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# ECONOMIC SITUATION AND PRODUCTIVITY OF THE POLISH PIG HOLDINGS

## Abstract

*The paper presents the situation of the Polish specialist pig holdings at the backdrop of similar holdings in Hungary, Germany, Denmark and the Netherlands. In order to study their development abilities, the following indices underwent a comprehensive assessment: productivity, profitability, management income, net investment rates and share of subsidies in the income of an agricultural holding. The highest productivity indices were achieved by the Dutch holdings, and profitability – the Hungarian and Polish holdings.*

*Very large Polish agricultural holdings also produced the highest aggregated values of the cumulative relative goodness index. Moreover, the paper points to the fundamental reasons behind the weakness of the Polish pig production sector, which cover low level of concentration and no linkages between the live pig producers and processing plants. It also determines how to take up and where to channel remedial actions.*

## Introduction

The agricultural production structure of each country results from several factors. It follows from specific natural features, such as latitude, soil quality, water availability, but also the level of economic development, state of affairs on the internal and foreign market, and past and present agricultural policy. Thus, it is neither easy nor possible to change the structure rapidly. It is all the more worthwhile to consider the fairly quick evolution of the Polish agricultural sector, evident in the recent years. According to Eurostat, in 2004-2011, Poland witnessed 65% growth in the value of agricultural production, 83% growth in the consumption of plant protection products, 15% growth in the consumption of natural fertilisers (per 1 ha), a growth in production concentration expressed in 26% drop in the number of farms having less than 5 ha of UAA and 42% increase

in the number of farms having more than 50 ha. The changes that took place over the time in the structure of production, namely decrease in the production of cereals, sugar beets, potatoes and live pigs, and increase in the production of rape and milk, were not coincidental, of course (Małkowski J., Zawadzka D., Pasińska D. 2014). They were generally convergent with those taking place in the other EU countries, which follows from implementation of the Common Agricultural Policy. The only exception in the aforementioned trends was the case of live pig production: in 2004-2011 the EU-27 countries noted a slight increase in the production, while in Poland there was a drop of six percent. Alongside a drop in the pig stock, there was an increase in the import of piglets and weaners, which translated into deterioration in the results of foreign trade in agri-food products and incomplete use of own production potential (Szymańska E., Hamulczuk M., Dziwulski M. 2012).

These are incredibly disturbing phenomena and many authors undertake to seek the reasons thereof, and attempt to describe the methods preventing collapse of the sector of agricultural production in Poland. The paper presents the research findings regarding economics and organisation of live pig production in Polish agricultural holdings, confronted with similar agricultural holdings in the selected countries of the European Union that are our competitors. It determines their production potential, organisation, and costs and effects.

## Place and role of live pig production in Polish agriculture and in selected countries

Poland is a major producer of pork. In 2009-2011, Poland – recording a share in the EU-27 live pig production at the level of 7.6% – was ranked fifth as regards live pig production; it was overtaken by Germany (21.7%), Spain (15.5%), France (10.1%) and Denmark (8.6%).

In 1990-2007 pig stock in Poland was rather stable; it was the lowest in 2000--2001, when it amounted to 17.1 million units, and the highest in 1992 – 22.1 million units (Figure 1). The pig stock plummeted (by 36%) in later years, namely 2007-2012: from 18.1 to 11.6 million units. From 2009 onwards, this drop caused a negative balance in foreign trade in pork both in quantity and quality terms. At the same time, there was a very strong growth in the negative foreign trade balance in live animals.

Decreased profitability of pig production, caused by a faster growth in the prices of concentrates than the prices of live pigs resulting, in turn, from a surge in the prices of cereals, is regarded as one of the reasons for a drop in the pig stock. In 2008-2012, the buying-in prices of wheat rose by 39.1%, barley by 27.1%, while the prices of live pigs grew by 12.7% in 2008-2011. In 2012, the buying-in prices of live pigs increased by 21% against the last year, but it did not stop the downward trend in pig stock.

