

Costs and profitability

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DOI: 10.5604/00441600.1153190

UNIT COSTS OF AND INCOME FROM SELECTED PRODUCTS IN 2013 – RESEARCH RESULTS IN THE AGROKOSZTY SYSTEM

Abstract

In 2013, the research covered: winter wheat, winter rye, spring barley, winter rape and live pigs. Results of activities were analysed at farms running small-, medium- and large-scale production. Although the production volume, recognised as small, medium and large, is of relative nature, the research results provide a premise for the selection of production scale able to ensure a fairly high production efficiency.

Analysis in groups of farms, selected according to production scale, showed that production profitability (ratio of production value to direct costs and overheads in total) at large scale was always higher than at small scale. The advantage of large scale was: for winter wheat – 6.4 pp, winter rye – 3.6 pp, spring barley – 6.9 pp, winter rape – 11.3 pp, and live pigs – 16.7 pp.

The positive effect of scale impact on economic results is evident. Above all, labour-intensity of production dropped along with an increase in scale, which had a positive impact on the level of income per 1 hour of own labour and, consequently, its degree of coverage. In case of crop production activity, farmer's labour inputs were covered in all scale ranges, but at significantly higher level at large and medium scale than at small scale. In 2013, production of live pigs in most of the farms from the research sample was unprofitable, which means that revenues failed to fully cover the production costs. However, in each group there were farms where live pigs were profitable, the highest share of such farms was noted at large scale of pigs for fattening – 47%, against 17% at medium scale and 9% at small scale of production.

Introduction

The study is a part of a cycle presenting production and economic results of agricultural production activities surveyed under the AGROKOSZTY system. In 2013, the research covered: winter wheat, winter rye, spring barley, winter rape and pigs for fattening (i.e. live pigs). The selection of the activities arose from the adopted research plan; each of the activities reappears regularly in the research – usually at two- or three-year intervals.

Individual agricultural holdings participating in the survey of production activities were not a representative sample for the group of agricultural holdings in Poland pursuing a specific type of production. They were purposefully selected from a representative sample of farms monitored by the Polish FADN. Consequently, the average results in a surveyed set of holdings is influenced solely by the structure of the set – taking into account the production volume of specific activities – and the results in selected groups of farms. Because of differences, on that account, in the level and structure of outputs and inputs and, simultaneously, not too numerous research sample, the results cannot be used as a basis for comprehensive generalisations transferred to the agriculture as a whole. Nonetheless, they provide a reliable overview of changes in production profitability in groups of farms different in terms of the scale size and they can be used to examine interdependencies between profitability and its key determinants.

In line with the literature, rationality of the scale size depends on the level of technique, adopted production technology, and natural and economic conditions. Large production scale is not always rational (Fereniec J. 1997). This is because increasing the production volume exerts impact on the level of sales revenues and the incurred costs. Optimisation of costs is a broad concept and it is difficult for a farmer to make the right decision on production intensity. According to Manteuffel (1984), over-intensification causes a drop in profitability, decrease in income and, finally, it cramps production growth.

The research on the agricultural production activities was mainly focused on the assessment of the production and economic effects, and demonstration of the benefits following from increased production scale at farms. Analyses covered the level of incurred inputs and manufacturing costs, it was also attempted to determine the factors preconditioning the best economic result and to answer the question: whether or not, the increase in the production scale was justified? The assessment involved the degree of diversification of production profitability, both between groups of agricultural holdings, i.e. scale ranges, and within the very holdings. To this end, selected statistical measures were used. The achieved results do not fully exhaust the issues concerning production profitability depending on the scale size but they provide an accurate overview of changes, despite the relative character of the production scale which was assumed as small, medium and large.

Research methodology

The accounts of costs and income for production activities were based on the data collected in the AGROKOSZTY system and the Polish FADN.

The AGROKOSZTY system gathers – for individual activities of crop and livestock production – data on the output level, incurred inputs and direct costs. The data allow calculating the gross margin. The generic structure of production value and direct costs is compliant with the assumptions of the European Union, formulated in the context of the Standard Gross Margin account (Augustyńska-Grzymek I. et al. 2000).

In the accounts for individual crop and livestock activities the production value is the sum of values of the main product and by-products under market turnover. It is defined according to the market selling prices or according to the loco selling prices of a farm (i.e. on the area of the farm). For crop production, it depends on the crop yield level and selling prices of products. All kinds of losses are deducted from the production value (per 1 hectare). For livestock production, the structure of production value is different depending on the analysed activity. However, the product, to be manufactured by means of the given type of production, is defined as the main product (e.g. milk). The growth in live animals (e.g. weaned calves) and one by-product or more (e.g. culled livestock) can occur regardless of the above. Losses, i.e. animal deaths, occurring in the production process (per 1 unit or per 100 kg of live animals), are deducted from the production value. The calculation of the production value for livestock production activity does not include the value of manure and slurry, which are produced at one's own farm.

Direct costs are components of costs that can be unquestionably assigned to a given activity. Their volume is proportional to the production scale and they have a direct impact on the production size (volume and value).

Direct costs of crop production include:

- seed and planting material (*purchased or manufactured at a farm*),
- purchased fertilisers¹ (*excluding lime*),
- plant protection products,
- plant growth regulators (*rooting agents, growth substances, defoliants*),
- insurances concerning directly a given activity,
- specialist costs covering:
 - specialist expenditures on crop production,
 - specialist services,
 - occasional hire to specialist works.

Direct costs of livestock production include:

- livestock covered by individual activities, for herd replacement,
- feedstuffs divided into:
 - feedstuffs from outside of a farm (*mainly purchased*),
 - feedstuffs from one's own farm divided into:

¹ Cost of purchased fertilisers covers also special taxes on fertilisers.

