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Costs and Profitability

UNIT COSTS AND INCOME FROM SELECTED PRODUCTS IN 2018: RESEARCH RESULTS IN THE AGROKOSZTY SYSTEM

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Abstract

The main objective of the research was to assess the production and economic results of winter wheat, rye, spring barley, grain maize, winter oilseed rape and sugar beets in 2018 depending on the scale of their cultivation. The research was conducted on commercial farms, which sell their production. These farms were purposively selected from a representative farm sample that was in the field of observation of the Polish FADN system. Data describing the studied agricultural products were collected in the AGROKOSZTY system, and then supplemented with data from the Polish FADN database.

The results of the analysed products were influenced by production capacity of farms, i.e. resources of land, labour and capital, their quality and the manner of use, but they were also dependent on external conditions (e.g. market, weather). These impacts resulted in varying degrees of changes in the volume of production, unit costs and price of products.

In 2018, the income from the surveyed agricultural products was within fairly wide limits. However, the positive impact of the size of the production scale was visible. In each group, there were farms where production was unprofitable, but in the case of large-scale cultivation, the percentage of farms with an indicator below 100 was always the smallest (the only exception was sugar beet).

Keywords: unit costs, agricultural products, production scale, production profitability.
JEL codes: D24, O13, Q12.

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Introduction

Farms perform many functions, one of them is the production function, which is seen in the context of producing agricultural products. In the production process, economic calculations play for farmers an important role, as the requirement of rational activity is to achieve the best possible outputs in relation to inputs incurred, i.e. to achieve the highest possible management efficiency. One of the most important criteria for assessing the efficiency are costs, therefore, it is so important to measure, control and plan them. The knowledge of production costs allows to analyse pursued activities in terms of profitability and efficiency. Cost optimisation is a wide-ranging issue and it is not easy for a farmer to make a right decision on the production intensity.[1]

Agricultural producers should search for solutions that would allow to reduce production costs. The reduction in costs can take place at the level of inputs directly related to the production produced, in this case the possibilities of change are determined by the technology used. The reduction may also take place at the level of fixed costs and concentrate on optimising resources of farms, the functioning of which, with the full use of production capacity, is an exception rather than a rule. When considering the reduction in costs, it should be borne in mind that costs are an economic indicator of resources consumed in the production process. Thus, high costs reflect the level of consumed resources, and therefore contribute to the low profitability of produced agricultural products and to the low management efficiency.

Rules functioning in the market economy make farmers increase both the management efficiency and the production scale. The study presented the production and economic results of winter wheat, rye, spring barley, grain maize, winter oilseed rape and sugar beets on farms differing in the cultivation scale of those products in 2018. The results achieved do not fully meet the issues of production profitability depending on the scale size, but are a good illustration of the situation, despite the relative nature of the production size, which was adopted as small, medium and large.

Subject and method of studies

The subject of the studies were the production and economic results of six crop production activities (winter wheat, rye, spring barley, grain maize, winter oilseed rape, sugar beet). The empirical data describing the analysed activities was collected in 2018 on individual farms located throughout Poland. These farms were purposively selected from a representative farm sample that was in the field of observation of the Polish FADN system. These were commercial farms that generally have greater development opportunities.[2] The selection of farms for the studies was carried out for each activity independently. The condition was a specific scale

[1] The volume of inputs of working assets per 1 ha or 1 animal reflects the intensity in agriculture – see Manteuffel (1984).

[2] Farmers operating commercial farms, i.e. those whose production is to be sold, are enterprises. Therefore, farmers are, in fact, entrepreneurs – see Ziętara (2009).

of its production and the farmer's consent to conduct the studies. Data describing the activities analysed was collected according to the methodological assumptions of the AGROKOSZTY system (System for Collecting Data on Agricultural Products). It was supplemented by data from the Polish FADN database (Farm Accountancy Data Network) and then processed according to the assumptions developed.

The studies covered revenues (value of potentially commercial production per 1 ha of crops), costs and economic effects. The indicator to assess the results achieved were the income categories (analysed without subsidies and after taking this support into account), i.e. gross margin and income from activity, the method of calculating them is presented below:

gross margin = production value – direct costs,

income from activity = production value – total costs (direct and indirect costs in total).

Subsidies are an instrument to support and stabilise farmers' income. Based on data on the amount of subsidies for analysed agricultural products on farms where the studies were conducted and the amounts of direct payment rates in 2018 and the rules for granting them, the maximum amount of subsidies that farmers could receive, assuming they had met all the required conditions, has been calculated. It should be added that in calculating the above-mentioned income categories the amounts of output and input VAT are not taken into account.

The production value of the analysed crop production activities includes the value of major products (e.g. grain, roots) and by-products (e.g. straw) placed on the market. It is determined according to market selling prices or according to ex-farm selling prices (i.e. on the farm). It therefore depends on the level of crop yield and the selling price of products. Losses (which arose following the harvest, e.g. during cleaning) are deducted from the production value.

Direct costs reflect costs incurred throughout the production cycle, so they illustrate current market conditions. The 12 consecutive months of the calendar year were adopted as a fiscal period. However, for some crop production activities (it refers mainly to winter crops), inputs and direct costs incurred reflect the whole production cycle, i.e. all production-related inputs and costs occurring in the year preceding the studies and in the year to which the studies conducted refer. Information on inputs and direct costs incurred in the case of crop production always refers to the harvest area of the analysed activity. The off-farm components of direct costs are determined according to purchase prices while on-farm components (e.g. seed material) according to ex-farm selling prices. The individual cost components are reduced by subsidies granted.

The rule governing the inclusion of specific cost components in direct costs is the simultaneous fulfilment of three conditions, i.e.:

– the costs can be attributed to a particular activity without any doubt,
– their amount is proportionally linked with the production scale,
– they have a direct impact on the production size (its volume and value).

Direct costs of crop production include:
- seed and planting material (*purchased or produced on the farm*),
- purchased fertilisers[3] (*without fertiliser lime*),
- plant protection products,
- growth regulators (*rooting products, growth substances, defoliants*),
- insurance relating directly to the activity concerned,
- specialised costs including:
  - specialised expenses on crop production,
  - specialised services,
  - occasional hiring for specialised work.