A sharp drop in pig stock was caused, e.g., by unfavourable relations between prices of agricultural products sold by farmers and prices of means of agricultural production and labour costs. In 1995-2012, labour costs in the national econ-

omy – whose main component were remunerations – increased by over 5.5 times and prices of means of production for agriculture rose by 3.2 times, while sale prices of agricultural products increased definitely less, namely by only 2.3 times. The price scissors index, determined by the ratio of sale prices of agricultural products to the growth in the prices of means of production for agriculture, amounted in the analysed period to 73.4%, which means that the sale prices of agricultural products grew slower than the prices of means of production (Szymańska E., Hamulczuk M., Dziwulski M. 2012). The difference in the growth rate of the sale prices of agricultural products and the prices of means of production for agriculture, to the advantage of the latter, results in a drop in the unit profitability of agricultural productivity. The presented trends are known to all market economy countries and they are recognised as timeless regularities.

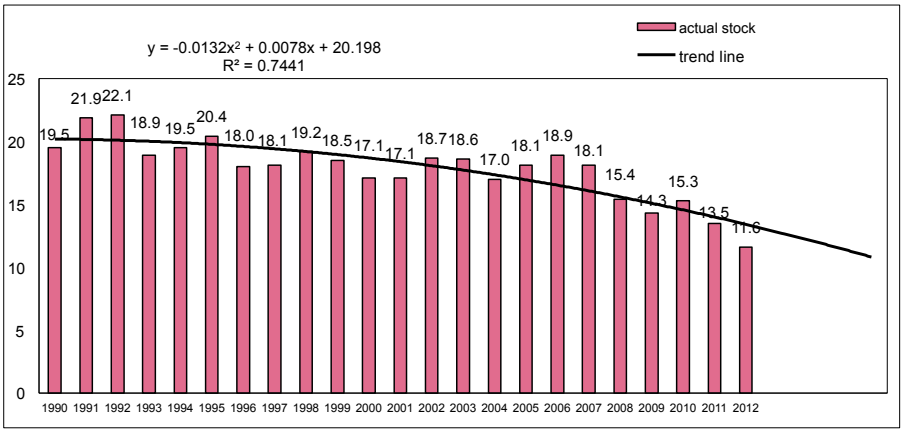


**Fig. 1.** Changes in pig stock in Poland in 1990-2012, million units

Source: W. Józwiak: Polskie rolnictwo i gospodarstwa rolne w pierwszej i drugiej dekadzie XXI wieku, IERiGŻ-PIB, Program Wieloletni 2011-2014, no. 53, Warsaw 2012.

To earn income at parity level[1], the farmers have to increase productivity of labour defined as value of production and calculated per one full-time employee[2], which is linked to the growth in the production scale. For pig rearing, concentration of a defined number of units of these animals at one farm is the measure of production. An important factor influencing the profitability of production is the ratio of the buying-in prices of live animals to cereal prices. In 2009-2013, this ratio was unfavourable (below 8) and was one of the factors having an impact on the decrease in the pig stock in Poland (Seremak-Bulge J. 2006).

Environmental restrictions in the growth of the breeding scale were also among the important reasons for the decrease in the pig stock (Kapłon M., Leśniak D. 2014). A fall in the pig stock showed varied intensity depending on the size of

[1] Parity income – income earned by those working in non-rural jobs in the national economy.

[2] Employed full-time in agriculture – working 2 120 hours per year in agriculture.

herds at farms. In 2007-2012, the pig stock decreased, in total, by 36.1%. In herds of less than 200 units per farm, the stock dropped by 56.5%. In larger herds, keeping 200 and more units, there was an increase in the stock by 682.8 thousand units, i.e. by 12.7%. In the group in 2010, the growth was definitely higher and amounted to 1 841.2 thousand units, i.e. 34.4%. In the next two years, there was a severe drop in the size of these herds amounting to 1 158.4 thousand units, i.e. 63%. This fact should be recognised as highly worrying and it should be linked not only to a decrease in the profitability of pig production but also to the aforementioned environmental restrictions (Ewolucja rynku… 2007; Józwiak W. 2012; Małkowski J., Rycombel D., Zawadzka D. 2013; Pejsak Z. 2013; Szymańska E., Hamulczuk M., Dziwulski M. 2012).

Notwithstanding the changes in pig stock on the national scale, the territorial differentiation of its distribution deepened. In 1990, 54.2% of all the stock was in five voivodeships (Wielkopolskie, Mazowieckie, Kujawsko-Pomorskie, Lubelskie and Podlaskie). In 2012, 68.2% of the stock was kept in five voivodeships (Podlaskie and Lubelskie were replaced with Łódzkie and Pomorskie).