- own feedstuffs from potentially commercial products,
- own feedstuffs from non-commercial products,
- rents for use of forage area leased for a period shorter than one year (for UAA and for areas not classified as UAA, e.g. mountain grasslands),
- livestock insurance concerning directly a given activity (e.g. cows, heifers),
- veterinary drugs and measures (including semen for insemination),
- veterinary services (insemination, castration, preventive vaccination),
- specialist costs covering:
 - specialist expenditure on livestock production,
 - specialist services,
 - occasional hire to specialist works.

The set of direct costs, which lower the production value, is different for crop and livestock production. In both cases they reflect the current market conditions, though.

The components of direct costs from outside of an agricultural holding are determined by purchase prices, while components of costs generated by a farm (e.g. seed material, own feedstuffs from commercial products) – by loco selling price of a farm. Own feedstuffs from non-commercial products (e.g. maize-silage), which are priced by direct costs incurred on their production, are the exception in case of livestock production. Respective cost components are reduced by the subsidies granted.

The account of costs for livestock production activity does not include the value of by-products of crop production (e.g. straw, beet greens) which are produced and used at one's own farm as feedstuffs or bedding.

Specialist costs are a special item among direct costs. These are costs which are directly related to a defined activity, and raise the quality and value of the final product. An example of a specialist cost for crop production activity is the cost of energy carriers spent on drying of products, preparing products for sales or carrying out analyses to find out the fertilisation needs of crops. Examples of specialist costs for livestock activity include, for instance, the costs of bedding spent in the production process of a given activity, the costs of agents for preserving and storage of feedstuffs, the classification of livestock or disinfection of livestock buildings.

The accounts, to calculate the income from activity, capture both direct costs and overheads. The level of overheads is defined based on the data from the Polish FADN. The overheads are the costs of readiness for production incurred for operation or for the very existence of an agricultural holding. These are divided into real and estimated overheads.

Real overheads include:

- farming overheads – electricity, heating fuel, motor fuels, current repairs, maintenance and overhauls, services, building insurance, property and motor insurance, other costs, e.g., water, telephone charges;
- taxes – agricultural, forest, special sections of agricultural production, property and others, e.g., means of transport;
- costs of external factors – contractual work, rents and interest on loans.

The estimated overheads include: depreciation of buildings and structures, machinery and technical equipment, means of transport, land drainage, orchards and perennial plantations, intangible fixed assets, and completed leasehold improvements.

The costs of depreciation calculated for respective activities show the level of spending of fixed assets involved in the production process. This cost is, however, reduced by the amount of subsidies on investments, used by the farmers as part of the support for agriculture from the EU funds and the state's budget. In case of surveyed activities both the number of farms and their distribution in the groups, formed based on a specific criterion, can be different. Thus, the strength of impact of this factor (i.e. subsidies on investments) on the level of the annual depreciation instalment is also different.

In the accounts made, overheads were divided between activities conducted at a given farm according to the share of production value of each of them in the total production value of an agricultural holding. To this end, holdings conducting the activities surveyed under the AGROKOSZTY system were identified in the database of the Polish FADN. Overheads breakdown algorithm was used separately for respective agricultural holdings and activities.

The account of unit costs of crop and livestock production activities is linked to the structure of costs of a farm presented in the Individual Farm Report – the Polish FADN (Goraj L., Mańko S. 2004). This resulted in adoption of a similar terminology for income categories in the account for activities – Scheme 1.

Scheme 1

How to calculate individual income categories for agricultural production activities?

- I Production value**
- II - *Direct costs*
- III = Gross margin less payments**
- IV - *Real overheads (excluding the cost of external factors)*
- V = Gross value added from activity**
- VI - *Estimated overheads – depreciation*
- VII = Net value added from activity**
- VIII - *Cost of external factors*
- IX = Income from activity less payments**
- X + *Payments*
- XI = Income from activity**

Income from activity is the surplus produced after deduction of direct costs and overheads from production value, and increased by payments. This income category is suitable for long-term assessment of results, assuming that the production capacity of a holding is kept at a fixed level.

It should be added that the calculations of individual income categories in the accounts for agricultural production activities do not include the amounts of input and output VAT.

The item: payments, covers only the payments that directly relate to individual activities, which are mainly complementary national direct payments. The account does not include the Single Area Payments, since in line with the provisions it is paid to agricultural lands owned by farmers on the date set in the Act and eligible for the payments.

The Tables presenting the research results include also data on (own and hired) labour inputs incurred per given activity, which are gathered in the AGROKO-SZTY system. These records allow defining the labour-intensity of production. In case of crop production activity, the registered works include works linked to pre-sowing soil preparation, cultivation works and works involved in harvesting and drying of seeds. Whereas in case of livestock production – these are mainly works linked to handling of animals and supplying feedstuffs, and inputs incurred on production of own non-commercial feedstuffs of a farm. The register does not include labour inputs that are connected to operation of a farm as a whole. This pertains to administrative works, general economic works or labour inputs incurred on repairs of buildings or machines.

Based on the number of working hours spent on the manufacture of respective products, the income from activity (excluding or including payments) is calculated per 1 hour of own labour. This income category reflects the coverage ratio of labour inputs of a farmer and his/her family with the income obtained per 1 ha of crops or manufacture of 100 kg of live pigs. For the needs of the analysis, the labour of a farmer was valued at standard rate set on the basis of the average level of remuneration in a given year, paid to workers hired in the overall national economy (according to the Central Statistical Office). It was assumed that one full-time employee works in agriculture for 2,120 hours per year. Payment per 1 hour of own labour thus calculated, amounted to PLN 13.79 in 2013. But it needs to be noted that own labour inputs in individual holdings, expressed in qualitative terms, are always conventional in nature.