Direct and indirect costs are included in the accounts that lead to calculating income from activity. Direct costs are attributed directly to products, based on relevant source documents. On the other hand, **indirect costs** are taken from the Polish FADN database. Indirect costs can be defined as production readiness costs, they are incurred for the functioning or only for the existence of the farm. Indirect costs of the farm are divided into indirect actual and estimated costs (Goraj and Mańko, 2004).

Indirect actual costs include:
- overhead costs – electricity, fuel, diesel fuel, current repairs, maintenance and inspections, services, insurance (e.g. for buildings, property and transport), other costs, e.g. payment for water, telephone, fertiliser lime;
- taxes – agricultural tax, forestry tax, tax on special sections, property tax and other taxes, e.g. tax on means of transport;
- costs of external factors – cost of paid labour, rents and interest.

Indirect estimated costs include depreciation of:
- buildings and structures,
- technical machinery and equipment,
- means of transport,
- drainage equipment,
- perennial orchards and plantations,
- intangible assets,
- completed investments in foreign fixed assets.

At the time of emergence, indirect costs cannot be divided among products, these are common costs for the whole farm, and division keys are used for their division. According to the methodology used, indirect costs of the farm have been divided among activities according to the share of production value of each activity in the total farm production value.

The tables presenting the study results also contain data collected in the AGROKOSZTY system on (own and paid) labour inputs incurred for the given activity. This record makes it possible to determine the labour intensity of production.

[3] The cost of purchased fertilisers also includes specialised fertiliser taxes.

What is recorded in the case of crop production activities, is the work related to pre-sowing soil preparation, improvement and grain harvesting and drying. What is not recorded, are labour inputs related to the functioning of the farm as a whole. This applies to administrative and general work or labour inputs incurred for renovations of buildings or machinery.

Based on the number of working hours incurred for producing individual products, income from activity without subsidies per 1 hour of own labour is calculated. It reflects the extent to which labour inputs of the farmer and his family are covered by income from 1 ha. For the purposes of the analysis, own labour inputs have been valued at the normative rate, determined on the basis of the average level of salaries for workers employed in the national economy in a given year (according to data of the Central Statistical Office – GUS), assuming that one full-time worker works in agriculture for 2,120 hours per year. This parity payment for 1 hour of work in 2018 was PLN 17.32[4]. However, it should be borne in mind that the presentation of own labour inputs in value terms on individual farms is always conventional.

The results of the analysed production activities were presented on average in the study sample of farms and in the groups classified according to their production scale. The horizontal analysis has been applied, by comparing the parameters describing each of them in the separate scale ranges. For the purposes of analysis, three scale ranges have been selected, i.e. small, medium and large. However, due to an insufficient sample, the results of dry grain maize are shown in two scale ranges only (i.e. small and large). The scale criterion applied was the cultivation area. When dividing the study sample of farms pursuing individual activities into groups differing in the size of the production scale, the sample size and the distributions of the characteristic, which was the scale criterion, were taken into account. The assumption was that the number of farms in the identified scale ranges should be as high as possible, the average level of the characteristic adopted as the scale criterion was close to the median of this characteristic and the scale range boundaries were not tangent. These factors determined the selection of three or two scale ranges, as a consequence, the number of farms in the identified ranges does not cover the whole study sample.

The size of the production scale ranges is relative, this means that the scale size adopted as large can be regarded as small on farms with the different area structure and different production organisation. Furthermore, due to purposive sampling, the study results cannot be statistically generalised to all individual farms in the country. Nevertheless, they are a prerequisite for selecting the scale size, which has a chance to guarantee the relatively high efficiency of production conducted. They also allow to present certain phenomena and relations which have become visible following the division of the study sample of farms.

In a broader perspective, the study results were included in a publication (Skarżyńska, 2019), which extensively discussed the production and economic situation of the analysed agricultural production activities. This article included the synthetic

[4] Own calculations based on the GUS data.

analysis of results. The results of calculations (in nominal terms) are presented in the Tables. Due to the electronic data processing technique, in some cases the sums of components may differ from the "total" values provided.

Study results

According to the GUS data (2019), in 2018 market conditions of agricultural production were unfavourable for agricultural producers. This was determined by the fall in prices of agricultural products sold by individual farms (by 2.8%) and the rise in prices of commodities and services purchased by these farms for the current agricultural production and investment purposes (by 2.9%). Consequently, the price index ("price scissors") was at an unfavourable level, i.e. amounted to 94.4% (in 2017, it was 110.0%).

In 2018, **winter wheat** was a profitable activity (Table 1). On average, in the study sample for the wheat cultivation on an area of 22.42 ha, income from activity without subsidies from 1 ha was PLN 1,147. In the identified cultivation scale ranges, the amount of income without subsidies was gradually growing. The highest income was obtained by large-scale wheat producers (40-120 ha) – PLN 1,150/ha. Poorer results were recorded on farms with the medium-scale wheat cultivation (12-30 ha) – PLN 1,059/ha, and the poorest in those with the small-scale cultivation (3-9 ha) – PLN 778/ha. The factor determining the amount of income was revenues, i.e. the value of a potentially commercial production. Along with the increasing wheat cultivation area, the grain yield was gradually growing (it was from 51.3 to 57.7 dt/ha), so was the selling price (from PLN 72.58 to PLN 78.22/dt). Total costs (i.e. direct and indirect in total) of cultivation of 1 ha wheat in the subsequent scale ranges were also growing, ranging from PLN 2,960 for the small scale to PLN 3,380 for the large scale.

To assess the efficiency of use of inputs incurred, the marginal cost of additional unit production has been calculated. The basis for calculating marginal and average unit costs were averaged results at the level of total costs. The medium scale was compared to the small scale and the large scale was compared to the medium scale. The marginal analysis shows that the level of inputs applied to the medium-scale winter wheat cultivation was more reasonable than for the large scale. This is indicated by the marginal cost of additional unit production, which was by 2.4% lower than the average unit cost. On the other hand, for the large-scale wheat cultivation, the increase in harvest by 1 dt required the increase in costs at the level higher than the average cost (by 3.0%). However, in both scale ranges, the production intensity limit was not exceeded, the costs increased more slowly than the production value. Increasing the production value by PLN 1, required the increase in costs by PLN 0.72 for the medium scale and by PLN 0.75 for the large scale.