On the country scale, the drop in the stock in 1990-2012 amounted to 40.5%. The highest declines were noted in the following voivodeships: Lubuskie: –82.2%, Podkarpackie: –75.6%, Podlaskie: –74.9%, Dolnośląskie: –72%, and Zachodniopomorskie: –71.8%. Pig stock growth was noted only in the Wielkopolskie Voivodeship in 2000 and 2011, and against 1990 the growth amounted, respectively, to: 34.8% and 27.3% (Ziętara W., Mirkowska Z., Adamski M., Blicharski T. 2014).

## Research methods

The research covered farms targeted at pig rearing (production type 51) included in the European FADN in 2009-2011 from Poland, Hungary, Germany, Denmark and the Netherlands, taking into account their economic size expressed in the value of Standard Output (SO)[3]. Hungary and Germany were chosen due to their proximity. Whereas, Denmark and the Netherlands are among the leading producers of live pigs. The research encompassed five economic size classes (II-VI). Class I holdings (very small) were not covered by FADN monitoring in the researched countries. Among Polish and Hungarian farms the following classes were researched: II-VI, and pig holdings of Germany and Denmark were represented by classes III-VI, while in the Netherlands by classes from IV to VI (Table 1).

Arithmetic means of individual properties were calculated for a three-year period (2009-2011), which were next used in tabular summaries and horizontal analysis. Change indices were also calculated for individual properties describing the production potential, production organisation, costs and effects, taking the value of the property in 2009 as the reference point. The scope of changes in the period was small, thus the calculated means basically reflect the level of

[3] Standard Output (SO) corresponds to the average value of output of individual productive activities from the period of 5 years. SO 2010 is the average for 2008-2012. SO per agricultural holding is the sum of values of Standard Outputs from crop or livestock activities (Goraj L., Bocian M., Cholewa I. 2013).

properties. Furthermore, the DEA (Data Envelopment Analysis) method was applied to analyse the efficiency of Polish pig holdings.

Table 1

**The number of researched pig holdings (type 51) in 2009-2011 (units)**

| SO classes EUR thousand | Poland | Hungary | Germany | Denmark | Netherlands |
|---|---|---|---|---|---|
| (II) 8-25 small | 2 005-2 044 | 149-477 | - | - | - |
| (III) 25-50 medium-small | 2 300-2 308 | 41-46 | 336-505 | 19 | - |
| (IV) 50-100 medium-large | 1 624-1 641 | 46-53 | 515-525 | 60 | 518-543 |
| (V) 100-500 large | 1 690-1 707 | 28 | 1 451-1 452 | 476 | 518 |
| (VI) 500 and more very large | 275-292 | 22-31 | 808-851 | 1 109 | 286 |

Source: Polish and European FADN, Institute of Agricultural and Food Economics – National Research Institute [*Polish: Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej – Państwowy Instytut Badawczy, IERiGŻ-PIB*].

Next, a comprehensive assessment of efficiency of specialist pig rearing holdings in the selected countries was carried out. It consisted in simultaneous consideration of a greater number of variables. The assessment took account of the following indicators: land productivity in EUR thousand defined by value of production per 1 ha of UAA; economic efficiency of labour defined by value of production per work unit (EUR thousand per AWU); land profitability defined by farm income in EUR thousand per 1 ha; own labour profitability defined by farm income per unit of labour input.

## Production potential of specialist pig rearing holdings depending on economic size

For pig holdings, the UAA[4] is less and less important as the measure of production potential of agricultural holdings. It is best visible in the case of the Dutch farms, whose area ranging from 6 to 16 ha acted rather as the place of production than its significant factor. But the UAA and the economic size of farms are interrelated in case of Polish, Hungarian, German and Danish farms.

All Hungarian and German holdings leased land and the trend increased along with the growth in economic size. Danish and Dutch holdings used land lease to a lesser extent. Among Danish farms, medium-large holdings used land lease to the greatest extent and the share of leased land for them amounted to 52%. As for Dutch holdings, very large ones, where the share of leased land amounted to 39%, were most interested in land lease. For Polish pig farms the share of such land showed an upward trend along with the growth in economic size ranging from 11% to 35%.

[4] The paper uses the abbreviation UAA to refer to "utilised agricultural area".