Assessing the production efficiency in groups of farms different in terms of scale size, the analysis covered the level of production value and total costs (i.e. direct costs and overheads in total) incurred on its generation. The relations between these variables are expressed by the profitability index. Selected statistical measures were used to describe it and determine the degree of its differentiation in the groups of holdings: percentile 5% and 95%, median, quartile deviation, positional coefficient of variation (Sobczak M. 2007). To assess the efficiency of use of the incurred inputs and to assess the economic usefulness of production intensification, the marginal costs were calculated. The marginal cost is a measure of total costs response to the increase in production volume; it most often reflects the increase in these costs in relation to the generation of one additional production unit. The marginal cost can change along with the next generated unit or it can remain unchanged. Depending on production scale,

the level of marginal cost can decrease or increase. But most often, marginal costs rise along with an increase in scale, simultaneously increasing the manufacturing cost (Samuelson P.A., Nordhaus W.D. 1995).

Research results

The research results were presented as averages for the surveyed set of holdings running a specific activity. However, in order to demonstrate the differences in the level of inputs and obtained production and economic effects, farms were grouped according to the production scales of respective activities. For the needs of the analysis, three scale ranges were selected, i.e. small, medium and large. The scale criterion applied for crop production activity was cultivation area and for live pigs – the net production level, measured with the volume of annual weight growth obtained per herd of pigs for fattening.

The presented calculations were far more extensively covered in the publication entitled *Wyniki ekonomiczne wybranych produktów rolniczych w 2013 roku* (published by IERiGŻ-PIB, Warsaw 2014), which comprehensively discussed the economic situation of surveyed agricultural production activities.

This paper presents the research results and analysis thereof in a synthetic manner, paying attention only to the most important issues. Results of calculations and costs incurred by farmers (in nominal values) are included in the tables. Given the electronic data processing technique, in some cases the sums of component parts may differ from the “total” values.

The results of surveyed activities were influenced by the production capacity of farms, i.e. land, labour and capital resources, their quality and how they were used, but the results depended also on the external conditions of operation, e.g. weather and market conditions. The global warming and climate change related thereto entail a number of threats to agricultural production. The above can occasion deteriorated production results of activity regardless of the scale of cultivation. Moreover, an agricultural holding – as a part of the entire economy – is affected by its surroundings. This may cover economic factors, e.g. structure and level of prices, inflation rate, availability of and interest on loans, exchange rates. These impacts result in different degree of changes in the level of production, unit costs as well as prices for making individual agricultural products. The decisions made by a farmer are always linked to some risk as regards obtained results. But the research showed that the benefits following from the increase in production scale are clearly visible. Some of them are listed below:

- along with an increase in the area under winter wheat, winter rye, spring barley and winter rape, their production results improved gradually, the advantage of larger scale is clear; barley was the only exception, as in its case the highest yield was obtained at medium scale;
- scale increase stimulated a growth in selling prices of cereal grains (except for rye – the highest price was obtained at medium scale of its cultivation), rape seeds and live pigs;

- along with an increase in the scale of all surveyed activities the revenues from production unit gradually grew (i.e. 1 ha or 100 kg of live pigs), just like direct costs corresponding to the generated production and, in case of crop production – total costs (i.e. direct costs and overheads in total), while in case of live pigs, the level of total costs noted an opposite direction – it dropped;
- in subsequent groups of farms, the labour-intensity of cultivation of cereals and rape and the production of live pigs decreased along with an increase in the production scale.

Because of differences – as regards selected scale ranges – in production and price results and the level of costs, differs also the production profitability understood as a difference between the production value and its corresponding costs, and as a quotient of the production value and costs in percentage terms. In the first case, profitability was expressed as income from activity, less payments, and in the second – the profitability index.

In 2013, in the surveyed farms **winter wheat**, cultivated at 23.85 ha, provided per 1 ha an average income from activity, less payments, of PLN 1,105 (Table 1). The groups of farms, differentiated by cultivation area of winter wheat, noted a positive economy of scale. Along with its growth a progressive improvement in the production and price results was noted, which caused increasingly higher revenues and higher level of income. Winter wheat at small scale of cultivation (3-12 ha) per 1 ha generated income, less payments, at the level of PLN 928, at medium scale (15-30 ha) – PLN 966, and at large scale (40-120 ha) – PLN 1,383.

The advantage of wheat cultivated at large scale is clear also at the level of gross margin, less payments. This is evidenced by its high level – PLN 3,333 per ha, higher by 17.2% as compared to the medium scale, and by 35.2% – compared to small scale. Wheat at large scale of cultivation is also marked by the highest cost competitiveness, which was measured by the share of direct costs in the gross margin, less payments. At large scale, these costs represented 47.3% of the level of generated margin, while at medium scale – 54.4%, and at small scale – 52.6% (Table 6).

The costs of wheat cultivation grew along with a raise in the cultivation scale. This line of changes concerned total costs, but also their components, i.e. direct costs and overheads. The cost of mineral fertilisers and plant protection products stimulated the growth in direct costs, and the raise in overheads was driven by the cost of fuels, repairs and rents. Marginal analysis showed that, at large scale of cultivation, the marginal cost and income, less payments, were in a positive relation to their average level, and at medium scale, the relation was not favourable. The production intensity limit was not crossed, though; a growth in production value by PLN 1 at medium scale required cost increase by PLN 0.79, and at large scale – by PLN 0.69.

