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Agricultural company and agricultural holding towards climate and agricultural policy changes (4)

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THE POLISH AND THE EU AGRICULTURES 2020+
CHALLENGES, CHANCES, THREATS, PROPOSALS

Warsaw 2018

All the authors are the researchers from the Institute of Agricultural and Food Economics – National Research Institute.

The work has been prepared under the topic **Farms and agricultural enterprises in the face of climatic change and changes in the agricultural policy.**

It is the fourth out of five publications devoted to functioning of agricultural enterprises and farms under conditions of changes in climate and the anticipated change in agricultural policy which is expected to take place in 2021 and beyond – its performance in the next several years.

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TABLE OF CONTENTS

FROM THE AUTHORS[1]

The initiation of the scientific and technical revolution and the total abandonment of the gold currency at the end of the 1940s opened new perspectives for growth of production and improvement of its efficiency. This also became possible in agriculture. Both of these phenomena allowed using means of production which are carriers of various forms of progress: technical, genetic, agro- and zootechnical, organisational and other. Innovative measures applied began to replace human labour and increase the productivity of land and production animals. The removal of the credit shortage barrier facilitated the modernisation of efficiently operating business entities and the expansion of their assets. The industrialisation of countries combined with urbanisation and progress in means of transport enabling long-distance transportation of agricultural products was conducive to the growth of demand for them and the management of surplus labour force among the agricultural population.

In Poland, these phenomena were not able to appear on a wider scale until the year 1989. The change of the socio-economic system to the market system triggered active attitudes of some of the farmers, consisting mainly in putting agricultural income and even profit from the funds invested in the farm on the first place among the goals they set themselves. These motives created the need to maximise the value of production according to the logic of the marginal cost increase.

In addition, at the beginning of the first decade of the current century, the management conditions improved. At that time, the PHARE and SAPARD programmes co-financed by the European Union, which provided funds for development of the food economy, began to be implemented. Despite relatively small amounts, they were – as it turned out later – of great importance in adaptation of this sector of domestic economy to the conditions of production which were to exist after Poland was granted membership in the EU.

It is hard not to appreciate the role of access to the European Union market for Polish food producers because earlier this market was protected by duties and non-tariff barriers. It was a very large market, and besides, there was a comparative advantage of Polish food producers as the costs of the majority of food products in Poland were lower than in the countries of the former EU-15.

[1] The initial part of the monograph was taken partly from a study by W. Józwiak, *Rozwój krajowych przedsiębiorstw rolnych osób fizycznych w świetle idei "spirali wzrostu"* [Development of domestic agricultural enterprises of natural persons in the light of the idea of "a growth spiral"], IERiGŻ-PIB, Multi-Annual Programme 2011-2014, No. 113, Warsaw, 2014.

In the first years after the accession, the degree of vertical integration of agriculture and processing was small, although constantly growing, but the requirements set by companies processing agricultural raw materials led to a change in agricultural production structures with quite stable size structure of farms. Besides, the EU support measures calculated at constant prices were significantly larger than those offered under the PHARE and SAPARD programmes. They contributed to further improvement of the competitiveness of the national food economy and agricultural development more sustainable than so far.

Due to progress in terms of quantity and improvement of quality of products combined with favourable price changes, the sum of revenues of domestic agriculture calculated in current prices was, on average, 80.3% higher in the six-year period of 2010-2015 than six years before the accession (1998--2003). The sum of income of agricultural producers calculated the same way was 283.2% higher. However, the share of subsidies in income amounted to as much as 49.1% and in the compared periods increased 39.6 percentage points (p.p.). The effects calculated in constant prices were, however, more modest. The sum of domestic agriculture revenues calculated this way was, for example, on average, 11.2% higher in the six-year period of 2010-2015 compared to six years before the accession (1998-2003).

In the period characterised, the changes taking place in Polish agriculture were accompanied by unfavourable climate changes the impact of which began to be felt more intensely in the 80s of the last century, the effects of the third wave of globalisation initiated in 1980 and events occurring in the European Union since the crisis of 2008. These phenomena forecast an increase in the uncertainty of management in agriculture. This uncertainty is further intensified by ageing of Polish population which will intensify the outflow of people from agricultural holdings.

In order to answer the question of the impact of these phenomena on further evolution of domestic agriculture in the period up to 2028, a research project "Agricultural company and agricultural holding towards climate and agricultural policy changes", being part of a large multi-annual governmental programme "Agriculture of Poland and European Union 2020+. Challenges, opportunities, threats, proposals", which will be completed in 2019, was undertaken in 2015. The presented monograph includes research results of the fourth stage of implementation of this project and hence its title, the same as the title of the entire characterised research project with the addition [4]. Results of the research which has been carried so far and will be conducted in 2019 will

become the basis for a summary study to be published after the completion of the research process.

The first chapter of the presented monograph includes a description of the basic problems which agricultural holdings are facing and will face in the next decade. These are the effects of climate change and changes in the conditions of agricultural policy. These are changes in the conditions of agricultural policy and climate change. The monographs prepared in 2015-2017 dealt mainly with the political, socio-economic determinants of agricultural policy and its expected changes in the next decade. In the current year, however, attention was focused on climate change and its consequences. Scientific studies including analysis and projections of the climatic situation were used.

The following chapters of the monograph deepen and at the same time update the characteristics of selected aspects of agricultural activity. This approach required the use of source materials appropriate to given issues and specific methods of their analysis.

The second chapter refers to issues related to the functioning of farms of different size. In the year 2015, a diagram of the analysis of economic activity referring to the idea of "growth spiral" was outlined, and in 2016 this became the basis for taking up the issue of small farms, some of which even had the features of households with agricultural production. Last year, the attention was paid to medium-sized farms, i.e. those with a size of EUR 15-25 thousand SO[2]. Analyses prepared in both years presented small and medium-sized farms compared to large farms with features of enterprises. In 2018, the latter were in the centre of attention. As a result, the chapter includes an analysis of labour productivity in large domestic farms compared to a corresponding feature referring to farms in selected European Union countries.

The third chapter includes the characteristics of domestic farms functioning under different environmental and organisational conditions. In 2015, research issues concerned the economic situation of agricultural entities which were operating in areas particularly exposed to the occurrence of droughts during the growing periods. The relevant chapter of the monograph from 2016 presented the results of the analysis covering farms located in less-favoured areas (LFA), and last year's monograph included the results of the analysis assessing the functioning of farms afforesting part of their agricultural land.

[2] The acronym SO stands for standard output and means the size of production of an agricultural holding measured by the system of coefficients. Coefficients are regionally differentiated average five-year prices obtained from the sale of individual products on the farm, excluding VAT on products, and direct payments. The SO measure is the sum of products of these indicators and the size of production of individual goods produced on farms.

The presented monograph discusses the issue of Natura 2000 areas, emphasising their impact on the functioning of local farms in Poland.

The next chapter continues the analysis of the organisation and competitiveness of Polish farms compared to farms in selected EU countries. In 2015, these were farms specialising in field crops. In the following year, analogical analysis covered horticultural farms, and in 2017 those with dairy cows and beef cattle. Presented analysis includes findings made in 2018 concerning farms specialising in pig farming.

The fifth chapter includes analyses of changes in the profitability of production of selected goods of agricultural origin. In 2015, determination of the production costs of selected products became the basis for their projection in the medium-term. The 2016 monograph included findings about direct production costs as a factor dependent to a large extent on the agricultural producer. The issue of direct production costs was continued in 2017 but on a regional basis. In 2018, the analysis covered the issue of regional diversification of the profitability of production of selected agricultural goods acquired in a conventional manner and using ecological management methods.

The presented monograph ends with a summary with conclusions.

CLIMATE CHANGE AND ITS EFFECTS

The title of this monograph includes a reference to climate and agricultural policy changes. The factors affecting agricultural policy and its expected changes until 2027 were described earlier in three subsequent monographs [Abramczuk *et al.* 2015, Abramczuk *et al.* 2016, Abramczuk *et al.* 2017]. In 2018, it is time to characterise climate change and the impact of this phenomenon on the situation of domestic agricultural companies and agricultural holdings owned by natural persons. Selected items of scientific literature were used to formulate the content of this chapter.

Current climate change is associated with the so-called industrial revolution, which began at the beginning of the eighteenth century, as a result of which many significant changes have taken place. In 1700-1998, total gross domestic products calculated in constant prices per person increased about four times which became an important factor of more than doubling the average life expectancy and around tenfold increase in the number of people living in the Earth [Ziewiec 2012]. However, not measured but significant effect of these changes is, *inter alia*, the increase in the content of the so-called greenhouse gases in the Earth's atmosphere. The share of only one of them – carbon dioxide – in the Earth's atmosphere increased about 22% in 1960-2010 [Kundzewicz 2013]. The increase in the content of greenhouse gases in the Earth's atmosphere limits the escape of part of rays of sunlight reflected from the surface of lands and waters into space, causing the climate to get warmer.

It was determined that the effects of global warming consist of [Kundzewicz 2013]:

- more than twofold increase of very dry areas since 1970;
- more and more frequent occurrence of heat waves intermingled with intense rainfall in many areas;
- increase of annual precipitation in medium and high latitudes in the northern hemisphere (especially in autumn and winter);
- a fall of about 10% of the global snow cover compared to the situation in the 1960s;
- decreasing surface of ice in circumpolar regions and mountain glaciers, as well as less frequent freezing of numerous rivers and lakes or lasting for a shorter time. Cold spells are less extreme;

- occurrence of cyclones in tropical areas and intense winds in other areas. These phenomena are dangerous to human existence and at the same time cause economic losses due to destruction of buildings and structures, the emergence of forest breaks, etc.
- average annual increase in the level of seas and oceans of about 3 mm in 1993--2003 intensifying, among others, coastal erosion.

Climate change also affects the increase in the temperature of water in rivers, lakes and water reservoirs, which is the cause of increasingly frequent occurrence of the so-called toxic algal bloom. After 1750, there was also an increase in the acidity of sea waters of 0.1 pH, limiting biodiversity of coral reefs perceptibly.

In Europe in the 20th century, the observed rate of change in the average annual rainfall was different [Kundzewicz *et al.* 2006]. Decline in rainfall by as much as 20% was recorded in the southern part of Europe, and the accompanying increase in air temperature intensified the occurrence of droughts. They were usually long-lasting and regional rather than local phenomenon. There was an increase in rainfall in the northern part of the continent. Numerous studies also show an increase in the frequency of intensive rainfall throughout the year or part of it in most areas of Europe.

In Poland, the problem are limited water resources enabling irrigation of crops and unfavourable distribution of annual rainfall. In this situation, the recorded increase in the number of sunny days and air temperature is the reason for the increasing occurrence of droughts. While in thirty years between 1951 and 1981 they occurred on average in every fifth year, in the following thirty years (1982-2012) droughts in different seasons of the year occurred on average in three years out of individual five years of this period [Abramczuk *et al.* 2015]. Shortage of precipitation during growing periods was noticeable in agriculture and had a negative impact on crop yields.

It was determined that the precipitation deficit for the majority of agricultural crops occurred most frequently in the central-western part of around 1/3 of the Polish territory. In 1961-2009, the average annual rainfall in this area was 75.5 mm smaller (12.1%) than the national average.

Water deficit is limited only partially by dams on larger rivers in the country, for example, on the Vistula in Włocławek. Collection (retention) of water in water reservoirs does not exceed 6% of the average annual outflow from the country to the sea, while in many other European countries this indicator is about twice as large [Maciejewski 2010]. The so-called small-scale

water retention, possible thanks to the reconstruction or construction of new dikes, gates and weirs on streams, the creation of polders in areas with abandoned agricultural production around regulated rivers (river-canals) and flooding them through culverts located in river levies [Kosina 2015], etc., is also underestimated.

In order to assess the effects of droughts, farms particularly at risk of agricultural drought and other farms were analysed. Both groups were monitored by the Polish FADN in 2006-2013. However, holdings of the first group were located in communes where drought affected at least one species or group of agricultural plants, in not less than seven out of eight years covered by the analysis. Next, each of these groups was divided into two subgroups following the soil bonitation index (SBI). Farms with poor quality soil included those with the SBI ≤ 0.7.

It was determined that on farms:

- with poor quality soil and particularly at risk of agricultural drought, labour productivity, calculated by the production value in PLN per one annual work unit, was on average 16.9% lower per year than in other farms, and the technical effectiveness indicator[1] was 11.7% lower;
- with good quality soil and particularly at risk of agricultural drought, labour productivity, calculated the same way, was on average 6.1% lower per year compared to the remaining farms. Analogically calculated technical effectiveness indicator was 4.5% lower.

The above findings indicate differences in economic effects of agricultural holdings in the contemporary state of climate change. Therefore, farms can limit the effects of this phenomenon by choosing the type (structure) of production which will at least balance the need to use organic fertilisation of soils. This was determined by analysing holdings of natural persons with different types (structure) of production covered by the monitoring of the Polish FADN and located on soils with the SBI up to 0.7, which in 2012-2014 were affected by droughts during the growing periods every year [Żak, Zieliński 2017]. They had smaller agricultural income per 1 ha of utilised agricultural area than farms operating in other areas. The difference was the largest on farms specialising in field crops and amounted to 42.4%, and about three times smaller on farms specialising in the production of cow milk, while in those with plant and animal production it was 20.7%. Therefore, droughts had a stronger negative impact on

[1] Established using the DEA method.

the economic effects of farms which had no possibility to balance the needs to use organic fertilisation or these possibilities were limited.

Lack of livestock or its small number does not have to adversely affect the economic effects of farms in drought-prone areas if sufficient quantities of substitutes of natural fertilisers of animal origin are introduced into the soil, for example, prepared straw and catch crop grown for ploughing. This hypothesis was confirmed by the study of two groups of agricultural holdings with soil quality below average. These were farms of natural persons specialising in the production of cereals and covered by the monitoring of the Polish FADN in 2005-2010 [Zieliński 2012]. One group consisted of farms with a positive balance of carbon dioxide sequestration in the soil as carbon supplying the soil contained in the organic matter predominated over the amount of carbon released during its mineralisation, and the other group – with a negative balance because mineralisation of the organic matter dominated over its replenishment. The issue of greenhouse gas emissions (methane, nitrous oxide) was omitted as the analysed farms conducted livestock production on a very small scale.

On this basis, it was determined that profitability of land (agricultural income per unit of utilised agricultural area) and labour profitability (agricultural income per unit of labour input) of farms with a negative balance of carbon dioxide emission was 18.2% and 27.6% lower, respectively. Both analysed groups were characterised by extended reproduction of fixed assets, but the rate of this reproduction (relation of net investment value to the value of fixed assets) on farms with a negative balance of carbon dioxide was 0.5% and was 3.5 percentage points lower than in the second group.

Another way of limiting the negative impact of drought on the economic effects of agricultural holdings is irrigation of crops, but the conditions existing in our country limit the use of this treatment. The water resources are scarce. Out of the total rainfall and underground water consumption in the country, for example, in 2011, economic and material needs (without consumption for irrigating crops) absorbed 4.7%, and 62.0% evaporated from the surface of the earth, waters and through plants, soaked in supplementing resources of groundwater, and replenished water resources evaporated from lakes, other water bodies and swamps. 32.8% flowed away in rivers [*Second draft*... 2014]. Only 0.5% of total water resources was used for irrigating crops, and the needs were and are large. Crops on sandy soil, where water soaks easily into the subsoil and quickly becomes inaccessible to plants, are particularly water-

consuming. A lot of water per unit of cultivation area is used by vegetables, sugar beets, potatoes, and some fodder and permanent crops.

There are several ways of irrigating crops which differ in the degree of water loss. It is the smallest in the case of low-pressure sprinkler and above all drip irrigation.

In addition to the lack of water, there are other reasons for the limited use of irrigation of agricultural crops. One of them is the lack of knowledge about the profitability of this treatment. The increase in irrigation costs (calculated excluding labour costs) is, however, compensated with a surplus with harvest growth and, as a result, also a surplus of income. With irrigation of, for example, an apple orchard, the relation of income to costs, in farms without irrigation and in the year with drought in the growing period, was estimated at 18%, with sprinkler at 52-53%, and with sprinkler drip irrigation at 58% [Sobierajewska 2011].

Agricultural producers can achieve further economic benefits related to irrigation by adjusting the dates of this treatment to the degree of plant development and the intensity of rainfall [Sobierajewska 2011].

However, on solid soils, it is advisable to use the so-called agro-drainage, which makes it possible to reproduce, to a greater extent than without this method, the deep-water resources used for economic and living purposes [Kędziora 2005].

Lessons from research aimed at reducing the negative effects of climate change are likely to be useful at least in the next decade. Projections of global climate change developed using mathematical models do not differ significantly from the previous findings. Projections predict further rise in warming of even 0.4°C until 2032 [Kundzewicz 2013]. However, starting production of energy with a small emission of greenhouse gases by that year and costs equal to that produced from fossil raw materials will not stop the increase in average air temperature. Replacing one type of energy source with another is not a one-off act but a process. For example, it took oil and natural gas 40-50 years to account for 25% of total global energy consumption each [Smil 2014] because the value of funds invested in currently used methods of energy production was too large to abandon them before final depletion.

In addition, global projections predict: particularly large increase in average air temperature in the high-latitude northern hemisphere regions, a drop in the number of extremely cold nights and days, and an increase in the number of extremely hot days and nights, as well as an increase in areas with water

shortage, periodic excess and areas with poor quality water. Water shortages will be felt more severely during summer months in medium latitudes.

Projections for Europe [Kundzewicz 2013] indicate an increase in precipitation in the north and north-east and deepening of water shortage in the southern part of the continent. The amount of precipitation in its middle part will grow during winter periods and to a smaller extent during spring and autumn. The forecast for the summer is less certain. The most likely scenario is the occurrence of intense rainfall, even when the total rainfall is lower.

It is worth noting that the projection of climate change confirms the correctness of assumptions (not yet the final version) of the common agricultural policy and that concerning rural areas to be implemented in the European Union countries in 2021-2027. Each Member State is to prepare its own plans for these policies, guided by EU-wide arrangements regarding primarily the mandatory implementation of political objectives and the specific circumstances of each country [COM (2018)].

Projections for Poland [Kundzewicz 2013] indicate that:

- the number of days with the maximum air temperature exceeding 30°C will increase, and the number of very cold and frosty days will decrease. The latter phenomenon will lead to a prolonged period without frost during the year, but late spring frost in some years cannot be ruled out;
- only some of the scenarios indicate an increase in average rainfall in summer periods (June -August), but the share of high intensity rainfall may increase. In winter periods (December-February), all scenarios indicate an increase in precipitation, mainly rainfall. The snow cover period, also in lower parts of mountains, will decrease;
- the winter water flows in streams and rivers will grow, but they will decrease in summer and autumn periods.

The above description of climate change indicates that in our country, in most years, there will be an increase in: droughts in growing periods, previously unknown pathogens, wind and water erosion on fields without plant cover, floods in different seasons, landslides in areas with large slopes, etc. These events will have an impact on the organisation and results of agricultural production, and hence on the economic situation of agricultural holdings. However, conscious actions of agricultural producers may limit the effects of some of these adverse phenomena.

It should be added that the presented projections may be subject to correction. Current computer models used to determine them do not take into

account the cloud physics accurately enough, and after all they cover about 70% of the sky on average. Relevant studies are ongoing, so we are unable to answer the question of whether with the rise of air temperature changes of phenomena in the clouds will intensify or limit adverse effects of global climate change. Another mystery lies in the oceans, namely a significant part of oceanic and marine plankton called mixotrophs. These tiny hybrid organisms use solar energy like plants, and hunt like animals, and their occurrence is ecologically significant. They contribute to the removal of carbon dioxide from water, thus indirectly also from the air, and its storage in bottom sediments in the form of carbon compounds [Mitra 2018]. The answer to the question about the impact of this phenomenon on global warming is not yet known.

In addition, the presented projections do not take into account the effects of: weather cycles caused by periodic changes in the activity of the sun, volcanic eruptions and collisions of larger meteorites with the Earth.

Summary of the above attempts to project weather conditions in which domestic agricultural holdings will be operating by the end of the next decade (2019-2027) has to start with a significant statement: it is quite likely that the moment of the emergence of low-carbon technologies for the production of electricity not more expensive than that generated from fossil raw materials is close. However, its implementation will last several decades, so adverse climate changes will certainly continue in the next decade.