The study results show that winter wheat cultivated on the large scale, when compared to other ranges, was characterised by:

- high cost competitiveness – direct costs accounted for 45.4% of generated gross margin without subsidies, while for the medium scale they accounted for 48.9%, and for the small scale – 46.4%;

- high production and technical efficiency – the share of gross margin in the production value was 68.8%, for the medium-scale wheat cultivation it was 67.2%, and for the small scale – 68.3%;
- relatively high economic efficiency – the profitability index was 134.0%, for the medium scale – 135.6%, and for the small scale – 126.3%.

The favourable impact of cultivation scale on the winter wheat results is evident. This is evidenced, *inter alia*, by the highest income without subsidies per 1 dt grain (PLN 19.92) and per 1 hour of own labour (PLN 146.09). Support in a form of subsidies was the least important for large-scale wheat producers. To PLN 1 of income without subsidies, they received support of PLN 0.70, while for the medium-scale wheat cultivation it was PLN 0.81 and for the small scale – PLN 1.14.

In 2018, the **rye** cultivation (Table 2) allowed to obtain income from activity without subsidies, but its level was low. On average in the sample, for the rye cultivation on an area of 11.60 ha, this income was PLN 330/ha. In the identified cultivation scale ranges, the amount of income without subsidies was changing in various directions. The highest income was obtained by large-scale rye producers (20-60 ha) – 473 PLN/ha. Poorer results were recorded on farms with the small-scale rye cultivation (2-5 ha) – 287 PLN/ha, and the poorest in those with the medium-scale rye cultivation (8-16 ha) – 180 PLN/ha. Along with the increasing rye cultivation area, the selling price of grain was rising, with the highest obtained by large-scale rye producers (PLN 64.06/dt). The cultivation scale also had a positive impact on the production results, the grain yield on small and medium-scale farms was 30.0 and 29.5 dt/ha, respectively, while on large-scale farms it was higher, i.e. 32.7 dt/ha. Total costs incurred per 1 ha of rye cultivation increased along with the increasing scale (they ranged between PLN 1,476 and 1,665), although for the medium- and large-scale cultivation their level was similar.

The marginal analysis shows that both for the medium and large scale, the limit of rye production intensity was not exceeded, costs increased more slowly than the production value. However, the ratio of marginal cost to average production cost of 1 dt rye points to the predominance of large-scale production. In this group of farms, the marginal production cost of 1 dt grain was lower than the average cost (by 5.2%), while for the medium-scale rye cultivation it exceeded its level (by 5.4%). In this situation, the increase in revenues by PLN 1, in the case of the medium scale, required an increase in costs by PLN 0.93, while for the large scale – only by PLN 0.72.

The analyses carried out showed that rye cultivated on a large scale, when compared to other ranges, was characterised by:

- high cost competitiveness – direct costs accounted for 48.6% of generated gross margin without subsidies, while for the medium scale they accounted for 63.2%, and for the small scale – 56.2%;
- high production and technical efficiency – the share of gross margin in the production value was 67.3%, for the medium-scale rye cultivation it was 61.3%, and for the small scale – 64.0%;
- high economic efficiency – the profitability index was 128.4%, for the medium scale – 110.8%, and for the small scale – 119.5%.

The positive effect of cultivation scale impact on the results can be dearly visible, as evidenced, *inter alia*, by the ratio of total production costs of 1 dt rye to selling price. For the large-scale rye cultivation, costs accounted for 79.5% in the selling price, while for the medium scale – 92.6%, and for the small scale – 87.2%. The predominance of large-scale production is also indicated by the highest income without subsidies per 1 dt grain (PLN 14.47) and per 1 hour of own labour (PLN 71.88). Subsidies to the rye cultivation significantly exceeded income from production (i.e. without subsidies). For the large-scale rye cultivation, support to PLN 1 of income without subsidies was PLN 1.72, while for the medium-scale cultivation it was PLN 4.79 and for the small-scale cultivation – PLN 3.11.

In 2018, **spring barley** (Table 3) was a profitable activity. On average, on farms participating in the studies, for the barley cultivation on an area of 9.97 ha, income without subsidies from 1 ha was PLN 755. In the identified groups of farms, the highest income was obtained by large-scale barley producers (20-50 ha) – PLN 914/ha. On the other hand, for the medium-scale cultivation (6-15 ha), income without subsidies from 1 ha was PLN 627, and for the small-scale cultivation (2-4 ha) – PLN 470. The amount of income was determined mainly by the production value as a derivative of production and price results. Along with the increasing barley cultivation area, the grain yield was gradually growing (ranging from 35.9 to 41.9 dt/ha), so was the grain selling price (ranging from PLN 64.40 to 69.28/dt). Total cultivation costs of 1 ha of spring barley in the subsequent scale ranges also increased, ranging from PLN 1,840 for the small scale to PLN 1,990 for the large scale.

The marginal analysis showed that for the medium- and large-scale spring barley cultivation the marginal production cost of 1 dt grain was lower than the average unit cost (by 0.6 and 3.5%, respectively). The production intensity limit was exceeded, which means that costs increased more slowly than the production value. Its increase by PLN 1 required the increase in costs by PLN 0.74 for the medium-scale cultivation and by PLN 0.65 for the large-scale cultivation.

The positive effect of cultivation scale impact on the results is visible. Spring barley cultivated on a large scale, when compared to other ranges, was characterised by:

- high cost competitiveness – direct costs accounted for 39.2% of generated gross margin without subsidies, while for the medium scale they accounted for 43.3%, and for the small scale – 46.9%;
- high production and technical efficiency – the share of gross margin in the production value was 71.8%, for the medium-scale barley cultivation it was 69.8%, and for the small scale – 68.1%;
- high economic efficiency – the profitability index was 145.9%, for the medium-scale cultivation – 132.5%, and for the small scale – 125.5%.

