size groups [ha UAA]				
	5-10 (small)	10-20 (medium)	20-30 (medium large)	30-50 (large)	over 50 (very large)
Farm income [thousand PLN]					
Total	25.72	46.28	79.04	118.44	223.11
Plant	19.46	31.33	51.65	79.39	194.46
Cereal	7.12	19.46	38.97	63.58	190.54
Share of subsidies in the farm [%]					
Total	49.9	54.3	54.1	52.4	53.9
Plant	60.9	71.7	79.0	72.8	67.2
Cereal	145.5	105.1	94.0	81.9	68.2
Farm income per 1 ha of UAA [PLN]					
Total	3 213	3 087	3 185	3 045	2 407
Plant	2 378	2 103	3 092	2 025	1 852
Cereal	828	1 297	1 571	1 602	1 726
Own labour profitability [thousand PLN/FWU]					
Total	18.11	29.48	47.05	67.68	122.59
Plant	14.41	21.46	36.37	52.93	119.30
Cereal	6.85	16.92	31.18	46.41	119.84
Total assets profitability [%]					
Total	5.3	6.2	7.2	7.6	7.4
Plant	4.3	4.7	5.5	5.8	6.2
Cereal	1.6	3.3	4.4	4.8	6.0

Source: see Table 1

## CONCLUSIONS

The studied agricultural holdings of various sizes, specializing in cultivating cereal, oil crops and protein crops in relation to total farms specializing in field crops and the total number of farms have a much lower labour input and lower capital value in relation to land resources. The level of production intensity on cereal farms was clearly higher, especially on smaller farms and compared to total farms. However, the production efficiency of resource management on this type of farm, similarly to production results, was at a much lower level (land productivity on small and medium-sized farms by over 50%). However, with an increase in cereal farm size, total land resource productivity increased, thus proving to be a reverse trend in comparison with the observed total number of farms as well as plant farms.



Cereal farms also attained far lower economic results, which is why the economic effectiveness of resource management on such farms was also visibly smaller, especially in relation to total farms. Together with the increase in farm size, these differences clearly decreased. The biggest differences were noted in the scope of land resource profitability, while the lowest in the scope of own labour profitability. On cereal farms exceeding 50 ha of UAA, own labour profitability was at the same level as plant farms and almost at the same level as total farms, which is a result of a relatively lower labour input on cereal farms. Thus, increasing the size of cereal farms leads to a significant improvement in resource management effectiveness on such farms.

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## WIELKOŚĆ A EFEKTYWNOŚĆ GOSPODARSTW NASTAWIONYCH NA UPRAWY POŁOWE

Słowa kluczowe: produkcja roślinna, wyniki produkcji rolniczej, efektywność w rolnictwie

### ABSTRAKT

Celem opracowania jest ocena efektywności gospodarowania zasobami produkcyjnymi w gospodarstwach nastawionych na uprawę zbóż, roślin oleistych i białkowych o różnej wielkości, na tle wyników ogółu gospodarstw nastawionych na uprawy polowe oraz ogólnej liczby gospodarstw rolnych. Ocenie poddano gospodarstwa objęte rachunkowością rolną w systemie FADN w 2017 roku w zakresie organizacji i intensywności produkcji, wyników produkcyjnych i ekonomicznych oraz efektywności gospodarowania zasobami. Produktywność i dochodowość zasobów w gospodarstwach zbożowych ukształtowała się na znacznie niższym poziomie, ale wraz ze wzrostem ich wielkości, produktywność zasobów ziemi na ogół wzrastała, co było odwrotną tendencją w porównaniu do obserwowanej w ogólnej liczbie gospodarstw rolnych, a także roślinnych. Wraz ze wzrostem wielkości porównywanych gospodarstw zmniejszały się różnice w ich dochodowości. Największe różnice wykazano w zakresie dochodowości zasobów ziemi, a najmniejsze w zakresie dochodowości pracy własnej, co wynikało z relatywnie mniejszych nakładów pracy w gospodarstwach zbożowych. Zatem powiększanie gospodarstw zbożowych jest drogą do wyraźnej poprawy efektywności gospodarowania zasobami w tego typu gospodarstwach.

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