The effects of climate change can be seen all over Europe. The greatest interest is aroused by droughts intensifying during growing periods, mainly in the southern and central part of the continent, including Poland. Particularly high intensification of droughts was recorded on about 1/3 of our country's area, in its central-western part. Their effects are the most troublesome in farms with soil quality below average which do not use organic fertilisers or use them in an insufficient quantity. The latter phenomenon is intensifying because the share of farms without livestock production is growing, and recently this share was around 48%. Irrigation of crops is very limited. It covers 0.5% of utilised agricultural area while the world average is 18%. The main reason for this is the shortage or poor condition of devices preventing unproductive runoff of about 38% of total annual average water resources with rivers to the Baltic Sea.

Droughts in growing periods are only part of the effects of climate change. The problem is not only the hurricanes, which cause the destruction of buildings and infrastructural devices and the formation of windfall in forests, but

also rare but sometimes very intense precipitation in winter and summer periods, resulting in local floods and landslides in areas with large slopes. In addition, new diseases have emerged, an obvious example of which is currently African swine fever. However, invasion of other troublesome pathogens on the area of Europe cannot be ruled out.

Projections made by climatologists indicate that climate change will affect Europe in a peculiar way. An increase in precipitation and temperature mitigation during winter periods in the north and north-east of the continent will progress and the shortage of rainfall in the southern part of the continent will deepen. The amount of precipitation in the middle of the continent will increase in winter and to a smaller extent during spring and autumn. In the summer periods, intensive rainfall is most likely to occur, even when the level of annual precipitation decreases. Therefore, one cannot rule out the initiation of the process of changes in the structure of agricultural production, especially in the northern and southern part of the continent.

In the central part of Europe, and thus also in Poland, the frequency of extreme phenomena: droughts, intensely blowing winds and intense precipitation in winter periods will increase. Therefore, the costs of collecting water for crop irrigation; maintenance and strengthening of water dams, embankments of rivers and other structures and devices which will prevent floods, as well as costs of removing damages to buildings, energy networks, fragments of roads, bridges and others, will increase. However, the draft making the common agricultural policy and the policy on rural areas for 2021-2027 more flexible, which is at the final stage of preparation, creates an important factor allowing for the establishment of a policy adequate to the specificity of our country. Measures improving water retention will gain significance, the importance of organic fertilisation will be appreciated, etc. The risk caused by invasions of previously unknown diseases and pests will force a new, stricter organisation of agricultural production. The emphasis will also be placed on the implementation of farm organisation and agricultural production technologies limiting greenhouse gas emissions. It is a probable thesis that these new processes will accelerate the decline of the number of small agricultural holdings because they will not be able to meet the growing requirements of the production regime.

It should be added that the presented projections of climate change and the effects of these changes may be subject to correction. Current computer models used to determine them do not take into account the cloud physics and

biological phenomena occurring in open waters (ocean, sea, lake, etc.) in the situation of an increase in average air temperature accurately enough. However, there are indications that these corrections will be small in the coming years.

Therefore, in the next few years, climate change will force expenses from the Polish budget, larger than currently, for measures limiting its negative effects and for the elimination of damage resulting from it, and at the same time changes in the structure of budget expenditures due to the desirability of undertaking various preventive actions. It will also be necessary to broaden the scope of measures limiting greenhouse gas emissions to the atmosphere.

It should be added that agricultural producers have means to limit some of the negative effects of climate change and reduce the negative impact of agricultural production on climate change and should use them. However, the effect of these measures may be changes in the directions (structure) of production.

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LARGE AGRICULTURAL HOLDINGS AND LABOUR PRODUCTIVITY IN POLISH AGRICULTURE AND IN OTHER SELECTED EU COUNTRIES IN 2016[2]

Introductory remarks

Size is an important feature differentiating agricultural holdings. Small ones have small land resources and usually experience lack of free capital, but they are characterised by the largest labour input per unit of land used. This accounts for low labour productivity which, in turn, results in even smaller agricultural income per unit of input of this production factor than the average pay rate of employed persons in agriculture [Abramczuk *et al.* 2016]. As a result, owners of farms with small area show limited interest in the growth and development of their holdings, and one of the sources of income is mainly work outside their own farm, also in neighbouring agricultural holdings. In literature on the subject, one can find an opinion about the decadence of these farms [Wojewodzic 2010] and about the problems which their owners have with finding a successor [Dudek 2013]. For this reason a part of small farms disappears every year, and only a small part of others undertakes measures that ensure transition to the group of medium-sized farms. Important factors conducive to the activation of such measures are subsidies for farms applied as part of the implemented agricultural policy and favourable economic conditions.

Medium-sized farms set the boundary between small farms and large farms. The number of farms of this intermediate group changes slightly from year to year, which means that the number of small and economically active farms that feed it is close to the number of those which undertook effective measures to ensure transition to the group of large farms [Abramczuk 2017].

On medium-sized farms, agricultural income per an hour of work on own farm is higher than the pay rate of an employed person in agriculture but lower than the parity pay. It is therefore aimless to take up paid work in other farms, and in other entities only if the pay rate is larger than the difference in income from an hour of work in own farm and the part of travel costs falling on it. It is also reasonable to increase the value of production to the extent ensuring transfer of the farm to the group of large ones. Large farms allow obtaining income similar to the parity pay for own labour in owned farm, or exceeding this

[2] The chapter refers to a study by W. Józwiak entitled "Agricultural holdings with a large utilised agricultural area in Poland and other selected EU countries in 2005 and 2016", IERiGŻ-PIB, typescript, 7.06.2018.

limit, as well as funds for modernising and increasing its production assets. This creates indications of long duration of such entities.

Table 1 indicates that the border separating large and medium farms in Poland in 2010-2016 was at the meeting point of size groups 15-20 and 20-50 ha of utilised agricultural area. The interpolation of relevant data from the studies by the Statistics Poland [Charakterystyka... 2017] allowed determining that this border was the average utilised agricultural area of 28.4 hectares. However, further in the chapter, the limit of 30 ha of these areas was adopted as it applies in Eurostat.

Table 1. Changes in the number of domestic agricultural holdings with more than 1 ha of utilised agricultural area in 2010-2016

Year	Holdings with utilised agricultural area in ha								
	Total	of which:							
		1-2	2-3	3-5	5-10	10-15	15-20	20-50	≥ 50
	Number in thousand								
2010	1509.1	300.6	213.3	276.5	346.3	151.5	72.0	97.0	27.0
2016	1410.7	271.2	201.7	264.2	309.9	137.3	66.9	102.0	34.7
	2010 = 100								
2016	93.5	90.2	94.6	95.6	89.5	60.6	92.9	105.1	128.2

Source: Own findings based on the study [Charakterystyka... 2017].

The chapter analyses changes in labour productivity in 2005-2016 in large Polish farms compared to corresponding data from farms in other selected EU countries. The objective of the analysis is to provide answers regarding three issues. The first one is the possibility to reduce the differences between labour productivity in large farms in Poland and the productivity of large farms in the EU-15. The second one is to determine whether changes taking place in the analysed context in Poland differ from those taking place in large farms in other post-communist countries, and what are the possible discrepancies and tendencies. The third issue is to determine whether the acceleration of changes in the size structure of agricultural holdings could result in an increase in labour productivity of the entire Polish agriculture.

Assessment method

The situation of large agricultural holdings in 2005-2016 was analysed. These were holdings with utilised agricultural area of 30 ha and more. Information characterising changes in the number of large farms in 2005-2016 and their: size structure (separated subgroups: 30-49.9 ha, 50-99.9 ha, and 100 ha and more), land used for agricultural purposes, labour input, as well as labour

productivity achieved by farms and the role played by the utilised agricultural area of holdings and livestock production in this regard, was used to fulfil the objective.

Non-agricultural activities were not taken into account in the calculation of production value. Labour productivity was calculated as the quotient of the standard output value (SO), i.e. calculated using the system of coefficients and labour inputs per annual work units (AWU). The conversion factors used to calculate the SO correspond to the annual production value of a given agricultural activity, plant and livestock, obtained from one hectare or from one animal in the production conditions average for a given region. These factors are expressed in thousands of euros and are averages of five years of the relevant period. Livestock is expressed in Livestock Units (LU) corresponding to the weight of one cow.

Changes in the size of the analysed features were measured with the indicator:

$$VI^n = 100 \, (S^{1n} / S^{2n} - 1)$$

where:

- VI is the volatility index of feature n,
- S^{1n} is the size of feature n in 2016,
- S^{2n} is the size of feature n in 2005.

Volatility indices were calculated for the features characterising the analysed agricultural holdings in selected EU countries. In addition to Poland, these were countries located in areas of similar latitude. However, Ireland and Great Britain were omitted due to the maritime climate of these countries. Finally, the analysed group of EU-15 countries included: Austria, Belgium, Denmark, the Netherlands and Germany, and from among those admitted into the European Union in the year 2004 – the Czech Republic, Lithuania, Latvia, Slovakia and Hungary.

It should be emphasised that in the Czech Republic, Lithuania, Latvia, Slovakia and Hungary, during the planned economy period, radical ownership changes, which were much slower in Poland, took place in agriculture. Thus, the return to the market economy in Poland took place differently and at a different pace than in these five countries.

The results of the Eurostat monitoring as of March 2018 were used for the calculations. However, the number of farms in Poland in 2005 was adjusted, adapting it to the definition of an agricultural holding in effect in 2016.

Labour productivity in 2016

Table 2 indicates that labour productivity in Polish agriculture was among the lowest in the analysed countries in 2016 and very close to that in Lithuanian, Latvian and Hungarian agriculture. In Slovak and Czech agriculture, however, it was about three times higher, in the EU-15 countries, more than four times, and in Denmark even thirteen times. It is obvious that these differences determined the diversity of income earned by agricultural producers between individual countries.

Table 2. Labour productivity in Polish agriculture and other selected EU countries in 2016 and the share of large farms

Country	Average labour productivity in agriculture[1]	Share of large farms (%) calculated with:			
		utilised agricultural area	the value of agricultural production	number of employees	number of farms
Denmark	197.2	91.1	80.4	67.0	45.4
the Netherlands	156.8	80.1	50.4	40.8	39.9
Germany	99.3	88.3	79.5	63.0	44.8
Belgium	70.4	80.8	61.7	44.1	42.9
Austria	60.4	61.4	50.8	33.6	20.2
the Czech Republic	49.2	96.2	85.3	75.5	36.0
Slovakia	41.4	94.0	84.8	71.2	16.7
Hungary	16.7	80.7	64.2	27.3	5.5
Latvia	15.9	74.5	75.7	33.5	14.1
Lithuania	15.0	70.3	68.2	28.6	10.8
Poland	15.2	42.3	20.6	12.4	5.4

1. Labour productivity expressed in thous. EUR of SO per annual work unit on the farm.

Source: own findings based on Eurostat monitoring results compiled by Z. Mirkowska as of April 2018.

The above table indicates at the same time the second feature suggesting the uniqueness of Polish agriculture. It is distinguished by the smallest share of large farms, regardless of the method of calculating this indicator. Moreover, numbers in Table 2 indicate that the average labour productivity in agriculture in the analysed countries was quite clearly correlated with the share of the number of large farms in the total number of farms. The correlation between the share of sub-groups of large agricultural holdings, separated according to the utilised

agricultural area owned by them, and the average labour productivity in agriculture, however, is not straightforward. This is indicated by Table 3.

Table 3. Labour productivity[1] on large farms with different utilised agricultural area in 2016

Country	Average labour productivity in agriculture	Productivity in percentage of average productivity in farms with utilised agricultural area of (ha):		
		30-49.9	50-99.9	100 and more
Denmark	197.2	50.4	74.2	137.5
the Netherlands	156.8	105.5	124.3	141.2
Germany	94.3	80.1	124.4	144.5
Belgium	70.4	107.9	129.7	227.4
Austria	60.4	138.6	162.2	170.2
the Czech Republic	49.2	58.9	68.5	118.9
Slovakia	41.4	80.7	121.7	120.0
Hungary	16.7	130.5	177.2	267.7
Latvia	15.9	84.3	137.1	304.0
Lithuania	15.0	144.7	209.3	276.0
Poland	15.2	201.3	282.2	521.7

1. Labour productivity expressed in thous. EUR of SO per annual work unit on the farm.
Source: as in Table 2.

Labour productivity in farms with utilised agricultural area of 30-49.9 ha was higher than the average productivity in agriculture in only six analysed countries (the Netherlands, Belgium, Austria, Hungary, Lithuania and Poland), i.e. in 54.5% of them. In other analysed countries (Denmark, Germany, the Czech Republic, Slovakia and Latvia), it was lower than the average productivity in agriculture. What is more, the situation was similar in farms with utilised agricultural areas of 50-99.9 ha in two countries of the latter sub-group, namely in Denmark and the Czech Republic. Both of these observations indicate that only farms with utilised agricultural area of 100 ha and more contributed in each of the analysed countries to the increase in average labour productivity in agriculture.

Figures in Table 4 indicate that labour productivity of farms with utilised agricultural area of 30-49.9 ha was under a slight influence of the area of land used for agricultural purposes because the average area was within small limits, from 37.9 to 39.4 hectares. However, livestock production was positively

correlated with labour productivity. The share of farms with livestock was involved to a smaller extent because in nine countries (81.8% of the total) this share was similar, ranging between 75.5% and 80.7%. On the other hand, the stocking of animals (their population expressed in livestock units and per unit of utilised agricultural area) and the concentration of herds of animals (the number of animals expressed in livestock units) on holdings with livestock was significant. The latter feature was, of course, correlated with the former one.

Out of EU-15 Member States, only in Denmark the stocking of animals was almost identical to that in Poland. In Austria and Belgium, the stocking was 17.9% larger, and in Germany and the Netherlands, 58.8 and 60.8% larger, respectively. The stocking of animals on Polish farms was at least 26.4% larger than the situation in other post-communist countries.

Table 4. Characteristics of selected factors determining labour productivity[1] in agricultural holdings with utilised agricultural area of 30-49.9 ha in Poland and selected European Union countries in 2016

Country	Average labour productivity	Average utilised agricultural area of a farm	Employment per 100 ha of UAA[2]	Share of farms with livestock (%)	Number of livestock units per 100 ha of UAA[3]	Number of livestock units per farm[3]
the Netherlands	165.4	39.4	5.7	80.6	182.5	111.3
Denmark	99.5	39.1	2.1	53.3	114.0	44.9
Austria	83.7	38.5	3.1	78.7	133.8	51.5
Germany	79.6	39.2	4.1	75.9	180.3	70.7
Belgium	76.0	39.1	7.5	80.7	133.8	51.5
Slovakia	33.4	38.1	3.4	79.7	89.8	34.2
the Czech Republic	29.0	38.7	4.2	79.6	53.0	20.5
Hungary	21.8	38.2	2.1	46.6	53.9	20.6
Lithuania	21.7	38.6	2.3	76.3	42.2	16.3
Latvia	13.4	38.2	0.9	75.5	35.3	13.5
Poland	30.6	37.9	5.8	71.2	113.5	43.0

1. Labour productivity expressed in thous. EUR of SO per annual work unit on the farm.
2. Employment calculated in annual work units.
3. Per holding with livestock.

Source: as in Table 2.

Therefore, the majority of farms in EU-15 countries with the utilised agricultural area within 30-49.9 ha conducted agricultural production in which livestock rearing with the use of (mainly or exclusively) purchased feed was of

great importance. The size of this activity was different in individual countries, and its maximum limits were determined by the possibilities of rational utilisation of the by-product – surplus of natural fertilisers. The figures characterising the stocking of animals in Germany and the Netherlands indicate, however, that the stocking was large enough that there had to be a natural fertiliser market to avoid using excessive doses that violate ecological rules.

Polish and Slovak agricultural holdings with utilised agricultural area of 30-49.9 ha stood out compared to analogous holdings from other post--communist countries with large stocking of animals, which allowed them to achieve the highest labour productivity in this group of countries.

Of course, one cannot rule out the influence of other factors on labour productivity in farms of the analysed countries with the utilised agricultural area of 30-49.9 ha, such as the share of intensive crops in the utilised agricultural area (with high costs per unit of utilised agricultural area) – orchards, vineyards, crops under shelter, etc.

The relatively high employment in the analysed farms of EU-15 Member States was probably caused by the high concentration of animal herds. A similar observation applies to the Polish farms.

Table 5 includes figures characterising agricultural holdings in Poland and in selected European Union countries with utilised agricultural areas of 50-99.9 ha. In 2016, compared to the group analysed earlier (with utilised agricultural area of 30-49.9 ha), these farms had:

- higher labour productivity,
- larger and at the same time not very diverse average utilised agricultural area,
- similar share of holdings with livestock,
- lower employment per unit of utilised agricultural area,
- larger stocking of animals (the number of animals expressed in livestock units per 1 hectare of utilised agricultural area) on farms with livestock in seven out of eleven analysed countries.

Labour productivity in the farms of EU-15 Member States with utilised agricultural area of 50-99.9 ha was at least 81.2% greater than that of farms in countries which were granted Union membership in 2004, whereas in farms with utilised agricultural area of 30-49.9 ha the analogous indicator was 175.4% larger. Therefore, the distance in labour productivity between larger holdings in countries with a different seniority in the European Union was smaller than in the case of farms with utilized agricultural area of 30-49.9 ha.

Among farms from post-communist countries, Polish farms were the second with utilized agricultural area of 50-99.9 ha, after Slovakia.

Table 5. Characteristics of selected factors determining labour productivity[1] in agricultural holdings with utilised agricultural area of 50-99.9 ha in Poland and selected European Union countries in 2016

Country	Average labour productivity	Average utilised agricultural area of a farm	Employment per 100 ha of UAA[2]	Share of farms with livestock (%)	Number of livestock units per 100 ha of UAA[3]	Number of livestock units per farm[3]
the Netherlands	194.6	67.5	4.1	78.4	293.4	196.9
Denmark	146.3	71.9	1.7	55.3	155.2	111.6
Germany	123.6	70.9	2.7	79.7	185.3	134.2
Austria	98.0	66.2	2.0	58.3	116.5	77.1
Belgium	91.3	69.7	5.1	84.6	241.5	168.3
Slovakia	50.4	71.0	1.9	51.1	38.9	27.6
the Czech Republic	33.7	71.0	3.7	70.2	54.6	38.8
Lithuania	31.4	70.2	2.4	67.0	43.2	30.3
Hungary	29.6	70.5	3.5	48.3	51.5	36.3
Latvia	21.8	68.9	2.7	75.1	40.0	27.9
Poland	42.9	68.0	1.6	71.2	104.6	71.1

1. Labour productivity expressed in thous. EUR of SO per annual work unit on the farm.
2. Employment calculated in annual work units.
3. On farms with livestock.

Source: as in Table 2.

The last analysed size group are farms with utilised agricultural area of 100 hectares and more. Their numerical characteristics are presented in Table 6.

In 2016, farms with utilised agricultural area of 100 ha and more differed from those with utilised agricultural area of 50-99.9 ha in higher labour productivity and larger average utilised agricultural area of these farms, at the same time diverse in the analysed countries. Lower employment per unit of utilised agricultural area was correlated (at least in part) with a smaller share of holdings with livestock.

There was a distance separating labour productivity in the farms of EU-15 countries and that achieved in farms of countries which were granted EU membership in 2004, including Poland.

Table 6. Characteristics of selected factors determining labour productivity[1] in agricultural holdings with utilised agricultural area of 100 ha and more in Poland and selected European Union countries in 2016

Country	Average labour productivity	Average utilised agricultural area of a farm	Employment per 100 ha of UAA[3]	Share of farms with livestock (%)	Number of livestock units per 100 ha of UAA[4]	Number of livestock units per farm[4]
Denmark	271.3	246.5	1.3	69.4	210.5	519.0
the Netherlands	221.4	152.7	3.2	60.1	234.1	357.5
Belgium	160.3	311.4	2.2	78.9	93.6	230.2
Germany	143.5	250.3	1.7	74.0	105.0	262.8
Austria	102.8	175.4	1.0	25.5	48.5	85.1
the Czech Republic	58.5	642.1	2.3	70.9	53.9	346.0
Slovakia	49.7	697.6	4.9	62.9	41.2	288.0
Latvia	48.4	336.3	1.4	63.1	32.9	110.5
Hungary	44.7	337.8	2.5	48.1	75.0	253.3
Lithuania	41.4	276.6	2.7	52.7	36.8	101.9
Poland	79.3	252.5	1.9	39.4	121.3	306.2

1. Labour productivity expressed in thous. EUR of SO per annual work unit on the farm.
2. Employment calculated in annual work units.
3. On farms with livestock.