Just like in the case of the previously discussed agricultural products, the positive cultivation scale impact on the results is clearly visible. Along with its increase, production costs of 1 dt grain and PLN 1 of income without subsidies decreased, with the simultaneous increase in income without subsidies per 1 dt grain and 1 hour of own labour. The large scale is also favoured by the smallest share of total production costs of 1 dt grain in its selling price – 68.5% (for the medium

scale, this share was 76.1% and for the small scale – 79.6%). The favourable scale effect is also a gradual decrease in subsidies per PLN 1 income without subsidies, for the small scale it was PLN 1.92, for the medium scale – PLN 1.36 and for the large scale – PLN 0.89.

In 2018, farmers cultivating **dry grain maize** (Table 4) did not suffer a loss. On average, in the sample for the maize cultivation on an area of 26.12 ha, income from activity without subsidies from 1 ha was PLN 1,260. Its amount in the groups of farms differing in the maize cultivation scale was similar. For the small scale (2-14 ha), this income was PLN 1,257/ha, and for the large scale (20-70 ha) – PLN 1,283/ha. The amount of income was conditioned by revenues, especially the yield, as the selling price of 1 dt grain differed slightly (by PLN 0.57). Large-scale maize producers achieved a higher yield – 104.0 dt/ha, it was by 18.5% higher when compared to the small scale (87.8 dt/ha). Maize cultivation costs were growing along with the increasing scale, for the large scale they stood at PLN 4,888/ha and were by 22.1% higher when compared to the small scale.

The marginal analysis showed that for the large-scale maize cultivation, the marginal production cost of 1 dt was slightly (by 0.6%) higher than the average unit cost, but significantly lower than the limit cost, i.e. the price of grain (by 20.3%). The production intensity limit was not exceeded, the increase in the production value by PLN 1 required costs to increase by PLN 0.80.

The study results show that dry grain maize, cultivated on the large scale, when compared to the small scale, was characterised by:

- higher competitiveness in relation to direct costs incurred – those costs accounted for 51.5% of generated gross margin without subsidies, while for the small-scale cultivation – 56.6%;
- higher production and technical efficiency – the share of gross margin in the production value was 66.0%, for the small-scale maize cultivation – 63.9%;
- relatively high economic efficiency – the profitability index was 126.2%, while for the small scale – 131.4%.

Maize cultivated on a large-scale is also characterised by a lower variability in the production profitability index, which is reflected, *inter alia*, by a smaller percentage of farms where its cultivation was unprofitable (Table 7). It is also characterised by a lower labour intensity of cultivation and a higher level of own labour payment valued at the parity rate (PLN 17.32/hour). The positive effect of cultivation scale impact on the results means also a lower importance of subsidies. Large-scale maize producers received support of PLN 0.63 to PLN 1 of income without subsidies, while for the small-scale cultivation this support was PLN 0.71.

In 2018, **winter oilseed rape** (Table 5) was a profitable activity. On average, in the study sample of farms cultivating oilseed rape on an area of 17.37, income from activity without subsidies was PLN 1,092 per 1 ha. The highest income was obtained by large-scale rape producers (20-60 ha) – PLN 1,294/ha. For the medium-scale (8-16 ha) and the small-scale (2-6 ha) rape cultivation, this income was lower, amounting to PLN 893 and PLN 730/ha, respectively. The relation between the amount of income and the rape cultivation area is clear. The increase in the cultivation area

had a positive impact on the level of yield and the price of seeds. The highest yield (32.4 dt/ha) and the highest selling price of seeds (PLN 154.07/dt) were obtained by farmers cultivating rape on the large-scale. Total winter oilseed rape cultivation costs increased along with the increasing scale. The large-scale cultivation of 1 ha of rape, when compared to the medium scale, entailed costs higher by 5.1% and when compared to the small scale – by 10.2%.

The marginal analysis showed that both for the medium and large scale, the marginal production cost of 1 dt rape was lower than the average unit cost (by 1.1 and 3.2%, respectively), which is a positive phenomenon. The marginal cost was also lower than the limit cost. In both ranges of the winter oilseed rape cultivation scale, the intensity limit was not exceeded, which means that costs increased more slowly than the production value. Increasing the production value by PLN 1, for the medium-scale cultivation required the increase in costs by PLN 0.79, while for the large-scale cultivation – by PLN 0.71.

The analyses carried out show that oilseed rape cultivated on a large scale, when compared to other ranges, was characterised by:

- high cost competitiveness – direct costs accounted for 51.4% of generated gross margin without subsidies, while for the medium scale they accounted for 59.6%, and for the small scale – 63.8%;
- high production and technical efficiency – the share of gross margin in the production value was 66.1%, for the medium-scale rape cultivation it was 62.7%, and for the small scale – 61.0%;
- high economic efficiency – the profitability index was 135%, for the medium-scale cultivation – 125.4%, and for the small scale – 121.8%.

The favourable effect of cultivation scale is clear, as evidenced, *inter alia*, by the gradually decreasing share of total production costs of 1 dt seeds in their selling price, which for the small scale was 82.1%, for the medium scale – 79.7%, and for the large scale – 74.1%. Other indices also confirm the favourable effect of winter rape cultivation area on the results. Along with its increase, production costs of 1 dt seeds and PLN 1 of income from activity without subsidies decreased, with a simultaneous increase in income per 1 dt seeds and 1 hour of own labour. An increase in the cultivation scale and better economic results of rape made the importance of subsidies decline. Their total amount per PLN 1 of income from activity without subsidies for the small scale was PLN 1.22, while for the medium scale it was PLN 0.97 and for the large scale – PLN 0.62.

In 2018, the **sugar beet** cultivation (Table 6) was profitable. On average, in the sample of farms for the sugar beet cultivation on an area of 9.53 ha income from activity without subsidies was PLN 1,202/ha. In the groups of farms differing in the beet cultivation area, income was not characterised by a one-way change. For the small-scale cultivation (2-3 ha), income without subsidies from 1 ha of beet was PLN 884, for the medium scale (5-15 ha) – PLN 1,448 and for the large scale (20-50 ha) – PLN 1,047. The yield of sugar beet roots for the small and medium-scale cultivation was similar and was quite high, standing at 647 and 645 dt/ha, respectively. On the other hand, large-scale beet producers achieved the lower

yield of 597 dt/ha. The increase in the beet cultivation scale, and thus the higher production volume, were linked to the rise in the selling price of roots. On large-scale beet cultivation farms, producers achieved the highest price – PLN 11.38/dt, when compared to the medium scale it was higher by 9.6% and to the small scale – by 13.8%. The rise in the selling price of roots in subsequent farm groups guaranteed the gradual increase in revenues. The factor that determined the highest income from 1 ha achieved by medium-scale beet producers were lower total beet cultivation costs. When compared to the small scale, they were lower by 5.8% and to the large scale – by 9.0%.