Overall labour input was the highest for Hungarian farms (ranging from 17.9 AWU per 100 of UAA at small farms to 5.3 AWU per 100 ha of UAA at very large farms). As for Polish holdings, it ranged from 14.9 (small farms) to 3.3 AWU per 100 ha of UAA (very large), while in case of German and Danish farms the value was similar and ranged from 5.7 to 2 AWU (Germany) and from 6.4 to 2.5 AWU per 100 ha of UAA. The share of own labour in the overall labour input at farms – from small to large – Polish, German, Danish and Dutch was high, i.e. it exceeded 80%. It was the lowest for Hungarian farms where it ranged from 87% (small farms) to 4% (very large holdings). In all groups of very large farms the share of own labour was the lowest.

For the researched holdings the value of assets per 1 ha of UAA was diverse, low for Polish and Hungarian farms (ranging from EUR 11 thousand to EUR 13 thousand per ha of UAA), and showing a slight upward trend along with an increase in the economic size. For German and Danish farms the value was higher and demonstrated a downward trend. Whereas, for Dutch farms the value of assets per 1 ha of UAA rose from EUR 81 thousand for medium-sized farms to EUR 194 thousand for very large farms. The assets of all agricultural holdings were predominated by the share of fixed assets (above 80%); except for Hungarian farms where it was slightly lower (Ziętara W., Mirkowska Z., Adamski M., Blicharski T. 2014).

## Production organisation of pig rearing holdings depending on economic size

The UAA of all pig holdings, except for Dutch ones, was dominated by cereals and their share was the highest (exceeding 80%) for Polish holdings, except for very large ones where it amounted to 75%. For small and medium-small farms it was ca. 90%. For small and medium-small Hungarian farms it amounted, respectively, to 55.1% and 54.6%. For other size classes it was higher: above 70%. The share of cereals was also high for German farms – ranging from 96% to 57%, and it decreased along with a growth in economic size. For Danish holdings the share of cereals was similarly high and it ranged from 61% to 78% and rose along with an increase in the economic size of holdings. The lowest share of cereals in the UAA was noted for Dutch farms: 10-29%. In general, it may be stated that the crop production organisation of the researched pig holdings, except for Dutch holdings, was very simple and it was dominated by cereals.

Along with an increase in the economic size the stocking density of pigs also grew (LU per 100 ha of UAA). This dependence concerned all groups of farms. In individual economic size classes, in all groups of holdings, except for the Dutch ones, the stocking density of pigs was similar. The aforementioned Dutch farms were distinguished by stocking density higher from several to several dozen times than in other groups of farms. Dutch farms noted an upward trend growing along with a rise in the economic size: from 1 596 LU at medium-large farms to 6 262 LU per 100 ha of UAA at very large farms. From the above, it follows

that such farms conducted live pig production with the use of industrial methods loosely reliant on land. The analysed countries showed definite differences in the level of pig rearing concentration determined by the number of pigs per one farm on average in a country. Table 2 gives respective figures.

The level of pig rearing concentration in Poland and Hungary was very low despite progressing concentration processes. In 2002, the share of holdings keeping over 200 pigs was 22.8%, and 47% in 2010. The progressing concentration process in pig rearing resulted from adjustments to requirements of the market – which expects large homogenous batches of raw materials – introduced by producers of live pigs. In both years the largest number of such farms was in north-western and central-western Poland. In 2010, Polish and Hungarian farms kept, on average, 39 and 17 units per farm, respectively, while German, Danish and Dutch farms, respectively: 459, 2 583 and 1 751 units. The figures point to a great gap between the Polish and Hungarian holdings, and holdings in other countries.