Source: as in Table 2.

Labour productivity in Polish farms with utilised agricultural area of 100 ha and more was the highest among farms from post-communist countries. It amounted to 77.1% of this indicator calculated for Austrian farms, largely probably because they were characterised by a similar share of those with livestock and a similar stocking of animals.

Conclusion

This chapter assessed labour productivity of farms with large utilised agricultural area in Poland and in other ten selected EU Member States. The scope of the analysis was limited by the set of available empirical data.

Firstly, it was demonstrated that in 2016, large agricultural holdings in EU-15 countries achieved much higher labour productivity than Polish farms, *inter alia*, through concentrating animal herds at a level reaching or even exceeding limits determined by ecological considerations. Therefore, in all three considered size classes of large Polish farms (30-49.9 ha, 50-99.9 ha and 100 ha and more),

increase in labour productivity is possible by increasing herds of animals, although of course to a degree which does not violate ecological standards.

The share of Polish farms with utilised agricultural area of 30-49.9 hectares and 50-99.9 hectares which do not conduct livestock production in 2016 did not differ from the analogous share in farms of EU-15 Member States, but this share was higher in the case of Polish farms with utilised agricultural area of 100 hectares and more. Entities of this size should, therefore, consider the possibility of starting livestock production whose size would enable further increase in labour productivity.

Secondly, the analysis indicates that an important reason for low labour productivity of farms in post-communist countries was low stocking of animals on farms with livestock production. Excluding Poland, this indicator was ranging from 35.3 to 89.8 livestock units per 100 ha of utilised agricultural area, while in the EU-15 the corresponding indicator was from 48.5 to 293.4 LU.

Polish large farms looked favourably compared to the majority of the post-communist countries analysed. In terms of labour productivity, those with 30-49.9 and 50-99.9 hectares of utilised agricultural area were in the second place, and those with 100 hectares and more in the first place. The stocking of animals expressed in the number of livestock units per 100 ha of utilised agricultural area on farms with livestock production had a large and positive share in this, and amounted to: 113.5, 104.6 and 121.3 units, respectively. These average numbers indicate that the size of livestock production in the majority of Polish farms did not violate ecological constraints.

Thirdly, it was determined that among the analysed countries Poland had the smallest share of large farms, and in terms of labour productivity in the entire agriculture it was next to the last. It follows from these two facts that the acceleration of the transformation of the size structure of agricultural holdings in our country would result in a marked increase in labour productivity in Polish agriculture as a whole.

It was also demonstrated that in the majority of the analysed countries of EU-15, in 2005-2016, the number of farms with utilised agricultural area of 30--49.9 hectares, and in some of them even farms with an area of 50-99.9 hectares, decreased. These areas were probably too small to provide for agricultural producers and members of their families at a level deemed satisfactory and ensure funds for investment enabling adaptation of farms to changing conditions. This is probably a foretoken of a situation which sooner or later will affect Polish agriculture.

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IMPACT OF NATURA 2000 AREAS ON THE FUNCTIONING OF FARMS

Introduction

One of the main objectives of the European Union (EU) rural development policy for 2014-2020 is to support the agricultural sector in the protection of rural biodiversity [*Regulation*… 2013]. This approach should be considered particularly necessary, as negative trends in the condition of biodiversity of many rural areas are still in progress in the EU[1]. In this context, the role of the agricultural sector in the protection of biodiversity of areas with high natural values covered by the European Ecological Network Natura 2000 (network of Natura 2000 areas) is extremely important. The more that in the EU, utilised agricultural area accounts for 38.0% of Natura 2000 areas [*Protected*.. 2012].

In Poland, in the Natura 2000 areas, biodiversity is currently protected in a special manner by 22.6 thousand beneficiaries of Package 4. Valuable habitats and endangered species of birds in the Natura 2000 areas of the Agri-environment-climate measure implemented within the Rural Development Programme (RDP) 2014-2020 in the area of 249.9 thousand ha[2,3]. These farms are obliged to conduct the agricultural production in accordance with the requirements set out in the package which lead to a need for more extensive farming. Therefore, for the farms of beneficiaries a financial incentive is payment granted annually, which, for a period of the five-year commitment, is to compensate them for lost income in this regard [*Programme*.. 2019].

The objectives of the analyses carried out under this chapter is to describe both the state of spending financial resources and the beneficiaries of Package 4. Valuable habitats and endangered species of birds in the Natura 2000 areas of the Agri-environment-climate measure implemented within the framework of the RDP 2014-2020, to assess the functioning of the farms of beneficiaries of this package against a background of the farms beyond the Natura 2000 areas, which constantly kept accounts for Polish FADN in the years 2014-2016 and to indicate factors influencing the decisions of the farms in the Natura 2000 areas on participating in this package.

[1] In the EU, the condition of 39% of valuable natural habitats is still deteriorating, moreover, the common farmland bird index is still decreasing and the wild bee population is declining [EC 2014, EC 2015 and Eurostat data].

[2] Applies to farms which joined Package 4. of the Agri-environment-climate measure within the RDP 2014-2020 and farms financed from this package as part of commitments from Package 5. Protection of endangered species of birds and natural habitats in the Natura 2000 areas of the Agri-environmental programme within the RDP 2007-2013.

[3] Unpublished data of the Agency for Restructuring and Modernisation of Agriculture (ARMA) and the Ministry of Agriculture and Rural Development (MARD), as of 31.12.2017.

Method

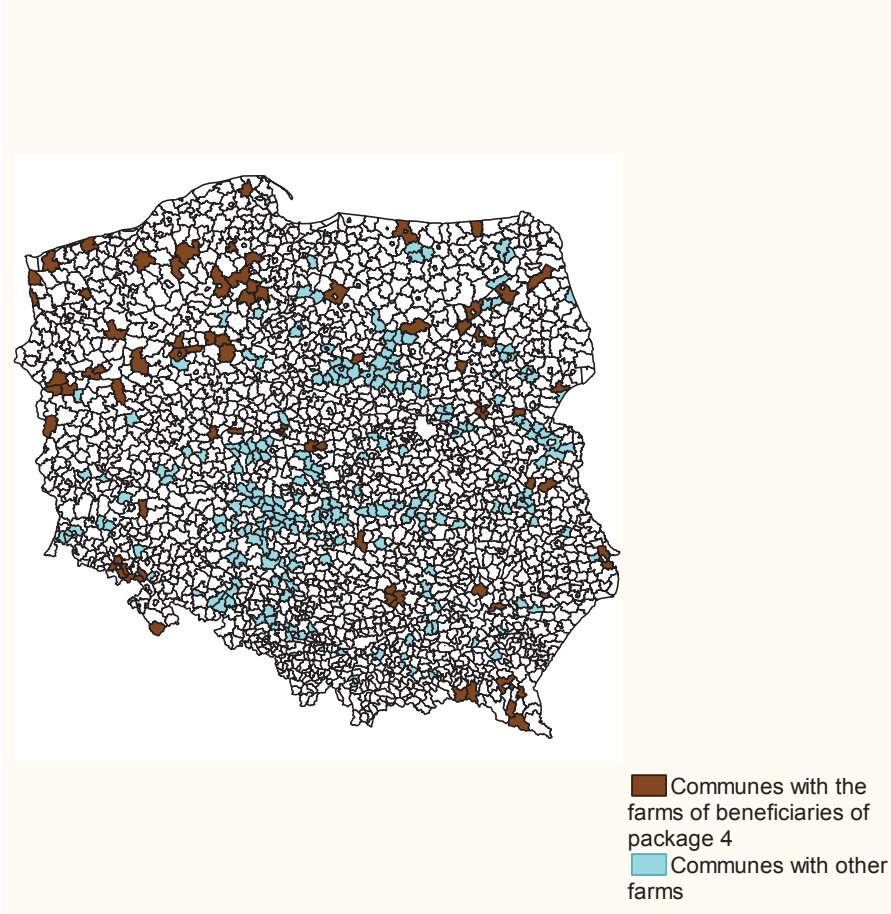
This chapter consists of three subchapters. The first subchapter shows the state of spending financial resources and describes the beneficiaries of Package 4. Valuable habitats and endangered species of birds in the Natura 2000 areas of the Agri-environment-climate measure implemented within the RDP 2014-2020 (Package 4). This information is derived from the ARMA database on spending financial resources in Package 4 as of 31 December 2016 or 31 December 2017, and from the data of the Institute of Soil Science and Plant Cultivation - National Research Institute (ISSPC-NRI) in Puławy. On the other hand, the second subchapter assesses how the farms of beneficiaries of Package 4 (farms of beneficiaries) function against a background of farms from outside the Natura 2000 areas (other farms), which constantly kept accounts for Polish FADN in the years 2014-2016. The comparative analysis covered 99 farms of beneficiaries from 76 communes with the Natura 2000 areas and 692 other farms from 235 communes located beyond the Natura 2000 areas (Map 1). Importantly, both identified groups of farms included the farms with the same production type and without the intensive production organisation[4,5]. In addition, in the case of other farms, only those farms were included which conducted the agricultural production in communes where the share of naturally valuable areas, i.e. permanent grassland, forests and inland waters in the area of UAA or in the total area was no smaller than in communes with the farms of beneficiaries[6].

[4] The impact of this type of farms on the protection of rural biodiversity is often negative and the impact of these areas on their economic effects is usually small. In these farms, the animal production is conducted with the high share of purchased feed which the plant production (horticultural and permanent crops) is often under covers and irrigated.

[5] Farms with the intensive production organisation are those which exceeded the threshold value of at least one identified technical and organisational indices (animal stocking density equal to or higher than 0.9 LU per 1 ha of utilised agricultural areas, share of permanent crops in utilised agricultural area is equal to or higher than 35.7%, share of horticultural crops in utilised agricultural area is equal to or higher than 15%). The method to identify farms with the intensive production organisation has been described in detail in the paper entitled Description and results of the fine-tuning procedure's application in Poland [IAFE-NRI and MARD 2017] and Updating the method to determine farms and areas with the extensive agricultural production under HNV along with areas characteristic for HNV (variant II) [Zieliński et al. 2017].

[6] In communes with the farms of beneficiaries, the share of permanent grassland in the area of UAA was from 11.0 to 85.6% and the share of forests and inland waters in the total area was, respectively, from 9.4 to 88.8% and from 0.1 to 20.4%.

Map 1. Communes with the farms of beneficiaries of Package 4 of the Agri-environment-climate measure within the RDP 2014-2020 and with other farms which constantly kept accounts for Polish FADN in the years 2014-2016



Source: own study based on the data from Polish FADN in the years 2014-2016.

In the comparative assessment of the identified groups of the farms of beneficiaries and other farms, what was taken into account first was their percentage structure, depending on the economic size expressed in Standard Output (SO) and the production type. Then, the following were determined:

1) Production potential

- Area of utilised agricultural area expressed in ha, which consists of: own land, land leased for a year or longer, land used on a basis of shared crops with the owner, as well as fallow land and set-aside land,
- Share of leased land (%),

- Valuation index of own soils (pts),
- Total labour input per 1 ha of utilised agricultural area, covering total labour inputs as part of the operating activity of the farm, expressed in hours,
- Average value of capital in thousand PLN;

2) Organization of production
- Share of arable land in utilised agricultural area (%),
- Share of cereals in arable land (%),
- Share of permanent grassland in utilised agricultural area (%),
- Animal stocking density in livestock units per 1 ha of UAA (LU/ha of UAA);

3) Production intensity, productivity, economic situation and investment capacity
- Total costs, including direct costs, overheads, costs of depreciation and external factors per 1 ha of utilised agricultural area (thousand PLN/ha of UAA),
- Land productivity (thousand PLN/ha of UAA) determined as a ratio of the total production value on the farm to utilised agricultural area,
- Labour productivity (thousand PLN/AWU) determined as a ratio of the total production value to the number of persons employed full-time,
- Capital productivity (%) determined as a ratio of the total production value on the farm to the average value of capital,
- Return on equity. It has been determined as a ratio of profit on equity to the value of this equity. The profit on equity has been determined as a difference between total revenues and total costs increased by conventionally calculated costs of unpaid labour of farmers and their family members. The cost of unpaid labour has been adopted based on an average level of remuneration in the national economy in the years 2014--2016. In the analysed period, this remuneration was PLN 14.8/hour [Abramczuk et al. 2015, 2016, 2018],
- Farm income per family work unit (FWU) (thousand PLN),
- Share of operating subsidies in farm income (%),
- Share of subsidies received as part of participation in Package 4 of the Agri-environment-climate measure within the RDP 2014-2020 in total operating subsidies (%),
- Net investment rate (%) determined as a ratio of net investments to depreciation.

In contrast, the third subchapter indicates significantly statistical factors, which in the case of farms from the Natura 2000 areas were underlying their decision on participating in Package 4. These factors and their direction have been identified using the probit model. It has been assumed that in this model the endogenous variable will be the fact that the farm participates in Package 4. Therefore, this variable has been treated as a binary (dychotomic) variable which adopted the value of one when the farm participated in Package 4 in 2016, and zero when the farm did not participate in this package in the analysed year. Then, a set of exogenous variables has been established in the model. To this end, it has been assumed that the individual exogenous variables should not be correlated or should be poorly correlated with each other, and that the subsequent exogenous variables should be highly correlated with the endogenous variable. The direction of the impact of the model's exogenous variables on the decisions of the farms to participate in Package 4 was indicated by the sign next to the specified parameter of the exogenous variable (plus/minus).

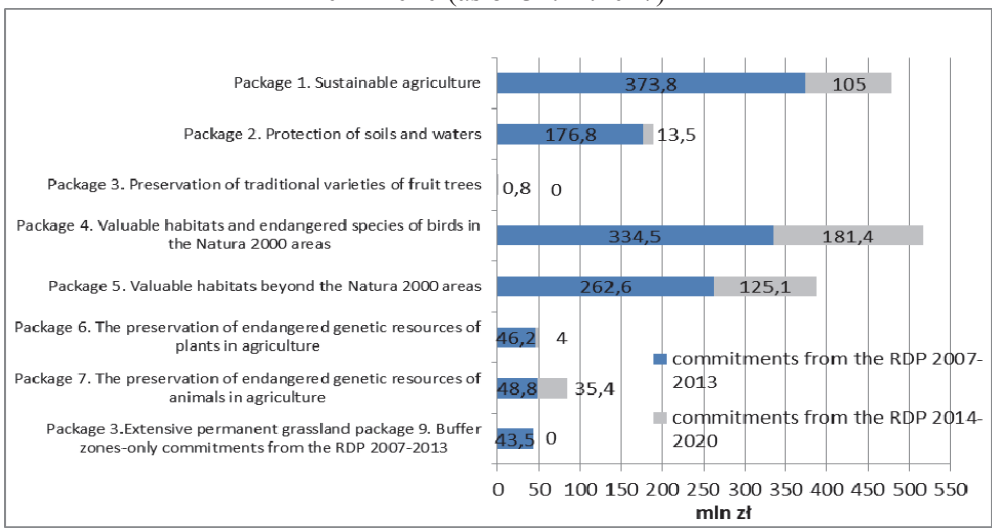
The quality of the analysed model was assessed using the McFadden R^2 index. This index is based on a comparison between the full model and the model reduced only to the absolute term. In practice, however, the values of McFadden R^2 are low, usually closer to 0 than to 1, as this statistics, even if the model is perfectly matched to the data, takes values much lower than 1 [Gruszczyński 2012]. The statistical significance of all variables in the analysed model has been determined using the likelihood ratio (LR) test[7].

State of spending financial resources and description of beneficiaries of Package 4. Valuable habitats and endangered species of birds in the Natura 2000 areas of the Agri-environment-climate measure within the framework of the RDP 2014-2020

So far, the state of spending financial resources under Package 4 has been PLN 515.9 million, where 64.8% are financial resources spent under the commitments of Package 5. Valuable habitats and endangered species of birds in the Natura 2000 areas of the Agri-environment-climate measure within the framework of the RDP 2007-2013. The remaining 35.2% are financial resources spent under the new commitments within Package 4 as part of the RDP 2014-2020 [Report 2018]. It should also be added that at the moment the state of spending financial resources under Package 4 amounts to 26.9% of financial resources spent in total as part of the Agri-environment-climate measure within the RDP 2014-2020 (Fig. 1).

[7] LR test statistics has the distribution χ^2 with the K degrees of freedom.

Fig. 1. State of spending financial resources on implementing the packages of the Agri-environment-climate measure within the RDP 2014-2020, broken down by commitments from the RDP 2007-2013 and new commitments from the RDP 2014-2020 (as of 31.12.2017)



Source: own study based on the ARMA data (as of 31.12.2017).

As it has been mentioned in the introduction, currently Package 4 is implemented by 22.6 thousand farms including 1.7 thousand farms from LFAs – mountainous type[8]. These farms implement Package 4 in the area of 249.9 thousand ha of UAA which accounts for 16.2% of total UAA supported under the Agri-environment-climate measure implemented within the RDP 2014-2020.

In the case of farms of beneficiaries of Package 4, the average area of UAA was 30.9 ha and the average area covered by support – 12.5 ha[9,10]. On those farms, the area of UAA was between 1 and 3,659.5 ha and the area covered by support – between 0.1 and 1,110.3 ha[11].

Taking into account the distribution of the farms of beneficiaries of Package 4, depending on the owned area of UAA and the area covered by support, the highest share was that of the farms with the area from 1 to 10 ha, respectively, 40.8 and 70% and from 10 to 20 ha, respectively, 24.9 and 11.5%.

[8] It is worth adding that at least one of seven packages of the Agri-environment-climate measure within the RDP 2014-2020 is implemented in 32.5 thousand of the farms located in the Natura 2000 areas in the area of 349.5 thousand ha (as of 31.12.2017).

[9] The beneficiary of Package 4 can be the farm with the area of UAA of not less than 1 ha and with the area of an agricultural parcel covered with support not smaller than 0.1 ha [MARD 2018].

[10] In the farms of all beneficiaries of the Agri-environment-climate measure within the RDP 2014-2020, the average area of UAA was 32.8 ha [IAFE-NRI and ISSPC-NRI 2017].

[11] Unpublished data of the ARMA and ISSPC-NRI, as of 31.12.2016.

Farms of beneficiaries against a background of other farms

In the farms of beneficiaries and in other farms, the distribution of the percentage structure of farms whose economic size is up to EUR 25 thousand and more than EUR 25 thousand SO was almost identical. In both cases, the more significant group in the table were the farms whose economic size was more than EUR 25 thousand SO, accounting for, respectively, 62.6 and 60.3% of all farms (Table 1).

Table 1. Percentage structure of the analysed farms of beneficiaries and other farms in the years 2014-2016 by owned economic size (SO)

Farms with the economic size	Unit	Farms:	
		of beneficiaries	other
Total	%	100.0	100.0
Up to 25 thousand euro SO	%	37.4	39.7
More than 25 thousand euro SO	%	62.6	60.3

Source: own study based on the data of Polish FADN for 2014-2016.

The distribution of the percentage structure of the basic agricultural types (TF8) on the farms of beneficiaries and other farms was included in Table 2. On the farms of beneficiaries, the most numerous group were the farms rearing animals fed on roughage feed in total, which accounted for 40.5% of all analysed farms. The smaller share, of 35.3 and 24.2% respectively, was that of the farms with mixed production and field crops. On other farms, the leading role was played by the farms with mixed production and livestock farms rearing animals fed on roughage feed in total, which accounted for, respectively, 40.3 and 31.1%. On the other hand, the share of the farms with field crops amounted to 28.6% (Table 2).