The marginal analysis indicates the greater efficiency of the medium-scale beet cultivation. On these farms, the marginal cost of additional unit production was lower than the average unit cost (by 2.8%), while for the large scale it exceeded its level (by 6.7%). However, in both scale ranges, the marginal cost was lower than the limit cost and the production intensity limit was not exceeded. The increase in the production value by PLN 1 required the increase in costs by PLN 0.75 for the medium-scale beet cultivation, and by PLN 0.87 for the large-scale cultivation.

Nevertheless, the results of sugar beet cultivated on the large scale, when compared to other ranges, were characterised by:

- high cost competitiveness – direct costs accounted for 63.5% of generated gross margin without subsidies, while for the medium scale they accounted for 64.1%, and for the small scale – 71.6%;
- high production and technical efficiency – the share of gross margin in the production value was 61.2%, for the medium-scale beet cultivation it was 60.9%, and for the small scale – 58.3%;
- relatively high economic efficiency – the profitability index was 118.1%, for the medium-scale cultivation – 127.5%, and for the small scale – 115.8%.

The favourable impact of sugar beet cultivation scale has become very clear at the level of gross margin without subsidies. Its amount increased gradually in the subsequent scale ranges. For the small scale, producers obtained PLN 3,773 from 1 ha, for the medium scale – PLN 4,091, and for the large scale – 4,181 PLN. Large-scale beet farms also demonstrated the lowest diversity in the production profitability index (which is reflected by production value/total costs ratio), which means that this was the most homogeneous group in terms of this characteristic (Table 7). Subsidies, as an instrument to support income from production, were of great importance to sugar beet producers. Their total amount significantly exceeded income without subsidies. For the small-scale sugar beet cultivation, support of subsidies to 1 PLN of income without subsidies was PLN 2.72, for the medium scale – PLN 1.62 and for the large scale – PLN 2.20.

Summary

The study results confirm that the production scale is an important factor determining the economic effects of producing agricultural products. This issue is not new, but still up-to-date. The selection of production scale size by farmers is difficult, as decisions are inextricably associated with uncertainty and risks. This is mainly due to differences between the time of making decisions and the period in which their effects are visible. Therefore, in practice, it is difficult to determine what the optimal production size of individual activities should be. However, the larger production size most often allows to generate higher revenues, it is also directly linked with the production efficiency. In addition, due to a higher level of specialisation and mechanisation of work performed, it stimulates the decrease in labour inputs. This results in higher labour profitability.

We may consider short and long-term benefits of scale growth. Short-term benefits result from an increased production volume, leading to reducing unit costs through increased labour productivity and distribution of fixed costs among more units, but also through making minor improvements in the method of producing products by accumulating production experiences. These experiences may result in long-term benefits that will take place when more radical changes in production techniques and in the product selling method are introduced (e.g. cooperation with processing plants). This results, *inter alia*, in improving production technology, increasing the production capacity of assets held (e.g. more efficient use of buildings, specialised machinery) and higher management efficiency.

The presented results of agricultural product studies have a large cognitive aspect and can be a prerequisite for changes at the planning stage, particularly in the context of selecting the production size and intensity on the farm.

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Table 1

Production, costs and income from the winter wheat cultivation in 2018 (actual data)

Specification		On average on farms cultivating winter wheat	Depending on the cultivation scale (ha/farm)		
			3-9	**12-30**	**40-120**
Number of farms in studies		158	36	51	29
Cultivation area	(ha/farm)	22.42	5.29	18.58	61.91
Grain yield	(dt/ha)	56.6	51.3	54.8	57.7
Grain selling price	(PLN/dt)	76.51	72.58	73.05	78.22
			Per 1 ha of cultivation area		
Total production value	**(PLN)**	**4,348**	**3,738**	**4,028**	**4,530**
Including: grain		4,330	3,720	4,003	4,515
Total direct costs	**(PLN)**	**1,348**	**1,185**	**1,323**	**1,415**
Of which: seed material		223	213	210	240
total mineral fertilisers		735	633	734	756
off-farm organic fertilisers		0	8	-	-
plant protection products		350	304	340	377
growth regulators		33	21	31	36
others		6	5	8	6
Gross margin without subsidies	**(PLN)**	**3,000**	**2,554**	**2,706**	**3,115**
Indirect actual costs[a]	(PLN)	817	917	728	856
Gross value added from activity	**(PLN)**	**2,183**	**1,636**	**1,977**	**2,259**
Depreciation	(PLN)	684	643	616	699
Including: buildings and structures		161	183	153	160
machinery and equipment		285	242	235	304
means of transport		235	211	223	232
Net value added from activity	**(PLN)**	**1,499**	**993**	**1,362**	**1,560**
Cost of external factors	(PLN)	352	215	303	410
Income from activity without subsidies	**(PLN)**	**1,147**	**778**	**1,059**	**1,150**
Subsidies[b]	(PLN)	828	890	857	801
Income from activity	**(PLN)**	**1,975**	**1,668**	**1,915**	**1,951**
TOTAL COSTS	***(PLN)***	***3,202***	***2,960***	***2,970***	***3,380***
Total labour inputs	(hour)	8.7	10.5	8.8	8.4
including: own labour inputs		8.3	9.8	8.4	7.9
		Economic efficiency indices			
Total costs per 1 dt grain	(PLN)	56.58	57.76	54.19	58.55
Total costs per PLN 1 of income from activity without subsidies	(PLN)	2.79	3.81	2.81	2.94
Income from activity without subsidies per 1 dt grain	(PLN)	20.26	15.18	19.31	19.92
Income from activity without subsidies per 1 hour of own labour inputs	(PLN)	137.66	79.57	126.38	146.09
Subsidies per PLN 1 of income from activity without subsidies	(PLN)	0.72	1.14	0.81	0.70
Share of subsidies in income from activity	(%)	41.9	53.4	44.7	41.0

[a] Indirect actual costs without the cost of external factors.