Table 2

**The level of pig rearing concentration in Poland and selected EU countries in 2010**

| Specification | Poland | Hungary | Germany | Denmark | Netherlands |
|---|---|---|---|---|---|
| Number of holdings keeping pigs (thousand) | 388.5 | 183.1 | 60.1 | 5.1 | 7.0 |
| Number of pigs (thousand) | 15 244.2 | 3 207.9 | 27 571.4 | 13 173.1 | 12 255 |
| Number of pigs per holding (units) | 39.2 | 17.5 | 458.8 | 2 583.0 | 1 750.7 |
| Share of holdings keeping 1-49 pigs (%) | 85.5 | 99.0 | 41.7 | 11.8 | 5.5 |
| Share of holdings keeping 50-199 pigs (%) | 11.9 | 0.7 | 16.5 | 5.9 | 10.0 |
| Share of holdings keeping over 200 pigs (%) | 2.6 | 0.3 | 41.7 | 82.3 | 84.3 |
| Share of pigs in herds of not more than 49 units (%) | 25.6 | 22.1 | 1.0 | 0.1 | 0.03 |
| Share of pigs in herds of 50-199 units (%) | 27.3 | 3.3 | 3.9 | 0.2 | 0.7 |
| Share of pigs in herds of over 200 units (%) | 47.1 | 74.6 | 95.1 | 99.7 | 99.3 |

Source: Statistisches Jahrbuch über Ernährung. Landwirtschaft und Forsten, 2012 I 2013.

Another index defining the concentration level is the structure of the pig stock by the scale of production. The share of farms having the lowest scale of production (not more than 49 units per farm) in Poland and Hungary was, respectively, 85% and 99%, while in Germany, Denmark and the Netherlands 42%, 12% and 6%, respectively. Then, the share of holdings keeping over 200 units per farms

in Poland and Hungary was, respectively, 2.6% and 0.3%, while in other countries: 42% (Germany), 82% (Denmark) and 86% (the Netherlands). Similar conclusions follow from an analysis of the structure of pig stock. In Poland and Hungary the share of pigs kept in herds of over 200 units per farm was, respectively, 47% and 75%, while in other countries – above 95%.

Therefore, it should be stated that the level of pig rearing concentration in Poland and Hungary was exceptionally low in 2009-2011 against other EU countries.

## The costs of pig rearing holdings of different economic size

The highest total costs for the researched holdings, except for Dutch farms, were noted for Polish and Hungarian small farms where they amounted, respectively, to EUR 14 thousand and EUR 15 thousand per ha of UAA. For the aforementioned Dutch farms, the costs ranged from EUR 14 thousand per ha in medium--large farms to EUR 71 thousand for the largest farms. Among the Danish holdings the highest costs were noted in medium-small farms and amounted to EUR 11 thousand. For German farms, the level of total costs increased from the level of EUR 3.7 thousand (medium-small) to EUR 4.8 thousand per ha of UAA (very large). Similar trends were noted in the distribution of direct costs. In this group the costs of fodder were the most important element, and apart from the smallest holdings the costs of purchased fodder were dominant. Their share increased along with the growth in economic size. They were lower for Polish farms (from EUR 0.48 thousand to EUR 0.57 thousand per LU), slightly higher for Hungarian ones, while the highest for German, Danish and Dutch holdings (from EUR 0.57 thousand to EUR 0.65 thousand per LU).

The costs of paid employment for small, medium-small and medium-large farms were at a relatively low level not exceeding EUR 110 per ha of UAA. For very large agricultural holdings, in all their groups, the costs of paid employment were definitely higher. In this class the lowest costs of paid employment were noted for Polish holdings, where they amounted to EUR 198 per ha of UAA, and the highest for Dutch farms were they amounted to EUR 2 603 per ha of UAA.

In all groups of farms, the costs of interest rates grew along with the increase in their economic size. They were high for Danish medium-small and medium--large holdings (EUR 1 922 and 1 762 per ha of UAA), but definitely the highest were noted for Dutch holdings (EUR 784 for medium-large and EUR 4 585 per ha of UAA for very large farms). Such a high level of costs of interest rates per 1 ha of UAA for Dutch holdings resulted from their small area. The costs of rent and depreciation per 1 ha of UAA were similar.

## The efficiency of pig holdings depending on economic size

The efficiency of pig holdings was defined with the use of indices of productivity and profitability of factors of production, management income and income parity. Land productivity increased for most of the farms along with an increase

in their economic size, and the lowest values of the index were noted for Polish farms (EUR 1.8-3.5 thousand per ha). For Hungarian farms, it ranged from EUR 2.3 thousand to EUR 5.8 thousand per ha, German – EUR 3.2-5.1 thousand per ha, Danish – EUR 5.2-10.1 thousand per ha. Definitely the highest land productivity was noted in the Netherlands: EUR 13.4-70.8 thousand per ha, but here it should be remarked that these pig holdings have the smallest UAA among all of the analysed farms.