Table 2. Percentage structure of the farms of beneficiaries and the other farms in the years 2014-2016 by farming type (TF8)

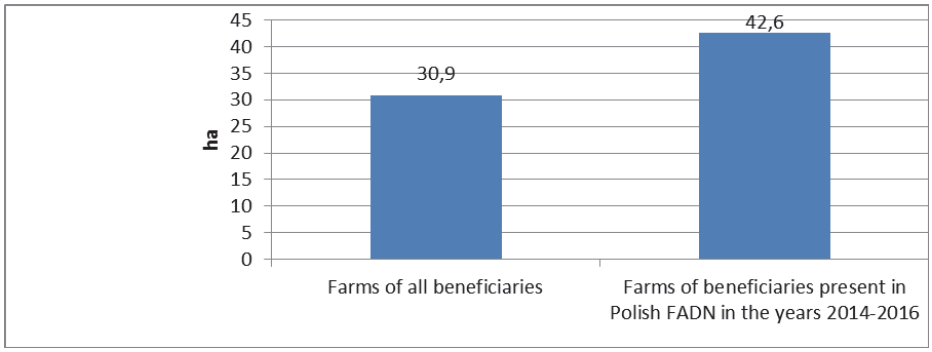
Farming type (TF8)	Unit	Farms:	
		of beneficiaries	other
In total	%	100.0	100.0
Field crops (1)	%	24.2	28.6
Horticultural crops (2)	%	0.0	0.0
Permanent crops (4)	%	0.0	0.0
Animals fed on roughage feed in total (5 and 6)[1]	%	40.5	31.1
Animals fed on concentrate feed (7)	%	0.0	0.0
Mixed production (8)	%	35.3	40.3

[1] Applies to the farming type: dairy cows (5) and other animals fed on roughage feed (6)

Source: as in Table 1.

The farms of beneficiaries, when compared to other farms, had only the slightly higher (by 3.4%) average area of UAA, although with the lower average quality, and they had the nearly identical share of leased land. It is worth adding, however, that on the analysed farms of beneficiaries the average area of UAA was much larger than the average area of UAA on the farms of all beneficiaries of Package 4, which according to the ARMA data was 30.9 ha (Fig. 2).

Fig. 2. Average area of UAA on the analysed farms of beneficiaries and on farms of all beneficiaries of Package 4 of the Agri-environment-climate measure within the RDP 2014-2020



Source: own study based on the data of ARMA (as on 31.12.2016) and the Polish FADN of 2014-2016.

Labour inputs and capital resources are also factors that determine the production potential of the farm. It was found that on farms of beneficiaries, when compared to other farms, labour inputs per 1 ha of UAA were lower by 11.5%. The same situation also took place in the case of capital resources. The farms of beneficiaries had the average capital value lower by 18.5% than other farms (Table 3).

Table 3. Production potential of analysed farms of beneficiaries and other farms in the years 2014-2016

Variable	Unit	Farms:	
		of beneficiaries	others
Utilised agricultural area:	ha	42.6	41.2
-leased land	%	33.2	33.0
Valuation index of own soils	pts	0.5	0.7
Total labour inputs per 1 ha of UAA	hours	81.1	91.6
Average value of capital	thousand PLN	500.4	613.9

Source: as in Table 1.

As it is apparent from the figures in Table 4, in the farms of beneficiaries the significantly smaller share in UAA was that of arable land and, in the structure of arable land the much smaller share was that of cereals than of farms used for comparisons. Furthermore, the farms of beneficiaries had the greater share of permanent grassland in UAA and the identical animal stocking density in livestock units (LU) per 1 ha of UAA, which was 0.5 LU/ha of UAA.

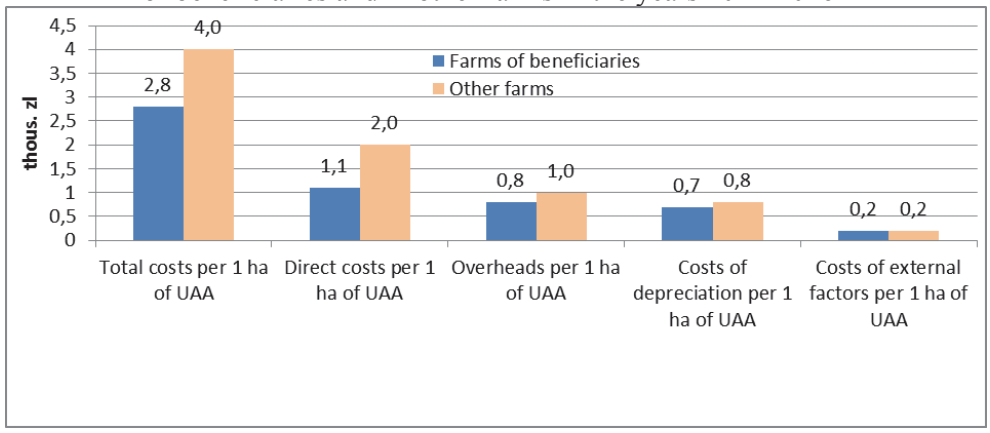
Table 4. Selected characteristics of production organisation in analysed farms of beneficiaries and in other farms in the years 2014-2016

Specification	Unit	Farms:	
		of beneficiaries	other
Share of arable land in utilised agricultural area	%	51.1	81.6
Share of cereals in arable land	%	52.7	70.9
Share of permanent grassland in arable land	%	48.8	17.6
Animal stocking density per 1 ha of UAA	LU	0.5	0.5

Source: as in Table 1.

Based on the figures from Fig. 3, it can be concluded that the farms of beneficiaries, when compared to other farms, had the lower production intensity. In these farms, total costs per 1 ha of UAA were lower by 30%. Direct costs, overheads and costs of depreciation were lower by, respectively, 45, 20 and 12.5%, and the costs of external factors in both groups of farms were identical.

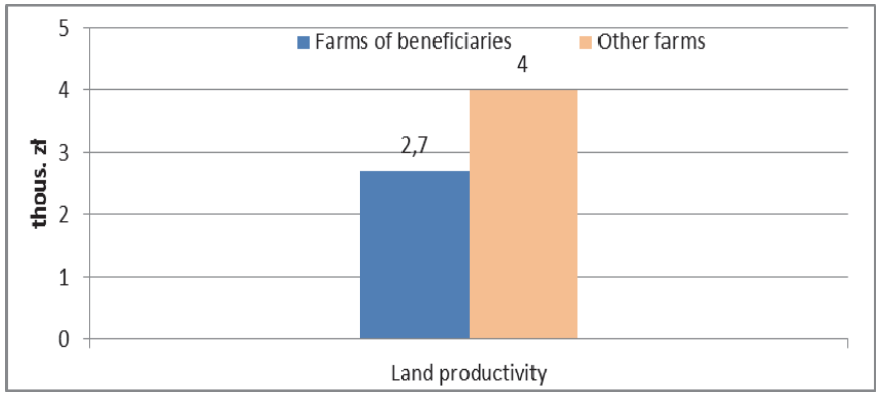
Fig. 3. Production intensity in analysed farms of beneficiaries and in other farms in the years 2014-2016



Source: as in Table 1.

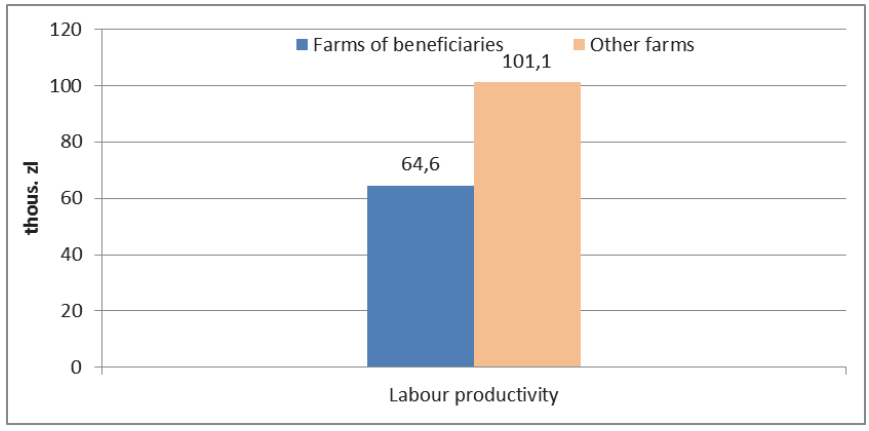
In addition, the farms of beneficiaries differed from other farms due to the lower level of productivity of basic production factors. In the farms of beneficiaries, the land productivity was lower by 41.3%, labour productivity (efficiency) by 36.1% and capital productivity by 8.4 p.p. (Fig. 4, 5 and 6).

Fig. 4. Land productivity in analysed farms of beneficiaries and in other farms in the years 2014-2016



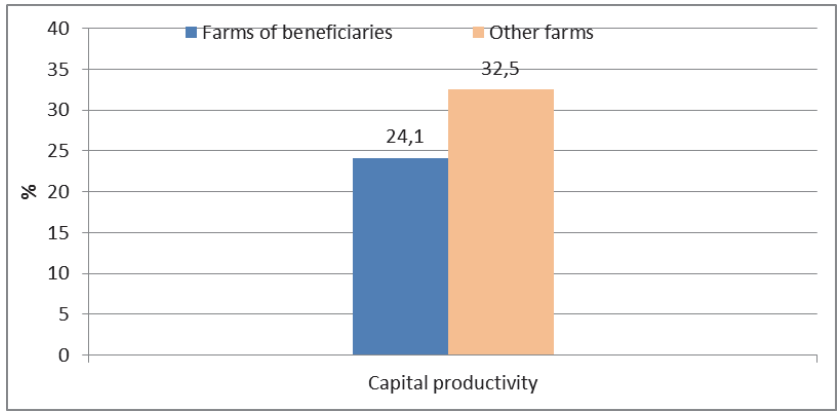
Source: as in Table 1.

Fig. 5. Labour productivity in analysed farms of beneficiaries and in other farms in the years 2014-2016



Source: as in Table 1.

Fig. 6. Capital productivity in analysed farms of beneficiaries and in other farms in the years 2014-2016



Source: as in Table 1.

The farms of beneficiaries had the slightly lower return on equity than other farms. In these farms, this return was 3.1% while in other farms was 3.3%. However, it must be added that in the same analysed period the interest rate on treasury bonds amounted to 2.9%[12]. This means that, in the case of the farms of beneficiaries and of other farms, investing free funds in own farm was the more profitable project (Table 5).

To assess the economic situation of the farms of beneficiaries and other farms, also their income per 1 AWU has been used. In the farms of beneficiaries, this income was by 6.2% lower than in other farms. In both groups of the farms, however, this income provided payment for labour of the owner and their family members at the level above the parity corresponding to the average annual net wage in the national economy in the years 2014-2016[13]. However, in the case of farms of beneficiaries, this income was executed only through subsidies to the operating activities, including subsidies received as part of participation in Package 4 of the Agri-environment-climate measure within the RDP 2014-2020. In the farms of beneficiaries, the share of operating subsidies in income was, in fact, 115.5% and, in other farms, 66.9% (Table 4).

[12] The analysis included the average interest rate of 24-month treasury bonds with the annual capitalisation of interest in the years 2014-2016 [www.obligacjeskarbowe.pl].
[13] In the years 2014-2016, the average net remuneration in the national economy amounted to PLN 31.3 thousand [Abramczuk et al. 2016, 2017 and 2018].

Table 5. Economic situation, share of operating subsidies in farm income and development capacity of analysed farms of beneficiaries and other farms in the years 2014-2016

Specification	Unit	Farms:	
		of beneficiaries	other
Return on equity	%	3,1	3,3
Farm income per 1 FWU	thousand PLN	42,5	45,3
Share of operating subsidies in farm income	%	115,5	66,9
Share of subsidies as part of Package 4 of the Agri-environment-climate measure implemented within the RDP 2014-2020 in operating subsidies in total.	%	19,4	0,0
Net investment rate	%	15,8	3,9

Source: as in Table 1.

Both groups of farms, having a favourable economic situation, were willing to increase the value of own fixed assets, as evidenced by their positive net investment rate. It should be stressed, however, that in the case of farms of beneficiaries this rate was higher than that of other farms (Table 5).

Factors determining participation of farms from the Natura 2000 areas in Package 4. Valuable habitats and endangered species of birds in the Natura 2000 areas of the Agri-environment-climate measure within the framework of the RDP 2014-2020

The probit model for farms located in the Natura 2000 area has been described as follows:

$$\Phi(X_i\beta)=-0,404-0,244\ X_1+0,636X_2-0,085X_3+0,353X_4 \quad (1)$$

where: X_0 – constant β_o, X_1 – land productivity (thousand PLN/ha), X_2 – share of permanent grassland in utilised agricultural area (%), X_3 – stocking density of ruminants in livestock units per 1 ha of permanent grassland (LU/ha), X_4 – age of the farm manager (years).

In the analysed model, the McFadden R^2 statistics was 0,206, while the statistical significance of all variables in the model was determined by the LR test (LR: χ^2 (4) = 114.3 at p = 0,0001). The value of the LR test proved to be highly significant. This model therefore included variables that significantly affected the opportunities for farms to participate in Package 4.

The model identified four significantly statistical factors underlying the decision of the farms from the Natura 2000 areas to participate in Package 4. As

indicated by the figures in Table 6, the use of Package 4 is encouraged by the fact that the farm has the greater share of permanent grassland in utilised agricultural area and the higher age of its manager. On the other hand, the increase in the stocking density of ruminants per 1 ha of permanent grassland and the increasing land productivity are factors which limit the use of this package.

Table 6. Characteristics of the probit model of analysed farms from the Natura 2000 areas in 2016

Specification	X_0	X_1	X_2	X_3	X_4
Assessment of parameter	-0,404	-0,244	0,636	-0,085	0,353
Standard error	0,213	0,039	0,230	0,039	0,178
t-Student statistics	-1,954	-6,219	2,756	-2,176	1,977
p level	0,050	0,000	0,006	0,029	0,048

Source: own study based on the data from Polish FADN for 2016.

Summary and conclusion

The chapter described both the state of spending financial resources and the farms of beneficiaries of Package 4. Valuable habitats and endangered species of birds in the Natura 2000 areas of the Agri-environment-climate measure implemented within the RDP 2014-2020. It also assessed the farms of beneficiaries of Package 4 against a background of the farms beyond the Natura 2000 areas, which constantly kept accounts for Polish FADN in the years 2014--2016 and also established factors which in the farms from the Natura 2000 areas underlay the decisions on their participation in this package.

In order to assess the functioning of the farms of beneficiaries of Package 4 against a background of the farms beyond the Natura 2000 areas which constantly kept accounts for Polish FADN in the years 2014-2016, the analysis covered 99 farms of beneficiaries from 76 communes from the Natura 2000 areas and 692 other farms from 235 communes located beyond the Natura 2000 areas.

On a basis of the analysis, it has been established that:

- In Poland, in the Natura 2000 areas biodiversity is currently protected in a special manner by 22.6 thousand farms of beneficiaries of Package 4 of the Agri-environment-climate action implemented within the RDP 2014--2020 in the area of 249.9 thousand ha and this represents 16.2% of total UAA supported under this measure. In the farms of beneficiaries, the average area of UAA was 30.9 ha and the average area covered by support was 12.5 ha. In these farms, the area of UAA and the area covered by support is, however, varied, and it is within the range from 1 to 3,659.5 ha and from 0.1 to 1,110.3 ha, respectively.

- The state of spending financial resources under Package 4 amounted to PLN 518.8 million and represents 29.6% of total financial resources spent under the Agri-environment-climate measure within the RDP 2014-2020. It must be added that the most resources under this measure have been spent on Package 4 so far.
- The analysed farms of beneficiaries against a background of other farms were characterised by the slightly larger area of UAA, however with the lower quality, and by the nearly identical share of leased land. They had lower labour inputs per 1 ha of UAA and had the lower average value of capital. These farms, despite the lower production intensity and, consequently, the lower productivity of production factors, through subsidies to their operating activity reached only a slightly lower return on equity and a slightly worse income per 1 FWU. Importantly, in these farms, this income was large enough to provide payment for labour of the owner and their family members at the level above the parity corresponding to the average annual net wage in the national economy and allowed them to increase the value of fixed assets held.
- Factors that have a positive effect on participation of the farms from the Natura 2000 areas in Package 4 are the fact that these farms have the greater share of permanent grassland in their utilised agricultural area and the higher age of their managers. In turn, the growing land productivity and the larger stocking density of ruminants per 1 ha of permanent grassland limits their willingness to use this package.

The analysis carried out showed that the farms of beneficiaries, despite their environmental constraints, provide payment for labour of the owner and their family members at the level above the parity, which makes it possible for them to see further opportunities to develop, as evidenced by their positive net investment rate. It should be underlined, however, that their good economic situation is only possible thanks to operating subsidies received, including subsidies as part of their participation in Package 4 of the Agri-environment--climate measure within the RDP 2014-2020. Furthermore, it should be assumed that the presented development potential of the farms of beneficiaries illustrates only the development potential of farms with the high production potential.

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A COMPARISON OF PIG HOLDINGS IN POLAND AND IN THE SELECTED EU COUNTRIES

Introduction

The production of pig livestock has a long tradition in Poland as already in the interwar period Poland was an important exporter of pig livestock to the Great Britain [Blicharski T., Hammersmeister A. 2013]. Also in the post-war period the production of pig livestock played a significant role and was characterised by a strong differentiation in the growth rate. There were two periods of a clear increase in the pig population: 1975-1979 and 1990-1994, in which the pig population was over 20 million heads. Between the year 2007 and the year 2016, there was a drastic decrease (over 37%), resulting in a reduction in the share of pig livestock in livestock production from 37.6% in 2007 to 22.6% in 2016. There was also a negative balance of foreign trade in pork, both in terms of value and quantity, with a strong – over fifteen-fold – increase in import of live animals (in 2007-2016). 2007 was the last year in which the balance of foreign trade in live animals was positive. In 2016, the balance of foreign trade in live animals was negative and amounted to 6310.8 thousand heads, and in 2017 – 6738.8 thousand heads.

The processes occurring in agricultural production, including pig farming, are determined by trends in the price relations of production factors and agricultural products. Since the mid-nineties, the labour costs in the national economy and prices of means of production for agriculture (including feed) have been growing faster than the sale prices of pigs. In 1995-2016, the labour costs in the national economy, in which the main component were wages, increased more than five times, the cost of means of production for agriculture over three times, and sales prices of agricultural products more than twice. Different price growth rates of means of production and prices of agricultural products resulted in a reduction of the "price scissors" ratio in the analysed period to 70%: the growth rate of prices of means purchased by farmers was therefore 30% higher than prices of agricultural products [Ziętara 2016]. Such unfavourable trends in pig farming, additionally intensified in recent years by ceasing export to Russia and the emergence of African swine fever, justify the need to undertake research which may contribute to indicating the possibility and directions of reversing these unfavourable trends.

Aim of research, sources and methods

The objective of research is to assess the production and economic activity of holdings focused on the production of pig livestock in Poland and to determine their effectiveness and competitiveness compared to corresponding holdings from selected European Union countries, as well as to determine the possibilities of their development. The following countries were taken into consideration: Denmark, Germany, Spain and the Netherlands. They are the leading producers of pig livestock in the EU. The basic source of research materials were statistical data and data from pig holdings covered by the Polish and European FADN in 2014--2016. The research uses a descriptive and comparative method. The number of analysed holdings from selected countries is given in Table 1.

Table 1. The number of studied pig holdings in 2014-2016

SO classes in thou. EUR	Poland	Denmark	the Netherlands	Spain	Germany
Pig holdings (type 45)					
8-25 (2. Small)	15-40	-	-	-	
25-50 (3. Medium small)	100-200	-	-	-	
50-100 (4. Medium large)	100-200	-	-	15-40	15-40
100-500 (5. Large)	200-500	40-100	40-100	100-200	500-1000
500 and more (6. very large)	15-40	200-500	40-100	40-100	100-200

Source: own study based on unpublished data of the European Commission.

The class of small and medium small holdings includes only Polish holdings. In the medium large class, apart from Polish holdings, there were also Spanish and German holdings. Only in the class of large and very large holdings, the FADN included holdings in all the countries studied. The fact that small and medium small holdings are not taken into consideration in all countries is associated with the structure of holdings. Larger pig holdings dominate in the remaining countries, except for Poland.

The following research hypothesis was adopted in order to deepen the research: "The main factor determining the production efficiency and competitiveness of pig holdings is the production scale". An additional research hypothesis was also adopted: "Highly specialised holdings show greater competitiveness compared to specialist holdings." For this reason, the analysis covered two groups of pig holdings in accordance with the classification used in the Polish FADN: holdings specialised in the production of pigs and highly

specialised in this production. In the first group, the share of production of pig livestock was 2/3 of the SO[1] value of a holding, while in the highly specialised holdings the share of pig livestock in total sales was 80% and more, and in the case of production of piglets 50% and more [Goraj et al. 2016]. The verification of this hypothesis was carried out in relation to Polish pig holdings. Other factors, such as production technology, breeding material, veterinary care, etc. are closely related to the scale of production. In order to determine competitiveness of holdings, the Competitiveness Index (CI) was used after W. Kleinhanss [Kleinhanss 2015].