[b] Subsidies include single area payment, greening payment and additional payment.

[-] – means that the given phenomenon has not taken place.

Source: own studies.

Table 2

Production, costs and income from the rye cultivation in 2018 (actual data)

Specification		On average on farms cultivating rye	Depending on the cultivation scale (ha/farm)		
			2-5	**8-16**	**20-60**
Number of farms in studies		124	42	25	24
Cultivation area	(ha/farm)	11.60	3.42	11.59	30.96
Grain yield	(dt/ha)	32.4	30.0	29.5	32.7
Grain selling price	(PLN/dt)	60.74	56.35	60.65	64.06
			Per 1 ha of cultivation area		
Total production value	**(PLN)**	**2,005**	**1,763**	**1,838**	**2,138**
Including: ziarno		1,965	1,693	1,792	2,094
Total direct costs	**(PLN)**	**724**	**634**	**712**	**700**
Of which: seed material		154	167	159	165
total mineral fertilisers		441	367	426	416
off-farm organic fertilisers		1	-	3	2
plant protection products		113	95	98	108
growth regulators		11	3	23	6
others		4	2	3	3
Gross margin without subsidies	**(PLN)**	**1,282**	**1,129**	**1,126**	**1,439**
Indirect actual costs[a]	(PLN)	407	442	416	379
Gross value added from activity	**(PLN)**	**875**	**687**	**710**	**1,060**
Depreciation	(PLN)	396	325	364	416
Including: buildings and structures		99	125	104	91
machinery and equipment		158	94	160	169
means of transport		130	106	101	140
Net value added from activity	**(PLN)**	**479**	**362**	**346**	**644**
Cost of external factors	(PLN)	150	75	166	171
Income from activity without subsidies	**(PLN)**	**330**	**287**	**180**	**473**
Subsidies[b]	(PLN)	836	893	861	814
Income from activity	**(PLN)**	**1,166**	**1,180**	**1,041**	**1,287**
TOTAL COSTS	***(PLN)***	***1,676***	***1,476***	***1,659***	***1,665***
Total labour inputs	(hour)	7,3	10,5	6,8	6,7
including: own labour inputs		7,2	10,0	6,6	6,6
	Economic efficiency indices				
Total costs per 1 dt grain	(PLN)	51.79	49.13	56.14	50.94
Total costs per PLN 1 of income from activity without subsidies	(PLN)	5.08	5.14	9.24	3.52
Income from activity without subsidies per 1 dt grain	(PLN)	10.19	9.56	6.08	14.47
Income from activity without subsidies per 1 hour of own labour inputs	(PLN)	45.88	28.76	27.31	71.88
Subsidies per PLN 1 of income from activity without subsidies	(PLN)	2.54	3.11	4.79	1.72
Share of subsidies in income from activity	(%)	71.7	75.7	82.7	63.3

[a] Indirect actual costs without the cost of external factors.
[b] Subsidies include single area payment, greening payment and additional payment.
[-] means that the given phenomenon has not taken place.

Source: own studies.

Table 3

Production, costs and income from the spring barley cultivation in 2018 (actual data)

Specification		On average on farms cultivating spring barley	Depending on the cultivation scale (ha/farm)		
			2-4	**6-15**	**20-50**
Number of farms in studies		141	30	44	21
Cultivation area	(ha/farm)	9.97	3.22	10.68	27.64
Grain yield	(dt/ha)	40.4	35.9	38.2	41.9
Grain selling price	(PLN/dt)	67.32	64.40	66.36	69.28
		Per 1 ha of cultivation area			
Total production value	**(PLN)**	**2,724**	**2,310**	**2,554**	**2,903**
Including: grain		2,717	2,310	2,532	2,903
Total direct costs	**(PLN)**	**805**	**737**	**772**	**818**
Of which: seed material		187	175	188	189
total mineral fertilisers		461	409	435	474
off-farm organic fertilisers		4	-	-	7
plant protection products		133	144	133	124
growth regulators		15	5	11	20
others		5	5	5	4
Gross margin without subsidies	**(PLN)**	**1,919**	**1,573**	**1,782**	**2,085**
Indirect actual costs[a]	(PLN)	544	582	562	496
Gross value added from activity	**(PLN)**	**1,375**	**992**	**1,220**	**1,589**
Depreciation	(PLN)	415	452	430	412
Including: buildings and structures		99	183	121	65
machinery and equipment		166	122	158	184
means of transport		150	139	151	163
Net value added from activity	**(PLN)**	**960**	**540**	**789**	**1,178**
Cost of external factors	(PLN)	205	70	163	264
Income from activity without subsidies	**(PLN)**	**755**	**470**	**627**	**914**
Subsidies[b]	(PLN)	840	903	850	812
Income from activity	**(PLN)**	**1,595**	**1,373**	**1,476**	**1,725**
TOTAL COSTS	***(PLN)***	***1,969***	***1,840***	***1,927***	***1,990***
Total labour inputs	(hour)	6.7	9.3	7.0	5.9
including: own labour inputs		6.5	9.2	6.9	5.6
		Economic efficiency indices			
Total costs per 1 dt grain	(PLN)	48.80	51.29	50.51	47.48
Total costs per PLN 1 of income from activity without subsidies	(PLN)	2.61	3.91	3.08	2.18
Income from activity without subsidies per 1 dt grain	(PLN)	18.72	13.10	16.42	21.80
Income from activity without subsidies per 1 hour of own labour inputs	(PLN)	115.62	51.11	91.09	162.23
Subsidies per PLN 1 of income from activity without subsidies	(PLN)	1.11	1.92	1.36	0.89
Share of subsidies in income from activity	(%)	52.7	65.8	57.6	47.0

[a] Indirect actual costs without the cost of external factors.

[b] Subsidies include single area payment, greening payment and additional payment.

[-] means that the given phenomenon has not taken place.

Source: own studies.