The assessment covered also the economic efficiency of production, which was measured by the profitability index (the relation of production value to total costs) and its selected statistics (Table 7). At this level of analysis, the advantage of large scale of cultivation is also clear. The profitability index amounted

to 139.2% and exceeded the level of the medium scale by 11.0 pp, and the small scale by 6.4 pp. Additionally, its dispersion in this sample of agricultural holdings was the lowest (positional coefficient of variation amounted to 10.2%, while at medium scale – 20.4%, and at small scale – 23.9%), just as the share of farms (4%) where wheat was unprofitable.

Another benefit following from large scale wheat cultivation was the lowest labour-intensity, which influenced the level of income per 1 hour of farmer's labour. Own labour inputs were covered in all scale ranges, income from activity, less payments, was 6.2 times higher than the parity rate (PLN 13.79 per hour) at small scale of cultivation, 7.9 times – at medium scale, and as much as 12.2 times – at large scale. After inclusion of payments into the account, the multiplication factor of parity rate coverage would be even higher. Thus, it is estimated that it was also possible to cover the remaining factors of production, i.e. land and capital.

In 2013, the income from activity, less payments, generated from **winter rye** cultivation was very low; in the research sample (cultivation area – 11.52 ha) it was, on average, PLN 282 per ha (Table 2). It was also low in the selected scale ranges, but there are differences in its level: for farms cultivating rye at small scale (1-3 ha) it was, per 1 ha, PLN 160, at medium scale (5-15 ha) – PLN 349, and at large scale (20-70 ha) – PLN 262. Rye cultivated at medium scale provided the highest income. Its advantage over large scale was determined by two factors – higher by 3.5% grain price and lower by 17.4% total costs.

However, benefits following from increased scale of rye cultivation are evident. They are, above all, manifested in gradually growing yield. Comparing extreme scale ranges, the difference in favour of the large scale was 34.4%. The advantage of the large scale of cultivation is also evidenced by the level of gross margin, less payments – direct costs amounted to 67.6% of its level (Table 6). This means that the cost of generating PLN 1 of the gross margin was PLN 0.68, but in the two other scale ranges it was higher – for the medium scale it was PLN 0.70, and for the small scale it was PLN 0.75. Rye cultivated at a large scale was, thus, the most competitive, if the incurred direct costs are taken into account.

Increase in the rye area in agricultural holdings and growth in yields were linked to increasingly higher costs of its cultivation. Rye cultivated at large scale was the most cost-intensive. But marginal analysis showed that both at medium and large scale, the marginal cost of production of 1 dt of grain was lower than the limit cost, i.e. selling price. The production intensity limit was also not crossed. However, the results at medium scale were better. This points to the level of the marginal cost, which was by 1.9% lower than the average unit cost, while at large scale it was higher by 1.4%. As a consequence, the marginal income – as compared to its average level – at medium scale was by 9.5% higher, while at large scale – by 22.8% lower.

Rye cultivated at medium scale was characterised also by the highest economic efficiency – the profitability index was 125.9% (Table 7). This group was also characterised by the lowest percentage of farms where rye was unprofitable – 23%, while at small scale the percentage of such farms was 31%, and at large scale – 32%.

The gradual drop in labour-intensity was a positive effect of the growth in the scale of rye cultivation. But the strength of impact of income obtained from cultivation of 1 ha was greater per the multiplication factor of parity rate coverage of own wage. As a result, the income from activity, less payments, per 1 hour of own labour at small scale rye cultivation was higher than the parity rate by 1.2%, while at medium scale – 2.8 times, and at large scale – 2.7 times.

In 2013, the income situation of **spring barley** was worse than that of winter wheat, but better than rye. The average income from activity, less payments, in the sample for barley cultivation at 10.47 ha amounted to PLN 732 per ha (Table 3). Increase in the scale had a positive impact on the level of income – farmers cultivating barley at small scale (1-3 ha) got PLN 609 per 1 ha, at medium scale (5-15 ha) – PLN 777, and at large scale (20-50 ha) – PLN 851. The selling price of grain rose along with the increase in the scale of barley cultivation. The change in the barley yield was not one-sided, though. The highest change was noted for medium scale (46.1 dt per ha) – against large scale it was higher by 2.4%. Despite this, the revenues per 1 ha of barley increased gradually determining the growth in both gross margin and respective income categories.

Although the gross margin, less payments (PLN 2,086 per ha), was high, barley cultivated at large scale ranked second as regards competitiveness against direct costs (Table 6). These costs represented 49.6% of the level of generated margin, while at medium scale – 48.3%. The least competitive, as it comes to the incurred direct costs, was barley cultivation at small scale. Its share in the gross margin was the highest, amounting to 58.6%.

Gradual, in subsequent scale ranges, growth in income, less payments, from barley cultivation was linked to increasingly higher costs (total). However, marginal analysis showed that both at medium and large scale, the marginal cost of production of 1 dt was lower than the limit cost, i.e. grain price. The production intensity limit, recognised as increase in costs to increase in production value, was also not exceeded, thus the law of diminishing returns was not noted. But in both scale ranges, the marginal cost of production of 1 dt was higher than the average level of cost, thereby it stimulated its growth, which is a negative phenomenon.