Table 2. Costs of using own production factors: land, labour and capital in the analysed pig holdings depending on the economic size of holdings in 2014-2016

Country	The size of the holding in SO (thou. EUR) type 15/16				
	8-25 (2)	25-50 (3)	50-100 (4)	100-500 (5)	≥500 (6)
	Average	Average	Average	Average	Average
	Costs of land (EUR/ha)				
Poland	76.1	72.6	90.3	96.8	98.3
Denmark	-	-	-	688.6	933.4
the Netherlands	-	-	-	965.2	2766.2
Spain	-	68.0	128.8	150.9	297.5
Germany	-	-	626.4	580.9	532.9
Countries	Costs of labour in agriculture (EUR/h)				
Poland	2.43	1.73	2.44	2.72	3.41
Denmark	-	-	-	19.96	20.3
the Netherlands	-	-	-	16.1	19.5
Spain	-	8.45	7.73	8.90	9.37
Germany	-	-	8.23	11.69	13.79

Country	The average wage[1] in the national economy (EUR/h)	Cost of capital according to ten-year bonds (%)[2]
Poland	3.91	3.1
Denmark	16.01	0.8
the Netherlands	16.23	0.8
Spain	9.75	2.0
Germany	13.3	0.6

[1] Median of earnings, all employees (except apprentices). 2 Calculations based on daily data from national central banks.

Source: http://appso.eurostat.ec.europa.eu/nui/show.do?dataset=earn_ses_pub2s&lang=en; access 298.08.2017), European FADN, data of the European Central Bank.

[1] SO – Standard Output – standard agricultural production of a holding.

The competitiveness index (factor) was determined as the quotient of farm income and the sum of estimated costs of using own production factors: family labour, own land and capital (Equation 1)[2]. Labour costs in agriculture are given according to the level of wages of hired labour on holdings, taking into account economic size in the national economy. The costs of using own production factors on holdings in Poland and the analysed countries in 2014-2016 are given in Tab. 2.

The following trend deserves to be emphasised: the costs of hired labour increase as the economic size of holdings increases. In addition, in large and very large holdings in Denmark and the Netherlands as well as in very large German holdings, the costs of hired labour were higher than in the national economy of these countries. This situation is different from the current trends according to which labour costs in agriculture were lower than in the national economy.

The value of the Competitiveness Index CI>=1 indicates that the income fully covers the costs of own production factors, while CI<1 indicates that these costs are not fully covered. Kleinhanss' further classification of the CI was adopted distinguishing the following classes: CI1 – in the case of a negative FI; CI2 – 0<CI<1 – partial coverage of costs of own production factors; CI3 – 1=CI<2 – full coverage of costs own production factors; CI4 – CI>=2 – twofold and larger coverage of costs of own production factors. The Competitiveness Index CI3 indicates the competitive ability of an agricultural holding, and CI4 its full competitiveness. This statement coincides with the opinion of Biswanger who states that an enterprise capable of development should achieve a profit rate twice as high as the interest rate on loans [Biswanger H.Ch. 2011].

$$CI = \frac{FI}{COL + CFL + COC} \quad (1)$$

where:
CI – Competitiveness Index,
FI – Farm Income,
COL – opportunity cost of own land,
CFL – opportunity cost of family labour,
COC – opportunity cost of own capital (without own land).

In this study, competitiveness is defined as the capacity of a holding to develop. The holding has this capacity when the farm income covers the costs of own production factors. This approach is different from the traditional definition

[2] The cost of work of a farmer and farmer's family members was set at the level of the cost of hired labour in corresponding classes of economic size of holdings. The cost of using own land was set at the level of rent in given classes of economic size. The capital cost was adopted at the level of interest on multi-annual government bonds.

of competitiveness as gaining an advantage (cost, price, quality etc.) in relation to competitors [Stankiewicz M.J. 2003]. Previously, the authors [Ziętara and Zieliński 2012] determined the competitive capacity of holdings using the category of income from management, which corresponds to the category of "entrepreneur's profit"[3]. They assumed that the competitiveness of a holding is determined by the entrepreneur's profit. The adopted competitiveness index allows determining various degrees of competitiveness. Thanks to this, it enables more complete assessment of the holding's capacity to develop. Agricultural holdings from different countries do not compete directly on the EU and global markets. The exception is trade in live animals (piglets and weaners). Trade and processing companies compete in these markets. Their effects are determined, among others, by the raw material costs whose share in total production cost of meat and its products is 2/3 [Woś A. 2003]. Therefore, it is appropriate to determine the competitiveness of holdings as the capacity to develop in the market conditions of a given country.

Place and role of production of pig livestock in Poland

Poland (Table 3), especially since the accession to the European Union, has recorded growth of marketable agricultural production and significant changes in its structure. In 2000-2016, marketable agricultural production increased 128.5%, while this increase was related to a greater extent to plant production.

Table 3. The structure of marketable agricultural production in Poland in 2000-2016

Detailed list	2000		2010		2016	
	million PLN	%	million PLN	%	million PLN	%
Marketable agricultural production Rate of change (2000=100)	33491.4 100.0	- 100.0	59357.1 177.2	- 100.0	76546.2 228.5	100.0
including: Livestock production Rate of change (2000 = 100)	20950.4 100.0	62.6	33240.8 158.7	56.0	44574.4 212.7	58.3
including: Production of pig livestock Rate of change (2000=100)	7885.7 100.0	23.5 37,6[a]	8191.1 103.9	13.8 24,6[a]	10099.2 128.1	13.2 22,6[a]

[a] the share in livestock production

Source: Statistical Yearbook of Agriculture 2016, Statistics Poland 2017, Warsaw.

[3] The entrepreneur's profit was calculated as the difference between the farm income and the opportunity costs of using own production factors (labour, land and capital).

In 2000, the share of pig livestock production in marketable livestock production was 37.6%, but in the following years, despite the quantitative increase, its share dropped to 22.6% in 2016.

Accession to the EU brought a definite improvement in trade in agri-food products. The removal of restrictions on food trade between Poland and other EU countries revealed high price competitiveness of many Polish food commodities, mainly beef, poultry meat and dairy products (butter, milk powder and ripened cheese). And although in the last dozen or so years the balance of Polish foreign trade in total has been negative, in foreign trade in agri-food products in 2009-2016 it was positive. Unfortunately, development of foreign trade in agri-food products has not brought favourable changes in trade in pork and live animals, where the balance, both quantitative and valuable, was still negative (Table 4). The negative balance in foreign trade in live animals, including the fact that piglets and weaners constituted over 70% of import, is particularly worrying. In 2016 and 2017, the negative balance in this respect was 6310.8 and 6738.8 thousand heads, respectively. Piglets and weaners were imported mainly from Denmark, the Netherlands and Germany.

Table 4. Foreign trade in pork and live animals

Detailed list			2009	2010	2014	2015	2016	2017
Export (thou. t) in meat equivalent			336.0	418.0	692.8	719.0	768.8	836.7
Import (thou. t)			614.0	602.0	847.7	854.1	880.4	907.7
Balance (in terms of quantity thou. t)			-278.0	-184.0	-154.9	-135.1	-111.6	-71.0
Balance (in terms of value million EUR)			-524.5	-336.0	-350.2	-197.4	-188.6	-175.9
Trade in pigs (live animals in thou. head in 2007-2013)								
	2007	2008	2009	2010	2014	2015	2016	2017
Export	434.0	418.8	442.2	274.4	85.5	38.9	60.1	82.7
Import	401.7	1124.6	1997.5	2285.3	5486.1	5568.7	6370.9	6821.5
Balance	32.3	-709.8	-1155.3	2011.1	-5401.6	-5229.8	-6310.8	-6738.8

Source: Statistical Yearbook of Agriculture 2017, Statistics Poland 2015, Warsaw, Market Analysis – Foreign trade in agri-food products [2011, 2018].

Changes in the pig population in Poland in 1990-2017

In 1990-2007, the pig population in Poland was stable and remained at the level of about 18 million heads, with slight fluctuations around 5% (Figure 1). Since 2007, however, a steady downward trend has been observed, which resulted in the achievement of the level of 10.8 million heads in 2016 (a decrease of 40% compared to 2007).

At the same time, there is a strong territorial diversity of the pig population.

In 1990, the largest share in the pig population in Poland was recorded in the Wielkopolskie Province (17.2%), followed by Mazowieckie (12.9%), Kujawsko-Pomorskie (9.3%), Podlaskie (7.6%) and Lubelskie (7.4%). The above-mentioned regions covered almost 55% of the national pig population. In the following years, there were changes as a result of which in 2016 five provinces accounted for 71.1% of the pig population: Wielkopolskie (35.3) Kujawsko-Pomorskie (10.6), Łódzkie (9.9), Mazowieckie (8.4) and Pomorskie (6.9). The dominant share of the Wielkopolskie Province deserves special attention. The pig population was very low in the following provinces: Lubelskie, Małopolskie, Podkarpackie and Świętokrzyskie (Figure 2).

Fig. 1. Pig population in Poland in 1990-2017

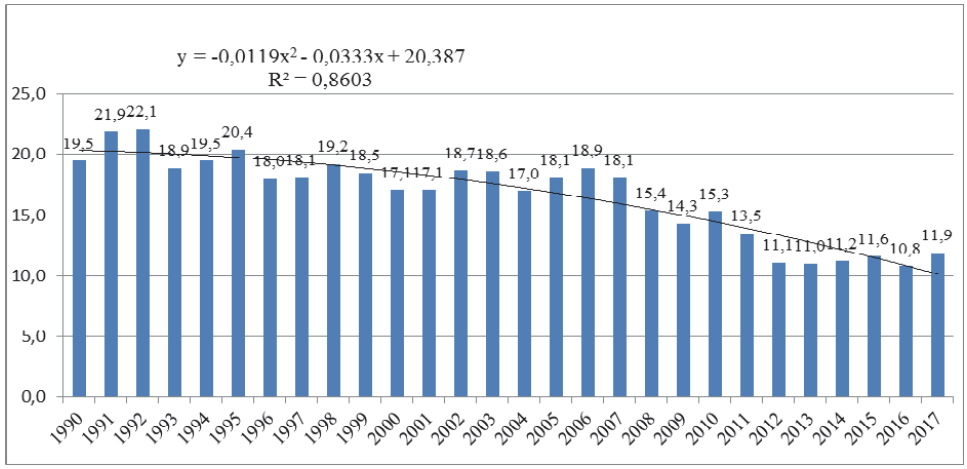


Fig. 2. Changes in the pig population in Poland in 1990-2016 in a spatial system by provinces

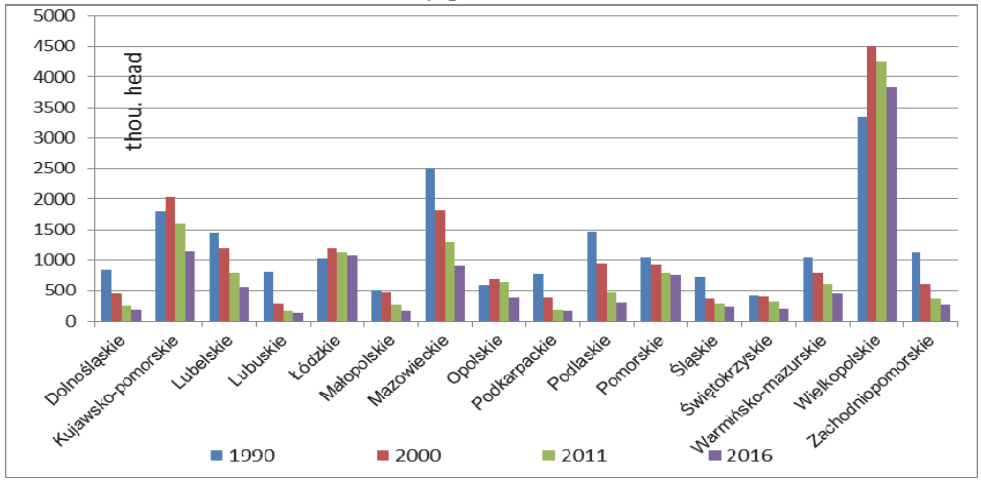
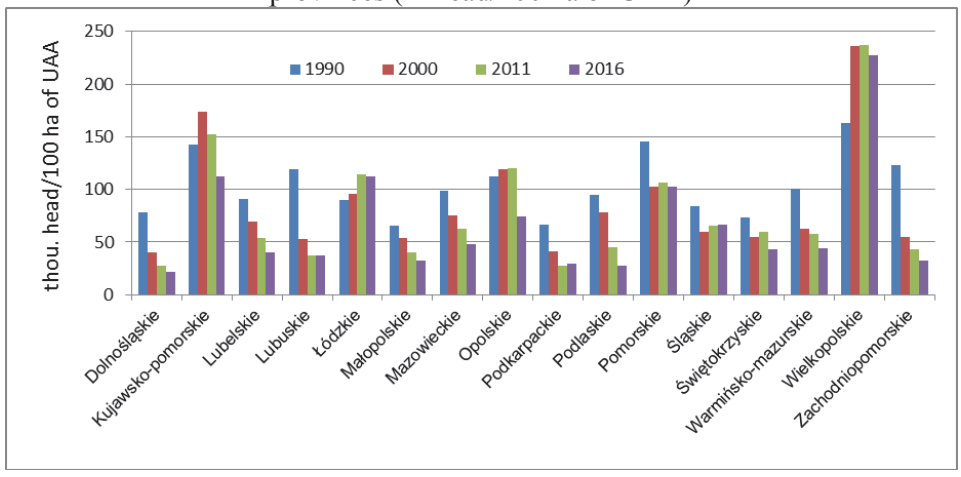


Figure 3 presents changes in the pig stocking in head per 100 ha of utilised agricultural area (UAA). The highest stocking in 1990, above the average (103.5 heads/UAA), occurred in the following provinces: Wielkopolskie (163), Pomorskie (146), Kujawsko-Pomorskie (142), Lubuskie (119) and Opolskie (112). In 2016, the average stocking was 74.7 heads/100 ha of UAA and was 27.8% lower than in 1990. At the same time, the territorial diversity of the stocking increased: the highest stocking was in the following provinces: Wielkopolskie (227) and Kujawsko-Pomorskie (112.1), Łódzkie (112.3) and Pomorskie (103.4). The increase of the pig stocking of 39.2% in the Wielkopolskie Province deserves underlining. In some of the districts (7) of this province, the pig population amounted to about 300 heads/100 ha and was four times larger than the average in Poland, and in 2010 in the districts of Krotoszyn and Środa Śląska, it amounted to 473 and 548 heads/100 ha of UAA, respectively [Pepliński 2018], and was similar to the stocking in Denmark and the Netherlands. The Wielkopolskie and Kujawsko-Pomorskie Provinces are among those with the largest scale.

Fig. 3. Changes in stocking of pigs in Poland in 1990-2016 in the system of provinces (in head/100 ha of UAA)



Changes in the number and structure of holdings keeping pigs correspond with changes in the pig population. The relevant data is shown in Table 5. It is worth emphasising that the number of holdings keeping pigs has dropped significantly. In 2005, there were 701.7 thousand of such holdings, while in 2016 – 172.2 thousand. The reduction was 75.4%. In the same period, the pig population decreased 34.2%. At the same time, the average size of the herd per one holding increased, from 25.8 heads in 2005 to 69.1 heads in 2016. The increase was 167.8%. The structure of pig holdings changed at the same time. The share of holdings keeping 10 and more pigs increased from 46.6% in 2005 to 60.2% in 2016. The share of pig population in these holdings increased from 92.6% to 97.4%.

The deepened structure of pig holdings and pig population in 2016 is presented in Table 6. The share of the smallest holdings, keeping up to 2 pigs, was 14.4%. These holdings had 0.3% of the pig population, and the average herd size was 1.4 heads. The share of holdings keeping between 10 and 49 heads was the largest and amounted to 40.7%.

14.4% of the pig population was kept on these holdings, and the average herd size was 24.6 heads. The share of the largest holdings keeping herds of 200 heads and more was only 4.5%, and 61.3% of the population was kept there. The average size of the herd in this class was 941 heads. These numbers confirm the process of concentration in pig farming.

Table 5. The number and structure of pig holdings and pig population in Poland in 2005-2016

Year	2005	2007	2010	2013	2016
The number of holdings (thou.)	701.7	664.0	388.5	278.4	172.2
Rate (2005=100)	100.0	94.6	55.3	39.7	24.5
Pig population (thou.)	18100.0	18100.0	15300.0	11000.0	11900.0
Rate (2005=100)	100.0	100.0	84.5	60.8	65.7
Average herd size (head)	25.8	27.1	39.3	39.5	69.1
Structure of holdings (%)					
1	11.1	10.6	9.6	11.8	
2	14.4	15.4	12.3	12.7	14.4
3-4	12.7	12.4	10.8	10.4	
5-9	15.2	15.1	15.0	14.4	25.4
10 and more	46.6	46.5	52.3	50.7	60.2
Total	100.0	100.0	100.0	100.0	100.0
The share of pig population in herds of 10 heads and more	92.6	93.3	95.6	95.7	97.4

Source: Characteristics of agricultural holdings in 2016, Statistics Poland 2017.

Table 6. The number of pig holdings, pig population and their structure in Poland in 2016

Herd size (head)	The number of holdings	Structure of holdings (%)	The number of pigs thou. (head)	Structure of the population (%)	Average of the heard (head)
1-2	24804	14.4	35.7	0.3	1.4
3-9	43750	25.4	273.7	2.3	6.2
10-49	70105	40.7	1713.6	14.4	24.6
50-99	17052	9.9	1285.2	10.8	75.4
100-199	8755	5.1	1297.1	10.9	147.6
200 and more	7752	4.5	7294.7	61.3	941.0
Total	172248	100.0	11900.0	100.0	69.1

Source: Characteristics of agricultural holdings in 2016, Statistics Poland 2017.

The basic element of pig farming are sows. Their number in the analysed period 2005-2016 decreased from over 1 million heads to 842,936 heads in 2016. Table 7 shows the number of holdings keeping sows and their number, as well as their structures in 2016.

Table 7. The number of holdings keeping sows and their number, and their structure in Poland in 2016.

Herd size (head)	Holdings		The number of sows		Average herd size
	The number (head)	Structure (%)	The number (head)	Structure (%)	
1-9	102635	88.0	292219	34.7	2.8
10-49	12588	10.8	235572	27.9	18.7
50 and more	1392	1.2	315145	37.4	226.4
Total	116614	100.0	842936	100.0	7.2

Source: Characteristics of agricultural holdings in 2016, Statistics Poland 2017, Warsaw.

The structure was dominated by holdings keeping herds up to 9 sows. Their share was 88%. They concentrated 34.7% of the population. The share of holdings keeping 50 sows and more was only 2.2%, and they had 37.4% of the sow population. This structure of holdings and the population of sows should be assessed as very unfavourable.

The second factor associated with changes in the population was the scale of production. In 2007-2016, the decrease in the total number of pigs was 34.2%, while in herds of 200 heads and more the population increased 36.61%. In herds below 200 heads, there was a decrease of 63.4% (Table 8). These numbers clearly indicate the role of the scale of production in shaping the pig population in Poland. The increase in the pig population in herds of 200 heads and more did not compensate for the drop in population in herds up to 200 heads.

Table 8. Changes in the pig population structure in Poland in 2007-2016

Detailed list	2007	2010	2012	2016
Pig population (thou. head)	18100.00	15278.10	11581.32	11900.00
Pig population in herds up to 50 heads	6208.30	3936.47	2710.02	2023.00
Pig population in herds of 50-200 heads	6552.20	4161.43	2849.00	2582.30
Pig population in herds of >=200 heads	5339.50	7180.71	6022.30	7294.70
Decrease in pig population in herds up to 200 heads The rate of decrease (%)	- 100.0	-4662.60 -36.50	-7201.48 -56.43	8155.20 -63.40
Increase in pig population in herds of >200 heads The rate of increase (%)	- 100.0	1841.21 34.50	682.8 12.78	1955.20 36.61

Source: Statistical Yearbook of Agriculture 2014 and 2017, Statistics Poland, Warsaw 2015 and 2018, Agricultural Census 2010. Research report, 2011, Statistics Poland, Warsaw.