The productivity of assets was less diversified for the researched farms, and it is difficult to find a correlation between the index and the economic size of holdings. Such correlation, of positive character, may be found only for Polish and German farms. The highest productivity of assets was noted for Hungarian farms, while for Danish and Dutch holdings it was at an average level as compared to the others.

Labour productivity was strongly diversified, simultaneously, demonstrating a strong positive correlation with the economic size of farms. For Polish holdings, it ranged from EUR 12.1 thousand to EUR 111.5 thousand per AWU; Hungarian – EUR 20.6-80.2 thousand per AWU; German – EUR 57-190.5 thousand per AWU. Definitely higher labour productivity was generated by Danish (EUR 281.4-274.9 thousand per AWU) and Dutch (EUR 311.5-428 thousand per AWU) farms.

The farm income was positive and growing along with the growth in economic size in the case of Polish and Hungarian farms. For Polish farms it ranged from EUR 4.5 thousand to EUR 220.9 thousand per farm, and for Hungarian – EUR 2.9-146.6 thousand per farm. But then, for German farms it ranged from EUR 4.6 thousand to EUR 49.9 thousand per farm, except for medium-small farms where the income was negative and amounted to EUR –1.57 thousand. All groups of Danish holdings noted a negative income (from EUR –7.1 thousand to EUR –56.7 thousand), while for Dutch farms only medium-large had negative income (EUR –1.56 thousand). For larger, in economic terms, Dutch pig rearing holdings income was positive, but not too high (EUR 7.7-10 thousand).

Management income – measure of entrepreneur's efficiency – for small and medium-small farms of researched countries was negative (Figure 2). For medium-large Hungarian holdings it was positive, but very low (EUR 2.2 thousand per farm).

In the remaining two classes of large and very large farms management income for Polish and Hungarian holdings was positive. Whereas for German, Danish and Dutch farms management income was negative. The lowest management income was noted for medium-large and very large Danish holdings, where it amounted, respectively, to EUR –417.8 thousand and EUR –311.8 thousand per farm. The negative management income means that the income generated by a farm was not sufficient to cover the costs of using own factors of production (labour, capital and land).

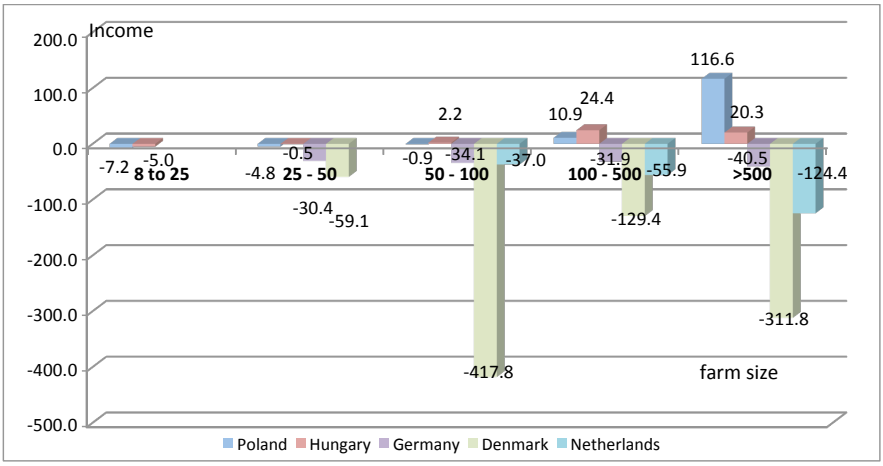


**Fig. 2.** Management income (EUR thousand per farm)
Source: based on the FADN data.

## Competitiveness of Polish pig rearing holdings

Farmers do not compete directly in foreign markets with the holdings of other countries, but they have an impact on the competitive position of the agri-food processing sector and trade in food products. The competitiveness of pig holdings may be understood as their ability to develop, in specific economic conditions, which is measured by such indices as: income parity, management income and net investment rate. Thus, a comprehensive assessment of pig holdings was held for the analysed countries, which consisted of the values of the following indices: productivity, profitability, management income, net investment rate and the share of subsides in farm income (Figure 3). Dutch farms noted the highest values of productivity indices of factors of production (land, assets and labour), while as regards profitability indices – Polish and Hungarian farms. The highest aggregated values in the class of small, medium-small and medium-large farms were noted by Hungarian farms, while in the class of very large farms – Polish holdings.