The benefits following from an increase in scale are also clear if barley cultivation profitability is assessed in quotient terms (Table 7). The highest average level of the profitability index was noted for large scale (137.5%). In the sample, the share of farms where barley cultivation was unprofitable was the lowest (6%). Barley cultivation at large scale contributed to a drop in labour-intensity, the difference between the large scale and small scale – to the advantage of the former – was 1.6 times. This affected the level of income per 1 hour of own labour. In separated groups of agricultural holdings farmer's labour was covered, but the income from activity, less payments, was higher than the parity rate of labour charges (PLN 13.79 per hour) at small scale of cultivation 4.7 times, at medium scale – 7.1 times, and at large scale – 11.9 times. After inclusion of payments into the account, the multiplication factor of parity rate coverage would be even higher.

In 2013, **winter rape** was a profitable activity (Table 4). Average income from activity, less payments, in the surveyed farms cultivating rape at 17.94 ha

was PLN 1,055 per ha and was close to the income earned on winter wheat cultivation (PLN 1,105 per ha). Along with an increase in the area under rape cultivation, results at the level of income, less payments, were better and better. At small scale of cultivation (1-5 ha) farmers got PLN 636 per 1 ha, at medium scale (10-15 ha) – PLN 1,186, and at large scale (20-60 ha) – PLN 1,212. The production and price results were a decisive factor, as their gradual improvement favoured generation of higher revenues. The costs of rape cultivation also grew, but the strength of impact of revenues at the level of income was greater.

Rape cultivation, against other activities, is quite cost-intensive. In subsequent scale ranges the increase in total costs was conditioned by both direct costs and overheads. Both cost groups were characterised by one-sided change. Research shows that the relation between direct costs and generated gross margin, less payments, was the most profitable for rape cultivation at medium scale – it amounted to 53.6% (Table 6). This is an evidence of cost competitiveness of rape in this scale range. The results of rape cultivated at large and small scale were worse in this respect. The share of costs in the generated gross margin amounted to 57.6% and 66.5%, respectively.

The account of marginal costs also proves that production efficiency of rape at medium scale was greater than at large scale. This points to a lower cost of generating additional production unit by 14.8%. Moreover, the cost was by 2.6% lower than the average unit cost; hence one pressured reduction on the other. Whereas, at large scale the marginal cost was higher than the average cost by 4.7%, therefore it encouraged its growth. But the limit cost, determined by the seed price, both at medium and large scale, was much higher than the marginal cost, respectively, by 37.4% and 24.4%. The production intensity limit, recognised as increase in costs to increase in the production value, was also not exceeded.

Statistical analysis of profitability of winter rape cultivation confirmed the conclusions drawn from the tabular data (Table 7). The average level of the profitability index was the highest for agricultural holdings cultivating rape at medium scale (133.9%), its median was also the highest (136.6%).

Nonetheless, positive scale effect is clear. This is evidenced by reducing labour-intensity of rape cultivation and, consequently, increasingly higher degree of coverage of own labour inputs. Income, less payments, per 1 hour of own labour at small scale exceeded 4.2 times the parity rate of labour charges (PLN 13.79 per hour), while at medium scale – 9.9 times, and at large scale – 12.4 times. The payments received enabled to cover the alternative costs of other factors of production (i.e. land and capital) to a greater extent.

In 2013, **live pigs** production in most of the farms from the research sample was unprofitable (Table 5), which means that revenues failed to fully cover the total production costs (i.e. direct costs and overheads in total). These costs were, on average, covered in the surveyed farms (223 dt growth in live pigs) in 90.4%. Along with an increase in the scale of fattening the positive direction of changes became apparent, i.e. increasingly greater coverage of costs and growth in the share of holdings where live pigs were profitable.

The average degree of coverage of production costs in the selected scale ranges amounted to: at small scale (10-50 dt) – 79.3%, at medium scale (100-350 dt) – 84.8%, and at large scale (500-1,500 dt) – 96.0%. Whereas the share of holdings where pigmeat production was profitable amounted to 18% on average in the set, and in subsequent scale ranges, starting from small, it was 9%, 17% and 47% (Table 7). The positive effect of production scale is, thus, evident. Despite this, the average own labour inputs incurred on production of live pigs in the selected groups was still uncovered.

Better results – along with greater production scale – were conditioned by two factors, i.e. higher price of live pigs and drop in (total) costs of their production. Comparing extreme scale ranges, the difference in favour of the large scale for price was 9.3%, and for production costs – 9.6%. A drop in costs was determined solely by overheads, which at large scale of pigs for fattening, accounted for 33.8% of the level noted for small scale. The level of these costs dropped mainly because production of live pigs is not so heavily burdened with the costs of depreciation of engaged fixed assets and costs of fuel, repairs and production services.

Calculations show that farmers producing live pigs at small scale incurred the lowest direct costs to produce PLN 1 of gross margin, less payments (PLN 5.21), which attests to competitiveness against this category of income. In case of medium scale, generation of PLN 1 of gross margin cost PLN 6.70, and large scale – PLN 10.04 (Table 6). Despite having cost advantage at the level of gross margin, the situation of farmers producing live pigs at small scale was unfavourable. At this scale of fattening, pigmeat production proved to be very capital-intensive, which is manifested in the highest overheads (total) – PLN 210 per 100 kg of gross live pigs, while at medium scale they amounted to PLN 164, and at large scale – PLN 71.

The marginal account explains the losses in live pigs production decreasing along with an increase in production scale and the impact of the scale on their level. At medium production scale the marginal cost (PLN 6.26 per kg) was equal to the average cost. Moreover, an increase in the production value by PLN 1 required cost increase by PLN 1.17, which means that production was too expensive. Whereas at large scale of fattening, the marginal cost (PLN 5.48 per kg) was by 3.2% lower than the average cost (PLN 5.66 per kg) thus it put a pressure on its drop. But the increase in costs was equal to the increase in production value. This means that further growth in costs (production intensity) at the same level of revenues is inadvisable. Hence, it will intensify the drop in production profitability.