Pig population in Poland and in selected countries

Until 2010, Poland was one of the leading producers of pig livestock in the European Union, taking the third place in terms of the pig population, after Germany and Spain (Table 9). In 2016, with the population of 11.1 million heads, it fell to the sixth place. During that period, the pig population in Poland decreased 24.7%, while in Spain and Germany it increased 13.6% and 1.7%, respectively. In Denmark and the Netherlands, it decreased slightly, 0.1% and 2.7%, respectively. In that period, there was also a decrease in the sow population, the largest in Poland, by 36.9%. In Germany and the Netherlands, 15.8% and 7.7%, respectively. The smallest decrease in the sow population occurred in Spain – 1.74%, and in Denmark, where it was 4.7%.

Table 9. Changes in the pig population in Poland and in selected countries in 2010-2016

Country	Pigs in total (thou. head)			Sows (thou. head)		
	2010	2016	2010=100	2010	2016	2010=100
Denmark	12293	12281	99.9	1297	1236	95.3
Germany	26901	27376	101.7	2265	1908	84.2
Spain	25704	29232	113.7	2458	2415	98.2
the Netherlands	12206	11881	97.3	1107	1022	92.3
Poland	14776	11107	75.2	1362	859	63.1

Source: Statistisches Jahrbuch über Ernährung, Landwirtschafts und Forsten 2017, Landwirtschaftsverlag Münster.

There were significant differences between the analysed countries in the structure of pig holdings and pig population. In Poland, this structure was unfavourable. This is proven by the share of holdings keeping herds up to 200 heads, which in 2013 amounted to 97%, and 200 heads and more – only 3% (Table 10). In countries such as Denmark and the Netherlands, the share of this group of holdings was over 80%. The structure of the population was equally unfavourable in Poland. Herds of 200 heads and more in Poland included about

50% of the pig population, while in other countries more than 96%, and in Denmark and the Netherlands almost 100% of the population.

Table 10. The structure of pig holdings and pig population in Poland and selected countries in 2013

Country	Structure of pig holdings (%)			Structure of pig population (%)		
	up to 200 heads	200 heads and more	total	up to 200 heads	200 heads and more	total
Denmark	17.5	82.5	100.0	0.1	99.9	100.0
Germany	53.8	46.2	100.0	3.3	96.7	100.0
Spain	75.5	24.5	100.0	2.2	97.8	100.0
the Netherlands	14.5	85.5	100.0	0.5	99.5	100.0
Poland	97.1	2.9	100.0	49.7	50.3	100.0

Source: Statistisches Jahrbuch über Ernährung, Landwirtschafts und Forsten 2014, Landwirtschaftsverlag Münster.

There were also considerable differences in the level of concentration of pig farming as indicated by the numbers given in Table 11 for medium sized herds. In 2005, the average size of the herd in Poland was 25 heads, while in countries such as Denmark and the Netherlands 1500 and 1167 heads, respectively, and it was 60 and 47 times larger. In other countries, it was ranging from 197 heads (Spain) to 303 heads (Germany). In 2013, the differences deepened. That year, the average size of the herd in Poland was 41 heads, while in Denmark and the Netherlands 3096 and 2208 heads, respectively, and it was 75 and 54 times larger. Larger differences between Poland and the analysed countries occurred in the concentration of sows. In 2005, the average number of sows in Polish holdings was 4 heads, while in Denmark and the Netherlands, 303 and 280 heads, respectively. In 2013, the differences increased. In Polish holdings, the number of sows increased to 6 heads, while in Denmark and the Netherlands to 600 and 488 heads, respectively. In the remaining countries, the number of sows kept in the holding was ranging from 131 (Spain) to 145 heads (Germany). It should also be emphasised that the analysed countries, except for Poland, had a higher degree of specialisation of holdings, with a division into those focused on the "production" of piglets and holding animals for fattening. Large differences in pig stocking per 100 ha of UAA should be also pointed out. In Denmark and the Netherlands, it was within the range of 474 heads (Denmark) and 679 heads (the Netherlands). It should be described as very high. In Germany, it was about 160 heads, which can be assessed as an average. In Spain, it showed an upward trend, from 85.3 in 2005 to 111.3 heads/100 ha of UAA in 2016. In Poland, there was a decrease in the stock from 114 to 75.6 heads in these years.

Table 11. Changes in the average size of the pig herd in Poland and selected countries in 2005 and 2013

Country	Average herd size total (head)			Average herd size sows (head)			Stocking head/100 ha of UAA[a]	
	2005	2013	2005=100	2005	2013	2005=100	2005	2016
Denmark	1500	3096	206.4	303	600	198.0	500.0	474.0
Germany	303	584	192.7	75	145	193.3	157.7	163.6
Spain	197	467	237.0	88	131	148.8	85.3	111.3
the Netherlands	1167	2208	189.0	280	488	174.3	578.0	679.3
Poland	25	41	164.0	4	6	150.0	113.9	75.6

Source: Statisches Jahrbuch über Ernährung, Landwirtschafts und Forsten 2014, Landwirtschaftsverlag Münster, [a] – Statistical Yearbook of Agriculture 2017.

There are very large differences between Poland and the studied countries in the area of trade in pigs (live animals for breeding, piglets and weaners). The relevant numbers related to import and export of live animals are shown in Table 12. The leading exporters of live animals were Denmark and the Netherlands. In 2015 and 2016, Denmark exported over 12 million pigs, mainly piglets and weaners. Import of this group of animals was small. In these years, the balance was 12.54 and 12.23 million heads, respectively.

Table 12. Export and import of live pigs (for breeding, piglets and weaners) in Poland and in the studied countries in 2015 and 2016 (thou. head)

Country	Import		Export		Balance	
	2015	2016	2015	2016	2015	2016
Denmark	1.52	0.27	12233.81	12.546.03	12232.29	12455.76
Germany	10163.41	10966.17	2264.73	1995.57	-7898.68	-8970.60
Spain	756.64	502.50	163.89	235.95	-592.75	-266.55
the Netherlands	706.52	865.27	4061.75	3873.21	3345.23	3007.94
Poland	4809.77	6045.74	6.96	5.51	-4802.81	-6040.23

Source: Statisches Jahrbuch über Ernährung, Landwirtschafts und Forsten 2014, Landwirtschaftsverlag Münster.

Export of pigs in the Netherlands in these years was around 4 million heads. Import of animals was higher than in Denmark and amounted to around 800 thousand heads. In the relevant years, the balance of foreign trade was 3.34 and 3.00 million heads, respectively. In the analysed years, Germany was the largest importer of pigs. In that years, import of live animals amounted to over 10 million heads. At the same time, it was a serious exporter of this group of animals, which amounted to around 2 million heads in the relevant years. The foreign trade balance in this respect was negative and amounted to 7.89 and 8.97 million heads, respectively. Poland is also a major importer of live animals.

In the analysed years, import of piglets and weaners was 4.8 and 6.04 million heads, respectively. Export was insignificant. The balance of foreign trade in pigs was negative and amounted to 4.8 and 6.04 million heads. Spain also had a negative balance of foreign trade in live animals but it was insignificant.

The effectiveness of Polish holdings specialised in the production of pig livestock

The subject of the analysis were holdings specialised in the production of pig livestock covered by the monitoring of the Polish FADN in 2008-2016. The relevant numbers are shown in Table 13.

The following statements can be made on the basis of the presented numbers – there is a positive relationship (correlation coefficient 0.9) between the area of holdings, pig population on the holding, the number of sows kept, stocking of pigs in LU/100 ha of UAA and farm income;

- on holdings keeping herds below 20 LUs and in the range of 20-50 LUs with approx. 8-12 and 17-23 ha of utilised agricultural area (UAA) and keeping about 5 and 12 sows, there was a negative income from management and competitiveness index below 1, between 0.15 and 0.92. These holdings were devoid of development opportunities;
- also on holdings keeping 50-100 LUs of pigs and with over 30 ha of UAA, keeping about 25 sows, in 2008 and 2015, there was a negative income from management and competitiveness index below 1, in the range of 0.87-0.98. In 2012 and 2016, the competitiveness index was 1.51, which indicates competitive capacity. However, the variability of results in this class of holdings indicates their limited development capacity,
- holdings with a pig population of 100-200 LUs, using about 45 ha of UAA and keeping about 40 sows, demonstrated their ability to compete in all analysed years. They achieved positive income from management, income at the parity level and competitiveness index above 1, between 1.42 and 1.87, and in 2016 even 2.29;
- holdings with a pig population of 200-300 LUs and more than 300 LUs, using about 65 and 110 ha of UAA, respectively, keeping 70 sows and more than 130 sows, where the competitiveness index was higher than 2, can be considered fully competitive;
- the share of all types of payments in farm income decreased with the increase of the pig population from 71-93% in the class keeping below 20 LUs to 16-30% in holdings keeping 300 LUs and more.

Table 13. The efficiency of Polish specialised pig holdings depending on the scale of production in 2008-2016

Year	The size of the pig population LU/holding					
	Below 20	20-50	50-100	100-200	200-300	300 and more
Utilised agricultural area (ha/holding)						
2008	10.01	21.21	35.37	51.64	71.84	119.03
2012	12.06	23.41	37.85	45.77	64.46	107.68
2015	8.18	17.12	29.73	42.32	61.55	106.01
2016	8.22	17.37	28.97	44.03	62.42	102.39
Pig population (LU/100 ha of UAA)						
2008	122.81	158.81	202.16	259.47	321.86	496.53
2012	93.33	138.07	188.81	296.11	376.95	462.03
2015	166.23	203.03	247.23	321.08	395.03	504.10
2016	170.95	202.20	250.52	309.15	391.20	530.78
The number of sows (head/holding)						
2008	5.70	13.78	27.67	44.46	82.91	204.60
2012	4.09	10.71	24.83	38.54	72.42	135.97
2015	5.63	12.33	26.37	40.38	56.24	134.24
2016	4.97	12.05	24.1	38.45	55.70	130.86
Farm income (thou. PLN/holding)						
2008	12.90	35.59	82.68	158.68	281.40	536.65
2012	22.19	66.14	140.87	203.02	316.79	692.06
2015	7.62	31.39	68.47	127.71	178.65	401.52
2016	16.74	57.62	111.60	196.60	325.36	482.84
Cost of own production factors (thou. PLN/holding)						
2008	45.82	65.90	84.00	105.86	136.71	180.62
2012	54.95	71.77	93.24	108.48	144.80	190.39
2015	48.81	62.78	78.75	89.56	106.95	135.51
2016	47.51	63.62	73.59	85.56	96.23	114.95
Income from management (thou. PLN/holding)						
2008	-32.92	-30.31	-1.32	52.82	144.69	356.03
2012	-32.76	-5.63	47.63	94.54	171.99	501.67
2015	-41.19	-31.39	-10.28	38.15	71.70	266.01
2016	-30.77	-6.00	38.01	111.04	229.13	367.89
Income parity (%)						
2008	39.56	89.00	190.26	353.40	595.42	1305.12
2012	54.61	142.18	261.82	381.33	579.78	1266.60
2015	18.91	65.26	139.49	233.46	288.91	683.87
2016	40.67	110.42	195.65	320.95	504.44	800.95
The share of payments in income (%)						
2008	71.33	52.53	38.80	27.80	22.91	16.59
2012	54.28	37.54	31.02	24.82	27.69	17.01
2015	93.67	54.96	41.13	32.69	29.08	18.79
2016	73.18	53.14	48.21	38.41	30.05	30.02
Competitiveness Index CI						
2008	0.28	0.54	0.98	1.49	2.06	2.97
2012	0.40	0.92	1.51	1.87	2.18	3.63
2015	0.15	0.50	0.87	1.42	1.67	2.96
2016	0.35	0.90	1.51	2.29	3.38	4.22

Source: Polish FADN 2010; 2014; 2017; 2018: Goraj L., Bocian M., Osuch D., Smolik A.: Technical and economic parameters by groups of agricultural holdings participating in the Polish FADN in 2008; 2012; 2015 and 2016 IERiGŻ-PIB; Warsaw.

In order to verify the adopted hypothesis assuming a higher degree of competitiveness of highly specialised holdings compared to specialised holdings, the competitiveness indices of these two groups of holdings for 2014 and 2016 by economic size are presented in Table 14.

Table 14. Competitiveness indices of specialised and highly specialised pig holdings in 2014 and 2016 by economic size

Year	Economic size of holdings in thou. EUR SO				
	8-25	25-50	50-100	100-500	500 and more
Specialised holdings					
2014	0.29	0.63	1.04	2.11	-
2016	0.47	0.95	1.52	2.82	-
Highly specialised holdings					
2014	0.28	0.58	1.33	1.97	-
2016	0.44	0.86	1.59	2.81	-

Source: as in Table 13.

Comparison of competitiveness indices of specialised and highly specialised holdings does not support positive verification of the adopted hypothesis assuming a higher degree of competitiveness of highly specialised holdings.

Polish pig holdings compared to corresponding holdings from selected countries

The production potential of the studied pig holdings

The production potential of the analysed holdings was characterised by the following indicators: economic size, utilised agricultural area (UAA), the share of leased land, total labour input, the share of family labour in total outlays, asset value/AWU, the share of capital in liabilities. The value of indicators for particular classes of economic size of holdings is given in Table 15. The following 5 classes were taken into consideration: small (EUR 8-25 thou. SO), medium small (EUR 25-50 thou. SO), medium large (EUR 50-100 thou. SO), large (EUR 100-500 thou. SO) and very large (=> EUR 500 thou. SO). The lowest class of very small holdings (up to EUR 8 thou. SO) was omitted as this class was not monitored by the European FADN. The monitoring covered Polish holdings from five classes. Spanish and German holdings were monitored in three highest classes, and holdings from Denmark and the Netherlands in the large and very large class.

The economic size of the analysed holdings was positively correlated with the utilised agricultural area. The exceptions were holdings from the Netherlands. This relationship was particularly strong in Polish holdings.

Table 15. The production potential of the studied holdings depending on the economic size

Detailed list	Economic size of holdings (thou. EUR)				
	8-25 (2)	25-50 (3)	50-100 (4)	100-500 (5)	=>500 (6)
Economic size					
Poland	18.08	37.49	73.29	191.15	921.25
Denmark	-	-	-	319.44	1662.07
Spain	-	-	72.68	289.37	1050.08
the Netherlands	-	-	-	280.74	1179.03
Germany	-	-	77.94	291.98	858.23
Utilised agricultural area (ha)					
Poland	7.70	14.16	23.38	46.17	215.95
Denmark	-	-	-	60.87	205.89
Spain	-	-	18.15	35.71	44.15
the Netherlands	-	-	-	5.26	13.13
Germany	-	-	18.77	60.87	141.29
The share of leased area (%)					
Poland	8.49	13.77	24.47	29.57	27.69
Denmark	-	-	-	23.35	31.20
Spain	-	-	60.42	46.83	53.01
the Netherlands	-	-	-	42.42	30.03
Germany	-	-	34.77	55.52	67.58
Total labour input (AWU/holding)					
Poland	1.28	1.53	1.76	2.20	3.40
Denmark	-	-	-	1.20	2.12
Spain	-	-	1.56	1.74	3.16
the Netherlands	-	-	-	1.08	2.66
Germany	-	-	0.95	1.57	3.81
The share of family labour in total outlay (%)					
Poland	99.22	99.35	98.82	86.16	19.18
Denmark	-	-	-	79.66	26.08
Spain	-	-	92.86	73.52	38.50
the Netherlands	-	-	-	92.91	58.75
Germany	-	-	99.99	90.17	41.39
Value of assets (thou. EUR/AWU)					
Poland	80.11	113.79	154.03	247.60	250.31
Denmark	-	-	-	1401.49	1401.93
Spain	-	-	118.36	287.92	318.76
the Netherlands	-	-	-	790.65	1251.44
Germany	-	-	429.65	568.93	473.58
The share of capital in liabilities (%)					
Poland	99.30	97.30	95.00	90.30	79.70
Denmark	-	-	-	43.50	24.80
Spain	-	-	98.50	93.50	87.75
the Netherlands	-	-	-	60.00	47.70
Germany	-	-	94.30	73.40	63.62

Source: Own study based on data of the European FADN.

In classes 2-4, the economic size of holdings corresponded to the average value of a given class. In class 2 and 3, there were only Polish holdings. In class 4, also Spanish and German holdings. The economic size of holdings in this class was similar, between EUR 72.68-77.94 thousand SO. In class 5, the degree of differentiation was greater. Polish holdings were the smallest (EUR 191.15 thou. SO), and Danish holdings the largest (EUR 319.44 thou. SO). They were 67% larger. The size of the remaining ones was similar, around EUR 290 thousand SO. The degree of differentiation of holdings in class 6 was larger. The difference between the smallest German holdings (EUR 885.23 thou. SO) and the largest Danish holdings (EUR 1 662.07 thou. SO) was 93.7%.

The area of the studied holdings, as noted above, was positively correlated with the economic size, with the exception of the Dutch holdings which were distinguished by far the smallest area. It can be assumed that in these holdings the utilised area was rather a place of production. In large and very large holdings, this area was: 5.26 and 13.1 ha of UAA, respectively, and was several times smaller than in other holdings. Spanish holdings also had a relatively smaller area. All analysed holdings used leased land. To the largest extent, Spanish and German holdings in which the share of leased land was between 35% and 67%.

The level of labour input per holding increased with the increase in economic size. In Polish holdings, it was between 1.28 and 3.40 AWU/holding and was higher than on other holdings in individual classes of economic size. In classes 5 and 6, it was the lowest in Danish holdings. The share of family labour in total outlays decreased along with the increase in the economic size of holdings. In classes from 2 to 4, it was ranging from 93% to 99.9%. In class 5, it was lower in Polish, Danish and Spanish holdings and amounted to 86.16%, 79.7% and 73.5%, respectively. It was higher in Dutch and German holdings, where it was 93% and 90%, respectively. In class 6, the share of family labour in total outlays was definitely lower, ranging from 19.2% (Poland) to 58.7% (the Netherlands).

The level of capital-labour ratio, determined by the value of assets converted into AWU, also increased with the increase in the economic size of holdings. In Polish holdings, it was between 80.1 (class 2) to 250.3 thousand EUR/AWU (classes 6). In was close to Spanish holdings in individual classes. It was by far the highest in Danish holdings, in which in classes 5 and 6 it amounted to 1401 thousand EUR/AWU and was 5.6 times larger than in Polish holdings, and 80% and 12%, respectively, larger than in Dutch holdings.

In German holdings, the value of assets was ranging from 430 to 569 thousand EUR/AWU and was more than twice as large as in Polish holdings.

The analysed pig holdings in classes from 2 to 4 were mainly using own capital. Its share in liabilities exceeded 95%. In classes 5 and 6, the share of capital in liabilities in Polish and Spanish holdings was also high. In class 5, it was 90% and 93%, respectively, and in class 6, 80% and 88%, respectively. Holdings in Denmark and the Netherlands had the lowest share of capital which in class 6 amounted to 25% and 48%, respectively.

Organisation of production on the studied pig holdings

The organisation of production on the analysed pig holdings was characterised by the following indicators: the share of cereal in UAA, pig population expressed in livestock units (LU)/holding, livestock stocking in LU/100 ha of UAA and total production structure. The relevant numbers are presented in Table 16.

The share of cereals in the UAA in Polish holdings was high, ranging from 90% in class 2 to 73% in class 6, showing a downward trend. In Danish holdings, in classes 5 and 6, it was also high – 78%. In other holdings it was lower and did not exceed 70%. It was definitely the lowest in Dutch holdings where in classes 5 and 6 it was 4.7% and 6.3%, respectively.

The size of pig herds per one holding increased with the increase in the economic size of holdings. In Polish holdings, it was between 14.3 and 839 LUs. The degree of differentiation between countries was not high. In class 6, the smallest herds were in German holdings, where the number of LUs of pigs was 593, whereas the largest in Spanish holdings, with a herd of 1048 LUs.