The advantage of Hungarian holdings over Polish holdings ranged from 11% for the class of medium-small farms to 49% for the class of medium-large holdings. For small farms it was 33%. In case of very large farms, the advantage of Polish farms over Hungarian farms amounted to 38%. As for the remaining holdings, higher cumulative values of indices were obtained by Dutch holdings. But these were by ca. 48% lower than equivalent indices for Hungarian farms, and in the class of very large farms they were by 26% lower than for Polish holdings. German farms noted lower indices than Dutch farms, while the lowest values of indices were recorded by Danish holdings, mainly because of very low profitability indices and negative management income.

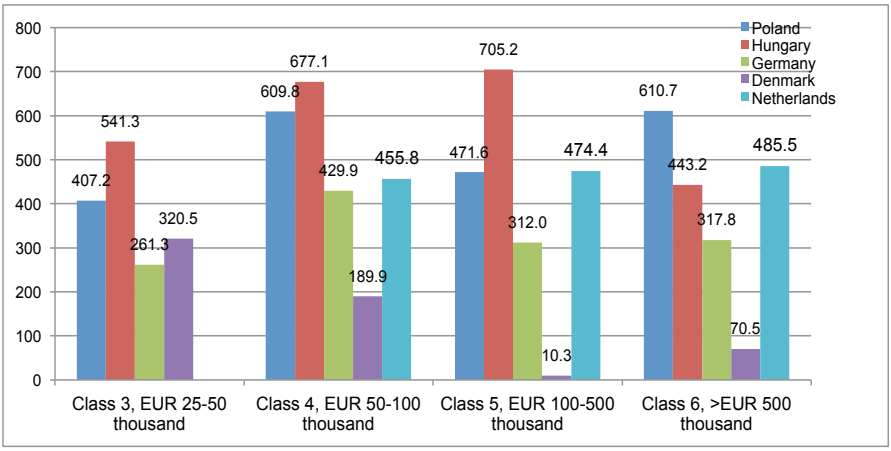


**Fig. 3.** Cumulative relative goodness index of pig holdings in the researched countries in individual SO economic size classes in 2009-2011

Source: based on the FADN data.

## Factors influencing the level of pig holding income

Among the indices describing the dynamics and competitive ability of farms, the earned income is recognised as the most important one. Therefore, statistically significant factors, which cause changes in income in specialist pig rearing farms in Poland, were analysed. The analysis covered specially selected group of 557 holdings (type 51) conducing accountancy for the Polish FADN in 2012. The assessment used econometric modelling and calculations were conducted in the GRETL programme (1.9.13 version). The marginal accounting referred to a theoretical farm specialist in live pig production, where the values of researched variables equalled the average in the sample and its economic size was 89.9 thousand SO (medium-large farm). The average income for such (model) holding in 2012 amounted to PLN 97.1 thousand.

The model simulation demonstrated a slight impact of changes in the labour input on income: its increase by 1 man-hour rose the income by PLN 4.03. The level defined by the model failed to offset the incurred inputs because in the period the acceptable level of labour charges ranged from PLN 7 to PLN 11 per man-hour. Thus, it seems that to increase the level of its competitiveness pig holdings instead of increasing, should limit the labour inputs.

The share of leased land in the farm area was another researched independent variable. As follows from the marginal accounting, increasing the share of leased land by 1% should cause a growth in farm income by PLN 477. The average area of the analysed holding was 34.5 ha, it may be stated that increasing the leased land by 1 ha would increase income by PLN 1 383. The share of fodder costs proved to be one of the variables having a negative impact on the income in the model.

But there is nothing surprising in the finding – farm income should decline along with an increase in costs incurred on fodder, at fixed or decreasing income generated by sales of live animals. The increase in the share of fodder prices in revenues by 1%, caused a decrease in farm income by PLN 1 708, as follows from marginal accounting of coefficients determined by the model. This confirms a well-known principle that in the holdings of this specialisation, the ratio of fodder prices to the prices of live animals determines production profitability. This correlation remains, at the same time, one of the strongest determinants of profitability growth defined by the model.