Research showed that, despite the generally unfavourable situation, there are farms (18%) in the research sample where live pigs' production allowed earning income (PLN 35 per 100 kg). This was determined by lower production costs. Positive economic effect largely depends on the rational feeding of pigs for fattening – this affects a decrease in the consumption of feedstuffs per 1 kg of growth and, consequently, determines lower production costs. Research shows that consumption of concentrated feeds per 1 kg of increase for farms earning on pigmeat production amounted to 2.74 kg, while for farms incurring losses – 3.47 kg (i.e. by 0.73 kg more).

The results of conducted research prove that the production scale is an important factor determining economic effects of agricultural products manufacturing. This is not a new issue, but it is still a valid one. Greater production volume, in general, makes it possible to generate higher income. What is more, there is a close negative correlation between production volume (scale) and unit labour-intensity. The increase in the scale – given higher level of specialisation and mechanisation of works – is linked to considerably lower labour inputs, which gives higher labour profitability. As a result, it can be expected that alternative cost of land and capital will be covered. This is important because in the final account what decides on the competitiveness of production activity and, consequently, farms is the ability to cover alternative costs.

The choice of the production scale of respective activities is a difficult decision for farmers and it is, most certainly, conditioned by many factors. Nonetheless, production volume is incredibly important from the economic perspective. Having no direct impact on price formation, a farmer can decide on the production volume by defining its scale (e.g. cultivation area), at the same time, considering the possibilities in the field of effective use of factors of production being at his/her disposal.

The drive at more efficient management of factors of production raises interest in the level of increased costs. Knowledge within the scope is a prerequisite of rational decision-making. Specialised and developing commercial farms have considerable information needs and the cost account is not only a survey of inputs but a tool supporting the process of planning and control of the use of resources. This expectations are met with research of agricultural production activities held under the AGROKOSZTY system. Of course, the results of the research do not fully exhaust the issues concerning management of costs, production profitability and rational farming. But the accounts provide a good overview of the situation in agricultural holdings participating in the research, reflect the existing trends and allow explaining the changes at hand.

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Table 1

Production and costs of and income from winter wheat cultivation in 2013
(real data)

Specification	Average for farms cultivating winter wheat	Depending on cultivation scale (ha/farm)		
		3-12	15-30	40-120
Number of surveyed farms	144	40	31	26
Cultivation area (ha)	23.85	8.14	22.09	61.86
Grain yield (dt/ha)	62.2	53.0	62.5	66.8
Grain selling price (PLN/dt)	71.86	70.20	70.23	73.36
per 1 ha of cultivation				
Total production value (PLN)	4,485	3,760	4,391	4,908
including: grain	4,472	3,722	4,391	4,899
Total direct costs (PLN)	1,535	1,295	1,547	1,575
including: seed material	253	266	256	251
total mineral fertilisers	857	702	879	857
organic fertilisers from outside of a farm	-	-	-	-
plant protection products	363	291	348	394
growth regulators	47	26	44	59
other	15	10	19	14
Gross margin less payments (PLN)	2,950	2,465	2,844	3,333
Real overheads ^a (PLN)	869	733	909	928
Gross value added from activity (PLN)	2,081	1,732	1,935	2,405
Depreciation (PLN)	706	568	723	694
of: buildings and structures	108	117	107	94
machinery and equipment	328	232	324	329
means of transport	266	218	280	270
Net value added from activity (PLN)	1,375	1,164	1,212	1,711
Cost of external factors (PLN)	270	236	246	328
Income from activity less payments (PLN)	1,105	928	966	1,383
Payments ^b (PLN)	123	126	125	115
Income from activity (PLN)	1,228	1,054	1,091	1,498
TOTAL COSTS (PLN)	3,381	2,832	3,424	3,525
Total labour inputs (hour)	9.1	11.3	9.6	8.8
including: own labour inputs	8.6	10.9	8.9	8.3
Measures of economic efficiency				
Total costs per 1 dt of grain (PLN)	54.32	53.41	54.77	52.78
Total costs per PLN 1 of income from activity less payments (PLN)	3.06	3.05	3.54	2.55
Payments per PLN 1 of income from activity less payments (PLN)	0.11	0.14	0.13	0.08
Share of payments in income from activity (%)	10.0	11.9	11.4	7.7
Income from activity per 1 dt of grain (PLN)	19.73	19.87	17.45	22.42
Income from activity per 1 hour of own labour (PLN)	143.55	96.31	122.62	181.49

^a Real overheads excluding the cost of external factors.

^b Payments include complementary national direct payment.

[-] – means that the phenomenon did not occur.

Table 2

Production and costs of and income from winter rye in 2013
(real data)