The stocking of animals in LU/100 ha of UAA was strongly diversified and increased with the increase of the economic size of holdings. In Polish holdings, it was ranging from 187 to 388 LUs/100 ha of UAA and exceeded the recommended value, which is 170 LUs/100 ha of UAA. The stocking of animals was dominated by pigs, the share of which exceeded 95%. The highest stocking was in class 6 in Dutch and Spanish holdings ranging from 831 (Spain) to 8267 (Netherlands) LUs/100 ha of UAA. Such a high level of pig stocking indicates "industrial farming." The stocking of animals in German holdings was similar to the stocking in Polish holdings. The production structure in all groups of holdings was dominated by livestock production. Its share was between 68% (Poland) and 97% (the Netherlands). The Spanish and Dutch holdings were among the most specialised holdings. The share of plant production was the highest in Polish holdings, in classes from 2 to 4. It was in the range of 31.5-24.6%. In class 4,

the share of plant production was also high in German holdings, at around 26%. The share of plant production was very low in Spanish and Dutch holdings, ranging from 1.6% to 13%. The share of remaining production in the majority of countries was small and did not exceed 7%. It was more significant in Spanish holdings in class 4, in which it amounted to 19%.

Table 16. The structure of production in the studied holdings depending on the economic size

Detailed list	Economic size of holdings (thou. EUR)				
	8-25 (2)	25-50 (3)	50-100 (4)	100-500 (5)	=>500 (6)
The share of cereals in the utilised agricultural area (%)					
Poland	92.20	89.40	83.80	80.00	72.50
Denmark	-	-	-	78.50	77.50
Spain	-	-	32.30	46.30	60.90
the Netherlands	-	-	-	4.70	6.30
Germany	-	-	69.10	64.30	54.00
Pig population (LU/holding)					
Poland	14.31	30.96	62.14	172.40	838.57
Denmark	-	-	-	237.40	1107.15
Spain	-	-	68.74	292.20	1047.56
the Netherlands	-	-	-	270.70	1071.77
Germany	-	-	55.01	212.90	593.19
Stocking of animals (LU/100 ha of UAA)					
Poland	186.90	221.80	270.20	378.20	388.57
Denmark	-	-	-	391.70	538.90
Spain	-	-	390.90	830.60	2380.70
the Netherlands	-	-	-	5231.20	8266.80
Germany	-	-	293.70	405.00	423.70
The share of livestock production in total production (%)					
Poland	68.00	72.20	75.00	79.90	76.50
Denmark	-	-	-	73.60	81.10
Spain	-	-	74.00	85.50	94.60
the Netherlands	-	-	-	92.80	97.30
Germany	-	-	69.20	75.40	74.20
The share of plant production in total production (%)					
Poland	31.50	27.30	24.60	19.90	19.30
Denmark	-	-	-	17.30	14.80
Spain	-	-	6.90	13.00	5.10
the Netherlands	-	-	-	1.70	1.60
Germany	-	-	25.70	20.40	18.80
The share of other production in total production (%)					
Poland	0.50	0.50	0.40	0.20	4.20
Denmark	-	-	-	9.10	4.10
Spain	-	-	19.10	1.50	0.30
the Netherlands	-	-	-	5.50	1.10
Germany	-	-	5.10	4.20	7.00

Source: Own study based on data of the European FADN.

The level and structure of production costs in the analysed pig holdings

The numbers characterising the level and structure of costs in the analysed pig holdings are presented in Table 17. Total and direct costs per 1 ha of UAA indicate the level of production intensity. The presented numbers clearly show that in all holdings the level of production intensity increased with the increase in the scale of production, which was closely related to the economic size of holdings. This trend is different from the previous one according to which the level of production intensity decreased along with the increase in the area of the holding. This trend indicates a loose relationship between pig farming and the land. The level of total costs per 1 ha of UAA in Polish holdings was ranging from 1.9 (class 2) to 3.8 (class 6) thousand EUR/ha of UAA. It was also lower than in other holdings. It was definitely the highest in Dutch holdings where in classes 5 and 6 it was 53 and 87 thousand EUR/ha of UAA, respectively. Such a high level of costs results from the very small area of these holdings. In Danish and German holdings, it was over 5 thousand EUR/ha of UAA and about 60% higher than in Polish holdings. The cost structure determined by the share of direct costs in total costs is also important. The share of direct costs in total costs in Polish holdings in classes 4-6 was between 71% and 75%. This share should be assessed positively. It was similar in very large Danish, Spanish and Dutch holdings as well as in large Dutch holdings. In German holdings, the share of direct costs in total costs was lower and amounted to around 60%.

Feed costs per 1 LU showed a declining trend with an increase in production scale. In Polish holdings, they were between 0.77 and 0.64 thousand EUR/LU and were lower than the costs of feed in Danish, Dutch and German holdings. Definitely the lowest costs of feed were in Spanish holdings. They were between 0.43 (class 4) and 0.30 (class 6) thousand EUR/LU. They were about 50% lower than in Polish holdings. The cost of feed was dominated by the costs of feed from purchase. In large Dutch holdings and in very large Spanish and Dutch holdings, their share was 100%. In the remaining holdings in classes 4-6, their share was ranging from 72% to 97%.

Hired labour costs increased along with the increase in the size of holdings. In all classes, they were the lowest in Polish holdings. In classes from 2 to 4, their level was very low – it did not exceed EUR 6. The highest costs of hired labour were recorded in Dutch holdings and very large Danish and Spanish holdings.

The cost of interest was also strongly diversified. It was the highest in Dutch holdings where, in large and very large holdings, it amounted to 647 and

3548 EUR/ha of UAA, respectively. It was the result of their small area. In very large Danish and Spanish holdings, it was lower but also high, and amounted to EUR 765 and EUR 883/ha UAA, respectively.

Table 17. The level and structure of costs in the studied holdings depending on the economic size

Detailed list	Economic size of holdings (thou. EUR)				
	8-25 (2)	25-50 (3)	50-100 (4)	100-500 (5)	=>500 (6)
Total costs (thou. EUR/ha of UAA)/including direct (%)					
Poland	1.89/(62.9)	2.09/(48.3)	2.40/(71.7)	3.18/(75.1)	3.76/(73.7)
Denmark	-	-	-	5.51/(63.9)	5.81/(74.7)
Spain	-	-	3.45/(73.0)	3.71/(65.2)	10.98/(73.2)
the Netherlands	-	-	-	53.35/(73.2)	87.20/(82.8)
Germany	-	-	4.18/(57.2)	5.14/(60.5)	5.81/(57.1)
Cost of feed (thou. EUR/LU), including from purchase (%)					
Poland	0.77/(63.6)	0.75/(68.0)	0.72/(72.2)	0.66/(78.8)	0.64/(82.8)
Denmark	-	-	-	0.84/(88.1)	0.78/(85.9)
Spain	-	-	0.43/(97.7)	0.32/(75.0)	0.30/(100.0)
the Netherlands	-	-	-	0.62/(100.0)	0.71/(100.0)
Germany	-	-	0.79/(77.2)	0.71/(83.1)	0.62/(91.9)
Cost of hired labour (EUR/ha of UAA)					
Poland	6.40	4.61	5.53	36.65	241.32
Denmark	-	-	-	175.33	674.57
Spain	-	-	111.40	259.29	883.0
the Netherlands	-	-	-	646.58	3548.05
Germany	-	-	6.06	71.27	467.65
Cost of interest (EUR/ha of UAA)					
Poland	0.69	3.64	6.47	12.06	12.41
Denmark	-	-	-	127.94	187.46
Spain	-	-	0.22	8.90	28.52
the Netherlands	-	-	-	769.15	1306.81
Germany	-	-	8.45	29.83	43.62
Cost of rent (EUR/ha of UAA)					
Poland	5.97	10.11	22.77	32.25	26.72
Denmark	-	-	-	155.50	294.02
Spain	-	-	64.65	72.02	161.15
the Netherlands	-	-	-	345.26	599.75
Germany	-	-	218.29	316.72	356.06
Cost of depreciation (EUR/ha of UAA)					
Poland	366.30	326.20	328.09	337.19	240.56
Denmark	-	-	-	462.36	634.49
Spain	-	-	175.88	326.34	548.26
the Netherlands	-	-	-	4019.62	7933.11
Germany	-	-	394.80	504.56	528.78
Cost of own production factors (EUR/ha of UAA)					
Poland	1842.33	1331.80	1028.78	748.45	329.83
Denmark	-	-	-	1142.00	895.38
Spain	-	-	1894.65	1085.50	1107.75
the Netherlands	-	-	-	14881.93	6453.31
Germany	-	-	1944.54	942.91	534.89

Source: Own study based on data of the European FADN.

The costs of rent were less varied. They were the lowest in Polish holdings ranging from 6 (class 2) to 32 (class 5) EUR/ha of UAA. The highest costs of rent were noted in Dutch holdings where they amounted to 345 and 600 EUR/ha of UAA, respectively. The costs in Spanish holdings were also relatively low.

The costs of own production factors (land, labour and capital) showed decreasing trends as the economic size of holdings increased. In Polish holdings, they were between 1842 and 330 (class 6) EUR/ha of UAA. In other holdings, except for Dutch ones, they were about twice as high. They were the highest in Dutch holdings where in classes 5 and 6 they amounted to 14.9 and 6.4 EUR/ha of UAA, respectively.

Depreciation costs in Polish holdings decreased as the scale of production increased. They were ranging from 366 (2) to 241 (6) EUR/ha of UAA. In class 5, they were close to the depreciation costs in Spanish holdings where they amounted to 326 EUR/ha of UAA. They were the highest in Dutch holdings where in classes 5 and 6 they amounted to 4,019 and 7,933 EUR/ha of UAA, respectively. They were similar in other holdings: Danish, Spanish and Dutch, in classes 5 and 6. They amounted to around 500 EUR/ha of UAA.

Productivity and profitability of the studied pig holdings

The numbers characterising the productivity and profitability of the analysed pig holdings are presented in Table 18. From among productivity indicators, the efficiency (productivity) of work determined by the value of total production per unit of total work (AWU) was taken into account. A relationship was found between labour productivity and the economic size of holdings. In Polish holdings, labour productivity was ranging from 11.57 (class 2) to 124.54 (class 6) thousand EUR/AWU. In class 6, it was about 12 times higher than in class 2. Labour productivity in Polish holdings was lower than in comparable holdings from other countries. It was the least different from the productivity of labour in Spanish holdings. It was lower ranging from 24% in class 5 to 40% in class 6. It was the most different from the productivity in Danish holdings in class 5 and from Dutch holdings in class 6, by 71% and 75%, respectively.

The profitability of family labour determined by the farm income per family work unit (FWU) in all groups of holdings was positively correlated with the economic size of holdings. In Polish holdings, it was between 1.52 (class 2) and 113.93 (class 6) thousand EUR/FWU. In class 4, it was 61% lower than in Spanish holdings, and more than three times higher than in German holdings. In class 5, it was about twice as high as in Danish and Dutch holdings, while in

class 6 it was four and two times higher, respectively. In these classes, however, it was lower than in Spanish holdings.

The profitability of family labour is the basis for calculating the income parity. The income parity A1 is the relation between the profitability of family labour and wage of hired labour in a given class of economic size. Polish holdings achieved the income parity A1 in class 3 and subsequent classes. Danish holdings in class 5 and 6. Dutch holdings in class 5 and German holdings in class 4 did not reach income at the parity level. The highest values of this indicator were obtained by Polish and Spanish holdings in class 6. They amounted to 1299% and 735%, respectively. Similar relations occurred in the case of the B2 indicator, which defines the relationship between the profitability of family labour and the level of wage in the national economy. The farm income at the B2 parity level was achieved by Polish and Spanish holdings in class 4 and subsequent classes, as well as German holdings in class 6. Danish and Dutch holdings in classes 5 and 6, and German holdings in classes 4 and 5 did not reach the B2 parity income.

Income from management, which is the difference between farm income and the cost of own production factors (land, labour and capital), is the final economic measure of management efficiency. It was negative in all holdings in classes from 2 to 4, which means that the farm income did not cover the cost of own production factors. In other classes, income from management was obtained by Polish, Spanish and German holdings in class 6. Danish and Dutch holdings in classes 5 and 6 and German holdings in class 5 had a negative income from management. The question arises: can holdings with a negative income from management function? The answer is yes, provided that the farmers who run such holdings accept a lower payment for family labour. However, holdings of this type do not have development opportunities.

An important factor affecting the level of farm income are all kinds of subsidies which farmers receive under the Common Agricultural Policy. The share of subsidies in income is negatively correlated with the economic size of holdings. In Polish holdings, this share was ranging from 97% (class 2) to 32% (classes 5 and 6). It was the highest in German holdings in class 4, where it amounted to 277%, and in Danish holdings in classes 5 and 6, where it was 155% and 215%, respectively. The lowest share of subsidies in farm income occurred in Spanish holdings, in which it was between 17% (class 4) and 6% (class 6), and in Dutch holdings in class 6, in which it amounted to 9%. It was the result of their small area.

Table 18. Productivity and profitability of studied pig holdings depending on the economic size

Detailed list	Economic size of holdings (thou. EUR)				
	8-25 (2)	25-50 (3)	50-100 (4)	100-500 (5)	=>500 (6)
Labour productivity (total production in thou. EUR/AWU)					
Poland	11.57	21.69	36.80	78.38	124.54
Denmark	-	-	-	276.22	344.71
Spain	-	-	57.89	102.84	206.46
the Netherlands	-	-	-	267.46	507.66
Germany	-	-	77.55	183.90	222.08
Productivity of family labour (farm income in thou. EUR/FWU)					
Poland	1.52	4.95	8.96	21.19	113.93
Denmark	-	-	-	11.78	25.25
Spain	-	-	23.22	43.75	147.59
the Netherlands	-	-	-	12.55	49.33
Germany	-	-	2.88	26.72	51.37
Income parity A1 (%)					
Poland	27.53	102.14	166.28	367.17	1298.89
Denmark	-	-	-	26.97	58.86
Spain	-	-	127.83	217.98	734.74
the Netherlands	-	-	-	31.59	116.21
Germany	-	-	18.06	108.90	173.66
Income parity B2					
Poland	18.33	59.71	108.29	241.09	1374.40
Denmark	-	-	-	34.73	74.39
Spain	-	-	112.33	211.65	714.85
the Netherlands	-	-	-	36.17	43.37
Germany	-	-	10.21	94.76	182.18
Income from management (thou. EUR/holding)					
Poland	-12.25	-11.33	-8.50	5.60	88.42
Denmark	-	-	-	-58.24	-155.51
Spain	-	-	-0.75	17.28	130.41
the Netherlands	-	-	-	-65.75	-7.63
Germany	-	-	-33.78	-19.67	5.45
The share of subsidies in farm income (%)					
Poland	98.63	51.12	42.37	31.64	32.74
Denmark	-	-	-	154.74	215.40
Spain	-	-	16.83	13.77	5.68
the Netherlands	-	-	-	25.89	9.03
Germany	-	-	276.88	56.03	70.23
Competitiveness Index (CI4)					
Poland	0.14	0.40	0.65	1.16	2.26
Denmark	-	-	-	0.16	0.16
Spain	-	-	0.98	1.45	3.66
the Netherlands	-	-	-	0.16	0.9
Germany	-	-	0.07	0.66	1.07

Source: Own study based on data of the European FADN.

The analysis of competitiveness indices indicates that all holdings in classes 2 to 4 do not have the ability to compete and develop. In Polish holdings, the value of this index was ranging from 0.14 (class 2) to 0.65 (class 4). In class 4, the highest value of this index was obtained by Spanish holdings. It was 0.98 and was close to the lower value indicating the ability to compete. In German holdings, the value of the index in this class was very low, it was only 0.07. In class 5, only Polish and Spanish holdings were able to compete – the values of the competitiveness index were 1.16 and 1.45, respectively. In class 6, holdings from these countries were fully competitive. The value of competitiveness indices was 2.26 and 3.66, respectively. Danish and Dutch holdings in classes 5 and 6 do not have the ability to compete. Their index values were very low and did not exceed 0.16. Also German holdings in class 5 did not have the ability to compete. The holdings from this country in class 6, in which the value of the competitiveness index was 1.07, showed a minimum ability.

Characteristics of pig holdings which are able to compete and competitive

The following features were taken into account in the characteristics of pig holdings which are able to compete and competitive: economic size of holdings, utilised agricultural area, the value of assets per annual work unit (AWU), the share of capital in liabilities, pig population in the holding (LU), stocking of animals in LU/100 ha of UAA, production intensity level (total costs/ha of UAA) and feed costs in thousand EUR/LU. The values of these indicators are given in Table 19.

In line with the competitiveness index discussed earlier, holdings in which the value of this index is ranging =<1<2 are considered to be able to compete. The holdings able to compete also include medium large Spanish holdings, in which the value of this index was 0.98, close to "1". In addition to these holdings, Polish and Spanish large and very large holdings, and very large German holdings showed their ability to compete. The economic size of this group of holdings varied: Spanish holdings were the smallest (72.68 thou. EUR SO), and German holdings the largest (858.23 thou. EUR SO). The SO value in Polish large holdings in the class of 100-500 thou. was EUR 191 thou. SO and was 34% smaller than in Spanish holdings and 78% smaller than in German holdings. The area of utilised agricultural land was also strongly diversified. In this group, very large German holdings had the largest area, it amounted to 141.29 ha of UAA, and was larger than Polish and Spanish large holdings 206% and 302%, respectively. They were about 8 times larger than medium large

Spanish holdings. The degree of differentiation in the value of assets was smaller. In German holdings, this value was about 474 thou. EUR/AWU and was larger than in Polish and Spanish holdings 91% and 65%, respectively. It was 4 times larger than in medium large Spanish holdings.

Table 19. Features of pig holdings with the ability to compete and competitive in 2014-2016

Economic size (thou. EUR SO)	Poland	Spain	Germany
Competitiveness Index			
(4) 50-100	-	0.98	-
(5) 100-500	1.16	1.45	-
(6) ≥500	2.26	3.66	1.07
Economic size (thou. EUR SO)			
(4) 50-100	-	72.68	-
(5) 100-500	191.15	289.37	-
(6) ≥500	921.25	1050.08	858.23
Utilised agricultural area (ha)			
(4) 50-100	-	18.15	-
(5) 100-500	46.17	35.71	-
(6) ≥500	215.95	44.15	141.29
Value of assets (thou. EUR/AWU)			
(4) 50-100	-	118.36	-
(5) 100-500	247.60	287.92	-
(6) ≥500	250.31	318.76	473.58
The share of capital in liabilities (%)			
(4) 50-100	-	98.50	-
(5) 100-500	90.30	93.50	-
(6) ≥500	79.70	87.75	63.62
Pig population (LU/holding)			
(4) 50-100	-	68.74	-
(5) 100-500	172.40	292.20	-
(6) ≥500	838.57	1047.56	593.19
Stocking of animals (LU/100 ha of UAA)			
(4) 50-100	-	390.90	-
(5) 100-500	378.20	830.60	-
(6) ≥500	388.57	2380.70	423.70
Total costs (thou. EUR/ha of UAA)			
(4) 50-100	-	3.45	-
(5) 100-500	3.18	3.71	-
(6) ≥500	3.76	10.98	5.81
Cost of feed (thou. EUR/LU)			
(4) 50-100	-	0.43	-
(5) 100-500	0.66	0.32	-
(6) ≥500	0.64	0.30	0.62

Source: Own study based on data of the European FADN.

In terms of the share of capital in liabilities, German holdings stood out as they used foreign capital to greater extent. Its share was about 36%. However, in other Polish and Spanish holdings it did not exceed 10%.

The pig population was highly diverse. In German holdings it was 593 LUs/holding and was 3.4 times larger than in Polish holdings, and 2 and 8.6 times, respectively, larger than in Spanish holdings. Such a large difference between German and other holdings indicates low unit profitability of pig livestock production in German holdings. The differences in stocking of animals, which was dominated by pigs (99%), were not as large as in their population. It was the largest in large Spanish holdings, where it amounted to 830.6 LUs/100 ha of UAA, and was about twice as large as in other holdings. Such a high stocking of animals, exceeding two times (Poland) and 4.9 times (Spain) the recommended stocking, namely 170 LUs/100 ha of UAA, indicates that pig farming is loosely related to land. Animal faeces from such holdings exceed the possibilities of agricultural management in given holdings. They must be managed in other holdings or used in other ways, e.g. for energy production in biogas installations.

The examined holdings with the ability to compete differed also in the intensity of production. It was the highest in German holdings, where the total cost per 1 ha of UAA amounted to 5.81 thousand EUR/ha of UAA and was about 1.5 times higher than in other holdings. Spanish holdings were distinguished by low feed costs, which in large holdings amounted to 0.32 EUR/LU, and were two times lower than in Polish and German holdings. These was mainly fodder from purchase (>75%).