Table 4

Production, costs and income from the dry grain maize cultivation in 2018 (actual data)

Specification		On average on farms cultivating dry grain maize	Depending on the cultivation scale (ha/farm)	
			2-14	**20-70**
Number of farms in studies		37	15	16
Cultivation area	(ha/farm)	26.12	7.44	40.29
Dry grain yield	(dt/ha)	100.5	87.8	104.0
Dry grain selling price	(PLN/dt)	60.46	59.91	59.34
			Per 1 ha of cultivation area	
Total production value	**(PLN)**	**6,078**	**5,259**	**6,171**
Including: dry grain		6,078	5,259	6,171
Total direct costs	**(PLN)**	**2,050**	**1,900**	**2,097**
Of which: seed material		538	516	517
total mineral fertilisers		975	956	1,031
off-farm organic fertilisers		7	-	11
plant protection products		177	165	188
growth regulators		0	-	0
others		353	263	350
Gross margin without subsidies	**(PLN)**	**4,029**	**3,359**	**4,074**
Indirect actual costs[a]	(PLN)	1,299	997	1,344
Gross value added from activity	**(PLN)**	**2,730**	**2,362**	**2,730**
Depreciation	(PLN)	918	799	894
Including: buildings and structures		171	166	159
machinery and equipment		444	313	465
means of transport		294	315	262
Net value added from activity	**(PLN)**	**1,812**	**1,563**	**1,837**
Cost of external factors	(PLN)	552	306	554
Income from activity without subsidies	**(PLN)**	**1,260**	**1,257**	**1,283**
Subsidies[b]	(PLN)	830	897	812
Income from activity	**(PLN)**	**2,090**	**2,154**	**2,095**
TOTAL COSTS	***(PLN)***	***4,818***	***4,002***	***4,888***
Total labour inputs	(hour)	13,1	13,1	11,8
including: own labour inputs		12,3	13,1	11,7
	Economic efficiency indices			
Total costs per 1 dt grain	(PLN)	47.93	45.59	47.00
Total costs per PLN 1 of income from activity without subsidies	(PLN)	3.82	3.18	3.81
Income from activity without subsidies per 1 dt grain	(PLN)	12.53	14.32	12.34
Income from activity without subsidies per 1 hour of own labour inputs	(PLN)	102.14	95.94	109.41
Subsidies per PLN 1 of income from activity without subsidies	(PLN)	0.66	0.71	0.63
Share of subsidies in income from activity	(%)	39.7	41.7	38.8

[a] Indirect actual costs without the cost of external factors.

[b] Subsidies include single area payment, greening payment and additional payment.

[-] means that the given phenomenon has not taken place.

Source: own studies.

Table 5

Production, costs and income from the winter oilseed rape cultivation in 2018 (actual data)

Specification		On average on farms cultivating winter oilseed rape	Depending on the cultivation scale (ha/farm)		
			2-6	**8-16**	**20-60**
Number of farms in studies		149	31	51	50
Cultivation area	(ha/farm)	17.37	3.90	11.84	32.71
Grain yield	(dt/ha)	30.4	26.9	28.9	32.4
Grain selling price	(PLN/dt)	153.55	151.65	152.56	154.07
		Per 1 ha of cultivation area			
Total production value	**(PLN)**	**4,668**	**4,084**	**4,408**	**4,989**
Including: grain		4,668	4,084	4,408	4,989
Total direct costs	**(PLN)**	**1,660**	**1,591**	**1,646**	**1,693**
Of which: seed material		193	244	211	181
total mineral fertilisers		904	877	933	923
off-farm organic fertilisers		25	2	5	37
plant protection products		476	432	449	486
growth regulators		27	11	28	30
others		34	25	21	36
Gross margin without subsidies	**(PLN)**	**3,008**	**2,493**	**2,762**	**3,296**
Indirect actual costs[a]	(PLN)	826	859	856	821
Gross value added from activity	**(PLN)**	**2,182**	**1,634**	**1,906**	**2,475**
Depreciation	(PLN)	752	681	748	803
Including: buildings and structures		169	201	209	163
machinery and equipment		314	233	277	358
means of transport		264	242	259	280
Net value added from activity	**(PLN)**	**1,431**	**953**	**1158**	**1672**
Cost of external factors	(PLN)	339	224	265	378
Income from activity without subsidies	**(PLN)**	**1,092**	**730**	**893**	**1,294**
Subsidies[b]	(PLN)	826	893	862	808
Income from activity	**(PLN)**	**1918**	**1,623**	**1,755**	**2,102**
TOTAL COSTS	***(PLN)***	***3,576***	***3,354***	***3,515***	***3,695***
Total labour inputs	(hour)	8.5	10.5	9.3	8.0
including: own labour inputs		7.9	10.3	9.1	7.4
		Economic efficiency indices			
Total costs per 1 dt grain	(PLN)	117.62	124.55	121.65	114.10
Total costs per PLN 1 of income from activity without subsidies	(PLN)	3.27	4.60	3.94	2.85
Income from activity without subsidies per 1 dt grain	(PLN)	35.93	27.10	30.91	39.97
Income from activity without subsidies per 1 hour of own labour inputs	(PLN)	138.06	70.76	98.11	173.81
Subsidies per PLN 1 of income from activity without subsidies	(PLN)	0.76	1.22	0.97	0.62
Share of subsidies in income from activity	(%)	43.1	55.0	49.1	38.4

[a] Indirect actual costs without the cost of external factors

[b] Subsidies include single area payment, greening payment and additional payment.

[-] means that the given phenomenon has not taken place.

Source: own studies.