Specification	Average for farms cultivating winter rye	Depending on cultivation scale (ha/farm)		
		1-3	5-15	20-70
Number of surveyed farms	113	29	39	19
Cultivation area (ha)	11.52	2.06	10.73	31.73
Grain yield (dt/ha)	35.8	28.8	33.1	38.7
Grain selling price (PLN/dt)	48.90	49.81	50.12	48.45
per 1 ha of cultivation				
Total direct costs (PLN)	1,775	1,445	1,698	1,896
including: grain	1,750	1,435	1,657	1,874
Total direct costs (PLN)	730	620	700	765
including: seed material	154	179	142	164
total mineral fertilisers	455	369	431	476
organic fertilisers from outside of a farm	2	-	6	-
plant protection products	98	64	108	96
growth regulators	16	5	9	23
other	4	2	2	7
Gross margin less payments (PLN)	1,045	826	999	1,131
Real overheads ^a (PLN)	369	365	320	410
Gross value added from activity (PLN)	676	460	679	721
Depreciation (PLN)	298	265	250	353
of: buildings and structures	62	91	71	52
machinery and equipment	126	84	89	167
means of transport	109	87	89	134
Net value added from activity (PLN)	378	195	429	368
Cost of external factors (PLN)	96	35	80	107
Income from activity less payments (PLN)	282	160	349	262
Payments ^b (PLN)	133	137	133	132
Income from activity (PLN)	415	296	482	393
TOTAL COSTS (PLN)	1,493	1,286	1,349	1,634
Total labour inputs (hour)	8.8	11.6	9.0	7.8
including: own labour inputs	8.5	11.5	8.9	7.1
Measures of economic efficiency				
Total costs per 1 dt of grain (PLN)	41.70	44.63	40.80	42.25
Total costs per PLN 1 of income from activity less payments (PLN)	5.29	8.05	3.87	6.25
Payments per PLN 1 of income from activity less payments (PLN)	0.47	0.86	0.38	0.50
Share of payments in income from activity (%)	32.0	46.1	27.6	33.5
Income from activity per 1 dt of grain (PLN)	11.59	10.29	14.59	10.16
Income from activity per 1 hour of own labour (PLN)	49.06	25.87	54.15	55.05

^a Real overheads excluding the cost of external factors.

^b Payments include complementary national direct payment.

[-] – means that the phenomenon did not occur.

Table 3

Production and costs of and income from spring barley in 2013
(real data)

Specification		Average for farms cultivating spring barley	Depending on cultivation scale (ha/farm)		
			1-3	5-15	20-50
Number of surveyed farms		138	32	57	18
Cultivation area	(ha)	10.47	2.04	9.05	28.72
Grain yield	(dt/ha)	44.3	43.1	46.1	45.0
Grain selling price	(PLN/dt)	66.95	60.23	64.06	68.53
per 1 ha of cultivation					
Total production value	(PLN)	2,998	2,603	3,000	3,119
including: grain		2,967	2,594	2,956	3,082
Total direct costs	(PLN)	1,028	962	977	1,034
including: seed material		206	193	206	203
total mineral fertilisers		631	627	598	603
organic fertilisers from outside of a farm		3	-	8	-
plant protection products		153	124	144	171
growth regulators		26	15	15	49
other		10	2	7	8
Gross margin less payments	(PLN)	1,969	1,641	2,023	2,086
Real overheads ^a	(PLN)	581	548	597	571
Gross value added from activity	(PLN)	1,389	1,093	1,426	1,515
Depreciation	(PLN)	438	391	488	363
of: buildings and structures		87	123	93	65
machinery and equipment		189	134	200	181
means of transport		160	133	192	116
Net value added from activity	(PLN)	951	702	939	1,152
Cost of external factors	(PLN)	219	93	162	301
Income from activity less payments	(PLN)	732	609	777	851
Payments ^b	(PLN)	117	130	123	100
Income from activity	(PLN)	849	740	901	951
TOTAL COSTS	(PLN)	2,266	1,993	2,223	2,269
Total labour inputs	(hour)	7.1	9.5	8.6	6.0
including: own labour inputs		6.5	9.4	7.9	5.2
Measures of economic efficiency					
Total costs per 1 dt of grain	(PLN)	51.13	46.27	48.16	50.44
Total costs per PLN 1 of income from activity less payments	(PLN)	3.10	3.27	2.86	2.67
Payments per PLN 1 of income from activity less payments	(PLN)	0.16	0.21	0.16	0.12
Share of payments in income from activity	(%)	13.8	17.6	13.7	10.5
Income from activity per 1 dt of grain	(PLN)	19.15	17.18	19.52	21.14
Income from activity per 1 hour of own labour	(PLN)	130.72	78.55	113.69	183.87

^a Real overheads excluding the cost of external factors.

^b Payments include complementary national direct payment.

[-] – means that the phenomenon did not occur.

Table 4

Production and costs of and income from winter rape in 2013
(real data)

Specification		Average for farms cultivating winter rape	Depending on cultivation scale (ha/farm)		
			1-5	10-15	20-60
Number of surveyed farms		143	28	42	49
Cultivation area	(ha)	17.94	3.24	12.02	31.97
Seed yield	(dt/ha)	35.3	30.3	34.3	35.9
Seed selling price	(PLN/dt)	143.12	131.55	136.75	145.25
per 1 ha of cultivation					
Total production value	(PLN)	5,059	3,987	4,685	5,216
including: seeds		5,059	3,987	4,685	5,216
Total direct costs	(PLN)	1,904	1,593	1,636	1,907
including: seed material		189	189	178	184
total mineral fertilisers		1,160	964	1,021	1,167
organic fertilisers from outside of a farm		-	-	-	-
plant protection products		445	390	375	445
growth regulators		34	27	20	38
other		75	24	42	73
Gross margin less payments	(PLN)	3,155	2,394	3,049	3,309
Real overheads ^a	(PLN)	967	906	924	945
Gross value added from activity	(PLN)	2,188	1,487	2,126	2,364
Depreciation	(PLN)	786	628	749	803
of: buildings and structures		131	164	169	117
machinery and equipment		368	262	285	399
means of transport		280	193	291	281
Net value added from activity	(PLN)	1,402	859	1,377	1,561
Cost of external factors	(PLN)	348	223	191	349
Income from activity less payments	(PLN)	1,055	636	1,186	1,212
Payments ^b	(PLN)	122	125	124	124
Income from activity	(PLN)	1,176	762	1,310	1,336
TOTAL COSTS	(PLN)	4,004	3,350	3,499	4,003
Total labour inputs	(hour)	8.4	11.6	8.9	7.7
including: own labour inputs		7.9	11.1	8.7	7.1
Measures of economic efficiency					
Total costs per 1 dt of seed	(PLN)	113.29	110.56	102.14	111.49
Total costs per PLN 1 of income from activity less payments	(PLN)	3.80	5.27	2.95	3.30
Payments per PLN 1 of income from activity less payments	(PLN)	0.12	0.20	0.10	0.10
Share of payments in income from activity	(%)	10.3	16.4	9.5	9.3
Income from activity per 1 dt of seed	(PLN)	33.28	25.13	38.24	37.21
Income from activity per 1 hour of own labour	(PLN)	148.77	68.81	150.83	188.24