The size of the herd for a given farm also has a very significant impact on the income. The average annual herd size in the model holding is 30 livestock units. As follows from the marginal accounting, the increase in the average size of pig herd by 1 LU caused an income growth by PLN 914. Slightly simplifying the above, it may be assumed that 1 LU allows sales of additional 15 pigs for fattening per year. Thus, calculated per one more pig for fattening sold, the holding would increase its income by PLN 61. This correlation illustrates that, apart from the aforementioned correlation between costs of fodder and prices of live animals, the very growth in the scale of production has the greatest impact on the income generated by pig holdings.

The last analysed variable was the value of fixed assets. For the modelled farm it amounted, on average, to PLN 745.6 thousand. The marginal accounting showed, however, that an investment in fixed assets of a farm brings rather poor results. One invested zloty increased the generated income by PLN 0.03. But it is difficult to imagine an increase in the scale of production without investments in buildings and technical equipment. Therefore, it seems that this direction of investments – in case of no possibility to increase production in the current conditions – should be taken into account by pig producers, especially if it contributes to limiting the commitment of labour inputs.

## Conclusions

Comprehensive assessment of efficiency of pig holdings showed that among the researched farms, the best effects in the class of farms from medium-small to large were obtained by Hungarian farms followed by Polish ones, while in the class of very large farms – the best effects were obtained by Polish farms. It was also demonstrated that the scale of production of live pigs is the basic factor deciding on the efficiency of farms conducting this type of production and that the scope and type of correlations between producers of live pigs and enterprises of agri-food processing is a significant factor deciding on the use of the production potential of pig farms. It was also confirmed that the production of piglets is the weakest link in the production of live pigs.

The results of conducted research confirm the opinions of experts analysing the situation in the pig market in Poland. According to Z. Pejsak (Pejsak 2011, 2012, 2013), the key reason for a downward trend in the pig stock figures is its archaic structure: large number of small pig holdings of minor production

efficiency. This was the situation of Polish pig industry upon accession to the European Union and, unfortunately, this – according to Z. Pejsak – is still the case as the necessary changes progress very slowly. Moreover, the level of vocational education of farmers is low and what is worse it refers to the young farmers who will be taking over farms in the future. The minor activity of organisations associating pig producers is, to some extent, an effect of the level of awareness thus assessed. On the other hand, meat plants are not really committed to extending cooperation with suppliers of raw materials. Polish meat plants (with the rare exceptions, such as: Sokołów SA, Animex) fail to closely cooperate with pig producers, they do not have permanent suppliers, they lack capital ties and long-term contracts, etc. Whereas, based on observations of many years of experiences of the European leaders in the secter – namely Germany, Spain, Denmark – it may be stated with great certainty that assuming the coordinating role by processing plants could form grounds for an improvement of the situation in the Polish pig market. Introduction of such a system in Poland will be very difficult, though, because of lack of capital ties between producers of live pigs and meat plants (Gębska M., Malak-Rawlikowska A., Majewski E., Rekiel A. 2012; Pejsak Z. 2013). Farmers got some stocks of state-owned meat plants in the process of their privatisation, but due to low awareness they did not know how to use their ownership entitlements and, in many cases, sold them to majority shareholders representing foreign capital. In such circumstances, reconstruction of capital ties between producers of live pigs is practically very difficult or even impossible.

In the face of the above-outlined situation and in the light of results of conducted research, it might be tempting to make the following demands for the future:

1. When the scale of production is the basic factor deciding on the efficiency of production of live pigs, it is necessary to eliminate the existing administrative barriers hindering the setting up of pig farms of greater concentration of animals.

2. Intensification of specialisation of production at farms as regards piglets and pigs for fattening is another condition of efficiency improvement and development of production of live pigs. At present, the minimum size of sow herd from the perspective of production rationalisation and market requirements should amount to 150 units, and optimum to 300 units. This size will grow, taking into account the increase in the labour costs in the national economy and greater pace of increase of costs of means of production than agricultural products. Despite the lack of capital ties between producers of live pigs and meat plants, which form the grounds of efficient vertical integration, measures to develop horizontal integration should be intensified in the form of strong producers' groups, which would allow to shape partnership relations between producers of raw materials and meat plants.

3. It is recommended to undertake intensive measures to extend the professional knowledge of the producers of live pigs, especially in the sector of production of piglets.

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