Table 6

Production, costs and income from the sugar beet cultivation in 2018 (actual data)

Specification		On average on farms cultivating sugar beet	Depending on the cultivation scale (ha/farm)		
			2-3	**5-15**	**20-50**
Number of farms in studies		126	19	58	17
Cultivation area	(ha/farm)	9.53	2.72	8.45	30.68
Root yield	(dt/ha)	619	647	645	597
Root selling price	(PLN/dt)	10.82	10.00	10.38	11.38
			Per 1 ha of cultivation area		
Total production value	**(PLN)**	**6,727**	**6,476**	**6,715**	**6,835**
Including: root		6,692	6,476	6,693	6,792
Total direct costs	**(PLN)**	**2,638**	**2,703**	**2,624**	**2,654**
Of which: seed material		725	749	725	726
total mineral fertilisers		1,050	1,047	1,036	1,050
off-farm organic fertilisers		6	-	14	-
plant protection products		797	792	787	828
growth regulators		6	0	2	4
others		54	116	61	46
Gross margin without subsidies	**(PLN)**	**4,089**	**3,773**	**4,091**	**4,181**
Indirect actual costs[a]	(PLN)	1,266	1,433	1,277	1,216
Gross value added from activity	**(PLN)**	**2,823**	**2,339**	**2,814**	**2,965**
Depreciation	(PLN)	1,063	1,327	959	1,156
Including: buildings and structures		176	365	195	123
machinery and equipment		498	480	415	603
means of transport		373	466	343	403
Net value added from activity	**(PLN)**	**1,760**	**1,012**	**1,855**	**1,809**
Cost of external factors	(PLN)	558	127	406	762
Income from activity without subsidies	**(PLN)**	**1,202**	**884**	**1,448**	**1,047**
Subsidies[b]	(PLN)	2,330	2,409	2,344	2,298
Income from activity	**(PLN)**	**3,532**	**3,293**	**3,792**	**3,345**
TOTAL COSTS	***(PLN)***	***5,525***	***5,592***	***5,266***	***5,788***
Total labour inputs	(hour)	17.6	21.5	16.8	17.6
including: own labour inputs		15.0	21.3	15.2	13.5
	Economic efficiency indices				
Total costs per 1 dt roots	(PLN)	8.93	8.64	8.17	9.70
Total costs per PLN 1 of income from activity without subsidies	(PLN)	4.60	6.32	3.64	5.53
Income from activity without subsidies per 1 dt roots	(PLN)	1.94	1.37	2.25	1.75
Income from activity without subsidies per 1 hour of own labour inputs	(PLN)	79.90	41.59	95.34	77.46
Subsidies per PLN 1 of income from activity without subsidies	(PLN)	1.94	2.72	1.62	2.20
Share of subsidies in income from activity	(%)	66.0	73.1	61.8	68.7

[a] Indirect actual costs without the cost of external factors

[b] Subsidies include single area payment, greening payment and additional payment.

[-] means that the given phenomenon has not taken place.

Source: own studies.

Table 7

Selected descriptive statistics of the profitability index in the identified cultivation scale ranges of production activities analysed in 2018 [a]

Specification		Winter wheat			Rye			Spring barley			Dry grain maize		Winter oilseed rape			Sugar beet		
		3-9	**12-30**	**40-120**	**2-5**	**8-16**	**20-60**	**2-4**	**6-15**	**20-50**	**2-14**	**20-70**	**2-6**	**8-16**	**20-60**	**2-3**	**5-15**	**20-50**
On average	(%)	126.3	135.6	134.0	119.5	110.8	128.4	125.5	132.5	145.9	131.4	126.2	121.8	125.4	135.0	115.8	127.5	118.1
Percentile 5%	(%)	71.9	89.3	77.7	68.0	46.0	74.1	61.6	63.2	91.3	69.8	85.9	66.7	81.8	88.1	82.7	93.7	91.4
Median	(%)	131.9	132.8	143.2	126.1	110.3	128.7	113.5	135.3	139.1	136.7	132.8	118.6	129.6	130.0	121.7	126.7	117.5
Percentile 95%	(%)	201.7	223.0	222.2	224.2	175.7	227.1	204.4	236.3	264.2	216.2	191.7	202.4	191.0	222.1	151.0	184.2	161.9
Quartile deviation	(p.p.)	20.0	26.7	16.0	35.0	30.0	16.3	37.2	37.8	33.0	22.7	17.1	24.0	21.1	19.1	18.0	18.9	14.1
Position coefficient of variation	(%)	15.2	20.1	11.2	27.8	27.2	12.7	32.8	27.9	23.7	16.6	12.8	20.2	16.3	14.7	14.7	14.9	12.0
Percentage of farms with the profitability index below 100	(%)	22.2	13.7	17.2	33.3	36.0	20.8	30.0	27.3	23.8	13.3	12.5	32.3	25.5	14.0	26.3	20.7	35.3

[a] cultivation scale selection criterion as in Tables 1-6.

KOSZTY JEDNOSTKOWE I DOCHODY WYBRANYCH PRODUKTÓW W 2018 ROKU – WYNIKI BADAŃ W SYSTEMIE AGROKOSZTY

Abstrakt

Głównym celem badań była ocena w 2018 roku wyników produkcyjno-ekonomicznych pszenicy ozimej, żyta, jęczmienia jarego, kukurydzy na ziarno, rzepaku ozimego oraz buraków cukrowych w zależności od skali ich uprawy. Badania przeprowadzono w gospodarstwach towarowych, czyli takich, które swoją produkcję przeznaczają na sprzedaż. Gospodarstwa te wybrano celowo z reprezentatywnej próby gospodarstw, która znajdowała się w polu obserwacji systemu Polski FADN. Dane opisujące badane produkty zebrano w systemie AGROKOSZTY, a następnie uzupełniono danymi z bazy Polskiego FADN.

Na wyniki badanych produktów wpływ miał potencjał produkcyjny gospodarstw (tj. zasoby ziemi, pracy i kapitału), ich jakość i sposób wykorzystania, ale zależały także od warunków zewnętrznych (np. rynkowych, pogodowych). Oddziaływania te skutkowały różnym stopniem zmian w zakresie wolumenu produkcji, kosztów jednostkowych oraz cen realizacji produktów.

W 2018 roku dochód, jaki zapewniły badane produkty rolnicze, mieścił się w dość szerokich granicach. Korzystny wpływ wielkości skali produkcji był jednak widoczny. W każdej grupie występowały gospodarstwa, w których produkcja okazała się nieopłacalna, ale w przypadku dużej skali uprawy odsetek gospodarstw ze wskaźnikiem poniżej 100 zawsze był najmniejszy (wyjątek stanowiły buraki cukrowe).

Słowa kluczowe: koszty jednostkowe, produkty rolnicze, skala produkcji, opłacalność.

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