^a Real overheads excluding the cost of external factors.

^b Payments include complementary national direct payment.

[-] – means that the phenomenon did not occur.

Table 5

Production and costs of and income from live pigs in 2013
(real data)

Specification	Average for farms producing live pigs	Depending on net production scale (dt/farm)		
		10-50	100-350	500-1,500
Number of surveyed farms	134	34	41	19
Net production of live pigs (increase) ^a	(dt/farm) 222.76	26.47	191.29	788.69
Gross production of live pigs ^b	(dt/farm) 417.63	47.09	348.16	1,508.25
Average annual selling price of live pigs	(PLN/kg) 5.34	4.97	5.31	5.43
per 100 kg of gross live pigs				
Total production	(PLN) 534	497	531	543
Total direct costs	(PLN) 478	417	462	494
including: herd replacement	301	249	272	332
feedstuffs from outside of a farm	107	52	86	117
own feedstuffs	63	110	100	37
other	7	5	4	8
Gross margin less payments	(PLN) 56	80	69	49
Real overheads ^c	(PLN) 54	97	78	35
Gross value added from activity	(PLN) 2	-17	-9	14
Depreciation	(PLN) 45	94	72	27
of: buildings and structures	14	34	20	8
machinery and equipment	17	32	28	10
means of transport	14	26	24	8
Net value added from activity	(PLN) -44	-111	-81	-13
Cost of external factors	(PLN) 13	19	14	9
Income from activity less payments	(PLN) -57	-129	-95	-23
Payments	(PLN) -	-	-	-
Income from activity	(PLN) -57	-129	-95	-23
TOTAL COSTS	(PLN) 590	626	626	566
Total labour inputs	(hour) 2.4	7.4	3.2	1.4
including: own labour inputs	2.1	7.1	3.0	1.3

^a Net production of live pigs is the annual weight growth per herd of pigs for fattening.

^b Growth + weight of purchased pigs.

^c Real overheads excluding the cost of external factors.

[-] – means that the phenomenon did not occur.

Table 6
Direct costs and gross margin, less payments, and the ratio of costs to the margin in selected scale ranges of production activities surveyed in 2013^a

Specification	Winter wheat			Winter rye			Spring barley			Winter rape			Live pigs		
	3-12	15-30	40-120	1-3	5-15	20-70	1-3	5-15	20-50	1-5	10-15	20-60	5-50	100-400	500-2,000
Direct costs	1,295	1,547	1,575	620	700	765	962	977	1,034	1,593	1,636	1,907	417	462	494
	(PLN/ha)														
Gross margin less payments	2,465	2,844	3,333	826	999	1,131	1,641	2,023	2,086	2,394	3,049	3,309	80	69	49
	(PLN/ha)														
Ratio of costs to gross margin less payments	52.6	54.4	47.3	75.1	70.1	67.6	58.6	48.3	49.6	66.5	53.6	57.6	521.1	670.5	1,004.3
	(%)														

^a Production selection criterion as in Tables 1-5.

Table 7
Selected descriptive statistics of profitability index in selected scale ranges of production activities surveyed in 2013^a

Specification	Winter wheat			Winter rye			Spring barley			Winter rape			Live pigs		
	3-12	15-30	40-120	1-3	5-15	20-70	1-3	5-15	20-50	1-5	10-15	20-60	5-50	100-400	500-2,000
Average	(%) 132.8	128.2	139.2	112.4	125.9	116.0	130.6	135.0	137.5	119.0	133.9	130.3	79.3	84.8	96.0
Percentile 5%	(%) 95.4	92.7	102.1	53.9	84.4	65.0	83.2	81.5	101.9	81.5	82.9	83.2	61.4	67.6	79.2
Median	(%) 132.5	123.9	130.4	138.5	132.4	122.4	129.6	138.3	126.2	118.6	136.6	126.2	83.0	85.5	99.1
Percentile 95%	(%) 266.5	207.7	225.2	190.7	209.2	167.9	229.2	259.6	211.0	183.1	226.3	207.8	103.9	106.5	112.5
Quartile deviation	(pp) 31.6	25.2	13.3	37.1	29.2	28.1	24.4	37.9	22.8	23.1	20.8	12.2	7.5	8.1	10.9
Positional coefficient of variation	(%) 23.9	20.4	10.2	26.8	22.0	23.0	18.8	27.4	18.0	19.5	15.2	9.7	9.1	9.5	11.0
Percentage of farms with profitability index below 100	(%) 13	19	4	31	23	32	16	18	6	29	12	12	91	83	53

^a Production selection criterion as in Tables 1-5.

Key words: Polish FADN, AGROKOSZTY system, production value, income from activity, production scale, production profitability, labour-intensity, crop production, livestock production

Accepted for print: 26.06.2015.