Very large Polish and Spanish holdings were fully competitive with the competitiveness index equal to 2.26 and 3.66, respectively. Their economic size was similar, about EUR 1000 thousand of SO. They definitely differed in area, which in Polish holdings was about 216 ha and was 5 times larger than in Spanish holdings. This indicates a loose relationship between pig farming and the land in Spanish holdings. The value of assets in Spanish holdings was approximately 319 thousand EUR/AWU and was 27% higher than in Polish holdings. The analysed holdings used foreign capital to a small extent. Its share was about 15%. The pig population was similar. In Polish holdings it was 836.6 LUs, i.e. 20% lower than in Spanish holdings. There were significant differences in the stocking of animals. In Spanish holdings it amounted to 2381 LUs/100 ha of UAA and was over 6 times larger than in Polish holdings. Such a high stocking of animals in the Spanish holdings, which exceeded the recommended

level 14 times, indicates "industrial" farming of pigs. The level of production intensity in Spanish holdings was very high. It amounted to 10.98 thousand EUR/ha of UAA and was about 3 times higher than in Polish holdings.

Spanish holdings were distinguished by low feed cost, amounting to 0.3 thousand EUR/LU, which was 53% lower than in Polish holdings.

The analysis shows that the basic factor determining the competitiveness of pig holdings is the scale of production.

Barriers to and directions of development of pig farming in Poland

According to A. Dargiewicz [Dargiewicz 2018], the most important ones include:

- administrative barriers hindering access to land for entrepreneurs conducting larger-scale pig farming; they also apply to lessees,
- lengthy administrative procedures related to obtaining permits for investment in livestock buildings for pigs, which are to a large extent the result of the lack of spatial development plans in the majority of communes and protests of the residents,
- the threat of infectious diseases and the resulting need for special safeguards related to biosecurity, which entails additional costs. Small-scale holdings are not able to meet these requirements,
- a ban on the use of feed including raw materials originating from GMOs, mainly soya. The introduction of non-GMO substitutes will increase production costs, even up to 10%. Introduced moratoria on import of soya do not eliminate the uncertainty of producers,
- increasing requirements of animal welfare also lead to increased production costs,
- environmental barriers are related to the condition of management of 70% of effluent from pig farming (organic fertilisers) on land used (own and leased), the application of the Nitrates Directive according to which the maximum stocking of animals cannot exceed 1.7 livestock units per 1 ha of utilised agricultural area. The introduction of animal stocking restrictions is justified. However, the ban on the sales of organic fertilisers among farmers raises doubts. The introduction of a longer (6 months) storage of slurry forces investments in reservoirs, which leads to higher costs,
- organisational barriers result from the very low level of concentration of pig farming. In 2016, the share of holdings keeping 200 heads and more was only 4.5%. Low concentration of pig livestock production is the cause of

producers' very low bargaining position in relation to purchasing enterprises (commercial and meat processing). The degree of integration, both horizontal and vertical, is also very low.

The analyses carried out so far clearly indicate that in the current economic and environmental conditions, the holdings which conduct pig farming in a professional manner, which is inextricably linked with a larger scale of production, have development opportunities. A condition for development of such holdings is the elimination of existing barriers. The economic slaughter of pigs proposed by the Minister of Agriculture and Rural Development and small processing by farmers in holdings will not contribute to the reconstruction of the pig population to the level of the existing production potential, which is about twice as large as the current state. This market will have a character of a niche. The basis for development can be professionally run holdings with an appropriate production scale. Another condition is deeper specialisation of holdings, consisting in the separate production of piglets (up to a weight of about 25 kg) and fattening up to slaughter weight. The division of the pig livestock production process into these two phases will help to meet the environmental requirements. Fattening houses should be located in areas with lower population density. In order to limit the negative impact of pig farming on the environment, it is advisable to combine this production with biogas installations. Thanks to this solution, the unpleasant odours are reduced, and energy is obtained without losing the fertiliser value of animal manure.

An important factor in development of pig livestock production is the integration, both horizontal and vertical. A good example using integration is the pig livestock production system in Spain which has become the largest producer of this livestock in the European Union in a dozen or so years. In this country, feed companies which not only deliver feed but also provide veterinary and sales care acted as an integrator. These are systemic solutions. Such solutions can also be found in Poland in the form of an outwork system. An example is the feed company "Agrifirm Polska" which, being a feed producer, created a system of related companies supplying farmers with piglets and weaners for fattening, in fodder and sales. The farmer uses own livestock buildings and own labour. The price is also guaranteed. This system is beneficial for farmers with livestock buildings. They do not have to involve their own funds to purchase an "input" for fattening and feed. This system has been gaining recognition among farmers. However, it has also found critics among politicians who argue that it is unfavourable for farmers. A question should be asked here: what in return, what

other solution? There is no answer to these questions. Of course, the ideal solution would be the creation of such a system by farmers who would be owners of feed and meat companies. Such a system is functioning, e.g., in Denmark and the Netherlands. In these countries, a system in which farmers are members of cooperatives supplying them with means of production, operating purchasing centres and agricultural processing (dairies and meat establishments) dominates. It is virtually impossible to create such a pig livestock production system in Poland under current conditions. Former state-owned Meat Establishments were privatised. Feed mills also function as private companies. Purchasing and Marketing Cooperatives (Communal Cooperatives) have mostly collapsed or changed their character. Certain solution which does not require large capital expenditures could be the horizontal integration of pig livestock producers by creating producer groups (in the form of cooperatives or limited liability companies). Thanks to this, their bargaining power would increase in relation to suppliers of means of production, mainly feed and meat establishments.

Summary and Conclusions

Conducted research supports formulation of the following statements and conclusions:

– a dramatic drop in the pig population in Poland, which occurred after 2007, was 40% (2016), took place in holdings with a smaller scale of farming which kept herds up to 200 heads;

– despite the decline in the pig population, the value of marketable production of pig livestock in 2000-2016 increased 28.1%, with a simultaneous decrease in its share in marketable animal production by 15 pp, from 37.6% in 2000 to 22.6% in 2016;

– after 2007, there was a negative balance of foreign trade in pig livestock, mainly due to the import of live animals (piglets and weaners). In 2017, net import of this group of animals amounted to 6738.8 thousand heads. 2007 was the last year in which the balance was positive and amounted to 32.3 thousand heads;

– the level of concentration of pig farming in holdings in Poland is very low compared to the leading producers of pig livestock, such as Denmark, the Netherlands and Germany. In 2013, on average 41 pigs were kept on Polish holdings, while in the above-mentioned countries it was 3096, 2285 and 584 heads, respectively. In 2016, the average size of a pig herd in Poland was 69.1 heads;

– regional differences in the state of the pig population increased. In 1990, five leading provinces had 54% of the pig population, and in 2016 – 75.6%. The leading province in pig farming was the Wielkopolskie Province, which had 35.3% of the pig population in 2016. The level of the pig population is drastically low in the provinces of southern Poland: Małopolskie, Podkarpackie and Świętokrzyskie;
– there was also a considerable difference in the stocking of pigs per 100 ha of UAA. In 2016, the average stocking in Poland was 75 heads/100 ha of UAA, while in the Netherlands and Denmark 679 and 474 heads, respectively. That year in Poland, the highest stocking was recorded in the Wielkopolskie Province, in which it was 227 heads, while in some districts of this province – Środa Śląska and Gostyń – 547 and 445 heads/100 ha of UAA, respectively. These numbers indicate a huge development potential in the field of pig farming in Poland;
– holdings with up to 25 sows are deprived of development opportunities in Poland. Holdings keeping about 40 sows had such opportunities. Holdings with 70 sows or more can be considered fully competitive;
– conducted research confirmed the accepted research hypothesis assuming that "the main factor determining the efficiency of pig livestock production is the scale of its production",
– the hypothesis assuming that highly specialised pig holdings achieve better economic results than specialised holdings has not been positively verified;
– Polish small and medium small holdings keeping pig herds of 14.3 and 31 LUs/holding did not have developmental abilities. Their competitiveness index was 0.14 and 0.40, respectively;
– also Polish, Spanish and German medium large holdings keeping 62.1, 68.7 and 55.0 LUs did not have developmental abilities. Their competitiveness index amounted to 0.65, 0.98 and 0.07, respectively. Spanish holdings had the best chance of getting developmental abilities in this class;
– among large holdings, only Polish and Spanish holdings, keeping 172.4 and 292.2 LUs, respectively, demonstrate the ability to develop and compete; their competitiveness indices amounted to 1.16 and 1.45. The remaining holdings: Danish, Dutch and German, did not show the ability to develop. Their competitiveness index was 0.16, 0.16 and 0.66, respectively. The pig population in these holdings was 237.4, 270.7 and 219.9 LUs, respectively. It can be described as high;

– from among very large holdings, Polish and Spanish holdings were fully competitive with their competitiveness index of 2.26 and 3.66, respectively, and in which the pig population was 838.6 and 1047.6 LUs, respectively. Out of the remaining holdings, the ability to compete was demonstrated by German holdings in which the competitiveness index was 1.07 and the pig population was 593.2 LUs. Danish and Dutch holdings did not show the ability to develop. Their competitiveness index was 0.16 and 0.90, respectively. The pig population in these holdings was high, as it amounted to 1107.2 and 1071.8 LUs, respectively;
– the basic condition for the reconstruction of the pig population in Poland is effective removal of existing barriers hindering investment in livestock buildings adapted to a larger scale of production which enables professional production of pig livestock.

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GROSS MARGIN OF SELECTED AGRICULTURAL PRODUCTS IN 2017 – REGIONAL PERSPECTIVE

Introduction

Poland is characterised by a large diversification of natural conditions and their suitability for the agricultural production. This suitability is determined mainly by topographic and climate conditions and associated hydrographic conditions, however, showing the considerable variability over time. In Poland, climate conditions for conducting the agricultural production are quite good. However, their more accurate analysis shows that – like in other countries European Union – there is a high variability in the duration of the vegetation season, which determines the yielding of plants and thus their species selection [Musiał 2014].

The study results show that the regional diversification of the agricultural production in Poland has increased in recent years. Some regions, considered to be extensive in the past, are now distinguished by their ability and capacity to adapt to the European Union requirements. An example can be the Podlaskie Voivodeship, which in Poland occupies a very favourable place in terms of the milk production. The regional differentiation applies to most branches and types of the agricultural production. However, the strength of impact of various groups of conditions is not uniform [Krasowicz, Kopiński 2006].

The introduction of the market economy and the consequent transformation processes resulted in changes in the regional diversification of agriculture in Poland [Poczta, Mrówczyńska 2002]. The existing traditional divisions into agricultural regions have largely outdated. Also, the share of some groups of crops in the sowing structure has changed [Kuś, Jończyk, Kamińska 2001]. Therefore, the intensity of organisation and the intensity of production have changed. In the western and northern regions, the livestock production has been significantly restricted. On the other hand, there was a large concentration of cultivation of technologically similar plants, harvested by means of a harvester (cereals, oilseeds). The diversification of the intensity of farming has also changed, and its simplified indicator is the consumption of mineral fertilisers in kilograms of NPK per 1 ha utilised agricultural area [Fotyma, Krasowicz 2001].

Against a background of the European Union countries, Poland has the considerable production potential of agriculture (its level is determined by the resources of production factors, i.e. land, labour and capital). However, the existing analyses show that the use of this potential is differentiated by regions [Klepacki 2002].

Objective of the studies, data sources and methodology

The objective of the study is to identify the most important factors determining the regional diversification of direct profitability of agricultural products which in 2017 were covered by studies in the Agricultural Products Data Collection System AGROKOSZTY. The amount and structure of direct costs has also been assessed. These costs depend mainly on the farmer and they also determine the production intensity.

The subject of the studies in the case of conventional farms were the results of production of sweet lupin, field beans, fodder pea and soybean, and also of cow's milk and beef cattle and in organic farms – the results for winter wheat and winter rye. Data describing the individual agricultural products was collected in the individual farms located throughout Poland. The farms for the studies were selected in a targeted manner from a representative sample of the farms which was in the field of observation of Polish FADN. The studies were carried out in accordance with the methodology of the AGROKOSZTY system, under which data on the production level and on expenses and direct costs is collected[1].

The results of the studies have been presented in tables and graphically, the horizontal analysis has been used to compare the parameters of the agricultural products analysed in farms from 4 agricultural regions, i.e. Pomorze and Mazury, Wielkopolska and Śląsk, Mazowsze and Podlasie and Małopolska and Pogórze (Map. 1). The identified regions are formed by the voivodeships bordering on each other. The results of the studies have also been presented on average in the study sample of farms. The studies covered income (value of the potentially commercial production) per 1 ha, 1 dairy cow and 100 kg beef cattle, as well as inputs, costs and economic effects. The main indicator of the assessment of the results obtained was gross margin without subsidies. This category is a difference between the production value and direct costs necessary for its manufacture.

[1] The costs of the direct crop production include: cost of seed material, cost of purchased fertilizers, cost of plant protection products and growth regulators, insurance of the relevant activity and specialized costs, i.e. those which are directly related to a particular activity and which increase the quality and value of the final product (e.g. cost of water for irrigation, soil analysis). On the other hand, direct costs of the livestock production include: cost of animals introduced into the herd as part of its replacement, cost of feedstuffs, rents for the use of forage area up to 1 year, treatment and insurance of animals, and specialized costs (e.g. classification of animals, cost of means to preserve and store feedstuffs), their role is analogous to that of the crop production [Skarżyńska 2015].

Map. 1. Division of Poland into agricultural regions

Source: [Skarżyńska, Goraj, Ziętek 2005].

The accounts included primary current assets[2] which in the studies are expressed by the level of direct costs in value terms. It can be assumed that the amount of these costs per area unit (1 ha) and 1 livestock unit (LU) determines the production intensity [Żak 1976]. What was assessed was the diversification in the production intensity of the analysed agricultural products in four Polish agricultural regions.

Gross margin without subsidies allows to assess the economic efficiency of manufacturing agricultural products depending on the yield fluctuations, efficiency of the livestock, changes in product prices and prices of means of production. It also allows to assess properly the competitiveness of

[2] In agriculture, current assets are divided into primary and auxiliary. Primary current assets are a part of newly manufactured products, they are i.e. seeds, fertilizers, young animals for fattening. On the other hand, auxiliary assets are not a part of a new product, but are necessary in the production process, e.g. electrical energy, fuel, lubricants, materials for current renovations and maintenance of fixed assets [*Encyklopedia*… 1984].

production, as it covers the obtained production value and the specific direct costs incurred. Gross margin without subsidies may be increased by subsidies. Based on the data on subsidies received for agricultural products and the direct payment rates in 2017 and the rules for granting them, we calculated the maximum amount of subsidies which farmers could receive assuming that all requirements have been met.

To assess the analysed agricultural products – regardless of the level of gross margin – a set of indices has been applied which determine the economic efficiency of production, i.e.:

1. Share of direct costs in gross margin without subsidies,
2. Direct profitability index – ratio of the total production to direct costs expressed in percentage terms,
3. Direct unit cost – direct costs incurred per production unit (1 dt, 1 litre milk),
4. Production profitability – gross margin without subsidies per production unit (1 dt, 1 litre milk),
5. Labour input profitability – gross margin without subsidies per 1 hour of total labour inputs, i.e. unpaid and paid labour,
6. Share of subsidies in gross margin (counted together with subsidies).

Due to the electronic data processing technique, differences may occur for some calculations for rounding.

Regional differentiation of gross margin from selected agricultural products in 2017

Sweet lupin. Lupin is one of the basic species of fodder legumes cultivated for fodder seeds. In 2017, in the total structure of fodder legumes in the country it accounted for 62.8% and in individual farms – 50.7%. Cultivation area of sweet lupin for fodder seeds was 103.3 and 91.4 thousand ha, respectively. Lupin (like other legumes) is characterised by the large yielding variability, which is determined by the agronomic and habitat factors, and particularly by the weather conditions. In 2017, the agrometeorological conditions were quite favourable, consequently the yield of sweet lupin seeds in individual farms was 16.7 dt/ha and increased by 1.8% when compared to 2016 [*Wyniki...* 2018].

The buying-in price of fodder lupin seeds is characterised by the high variability over years, much higher than in the case of the yield. According to unpublished GUS data, in 2017 the buying-in price of fodder lupin seeds from the individual farms was PLN 74.93/dt and when compared to the average national buying-in price for these seeds of 2016 (PLN 82.95/dt) [*Ceny...* 2017] it fell by 9.7%. On the other hand, the price of lupin seeds in marketplace trade

was much higher than the buying-in price, in 2017 it was PLN 162.68/dt, and in 2016 – PLN 173.91/dt.

Table 1. Production, costs and gross margin obtained in 2017 from cultivation of **sweet lupin** on average in the study sample and in selected farms in the Polish agricultural regions (actual data)

Specification		Average in holdings cultivating sweet lupin	Average in selected holdings in			
			Pomorze and Mazury	Wielkopolska and Śląsk	Mazowsze and Podlasie	Małopolska and Pogórze
Number of surveyed farms		163	63	54	31	15
Area of utilized agricultural area	[ha]	56.55	72.73	54.74	38.15	33.10
Growing area	[ha]	5.67	7.01	4.90	4.90	4.41
Yield of seeds	[dt/ha]	15.6	16.7	13.9	17.1	12.5
Selling price of seeds	[PLN/dt]	83.30	79.81	87.85	89.70	96.64
		Per 1 ha of growing area				
Total value of production	[PLN]	1303	1331	1220	1531	1209
Total direct costs	[PLN]	457	421	506	488	423
from this: sowing materials		192	178	198	220	203
fertilizers		128	103	183	117	96
organic fertilizers		6	11	-	3	-
plant protection products		97	85	104	119	101
growing regulators		16	13	18	19	18
other		18	31	3	11	5
Gross margin without subsidies	[PLN]	847	910	714	1043	786
Subsidies[a]	[PLN]	1450	1445	1464	1419	1496
Gross margin	[PLN]	2296	2355	2178	2462	2282
Total labor input	[hours]	5.8	5.2	5.9	6.5	8.0
in this: own labor input		5.7	5.1	5.7	6.5	8.0
Indicators of economic efficiency						
Share of direct costs in gross margin without subsidies	[%]	53.9	46.3	70.8	46.8	53.8
Indicator of profitability	[%]	285.5	316.1	241.2	313.6	285.8
Direct costs per 1 dt of seeds	[PLN]	29.18	25.24	36.42	28.60	33.81
Gross margin without subsidies per 1 dt of seeds	[PLN]	54.12	54.56	51.43	61.10	62.83
Gross margin without subsidies / 1h of total labour input	[PLN]	145.42	174.56	121.38	159.46	98.22
Share of subsidies in gross margin	[%]	63.1	61.3	67.2	57.6	65.6

[a] Subsidies include: payment to protein crops, single area payment, payment for greening and additional payment.

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

Source: Own study based on the AGROKOSZTY system data.

The figures describing the volume and value of the sweet lupin production, inputs incurred and direct costs were collected in 163 individual farms located throughout the country. The results of the study have been presented on average across the entire analysed sample of farms and in regional terms, i.e. in the groups of farms identified by location in four agricultural regions identified for Poland – Table 1.

In 2017, on average in the analysed farms, the lupin seed yield was 15.6 dt/ha and was lower by 6.6% than the yield obtained on average in the individual farms in the country (16.7 dt/ha). In contrast, the selling price of seeds was PLN 83.30/dt and when compared to the buying-in price from the individual farms (according to unpublished GUS data – PLN 74.93/dt) it was higher by 11.2%.

In the study sample, the highest yield of sweet lupin seeds was found in farms in the Mazowsze and Podlasie region (17.1 dt/ha), it was by 2.4% higher than on average in individual farms in Poland. The lowest yield of lupin was obtained by farmers from Małopolska and Pogórze (12.5 dt/ha), however, they received the most favourable price of seeds (PLN 96.64/dt). On the other hand, producers from Pomorze and Mazury were selling lupin at the lowest price (PLN 79.81/dt).

It is estimated that the highest yield of lupin recorded in the farms from Mazowsze and Podlasie (17.1 dt/ha) was highly determined by the agrometeorological conditions quite favourable for cultivating this crop. On the other hand, the poorest yielding of lupin on the farms from Małopolska and Pogórze (12.5 dt/ha) was determined by the locally occurring adverse atmospheric phenomena observed almost throughout the vegetation season.

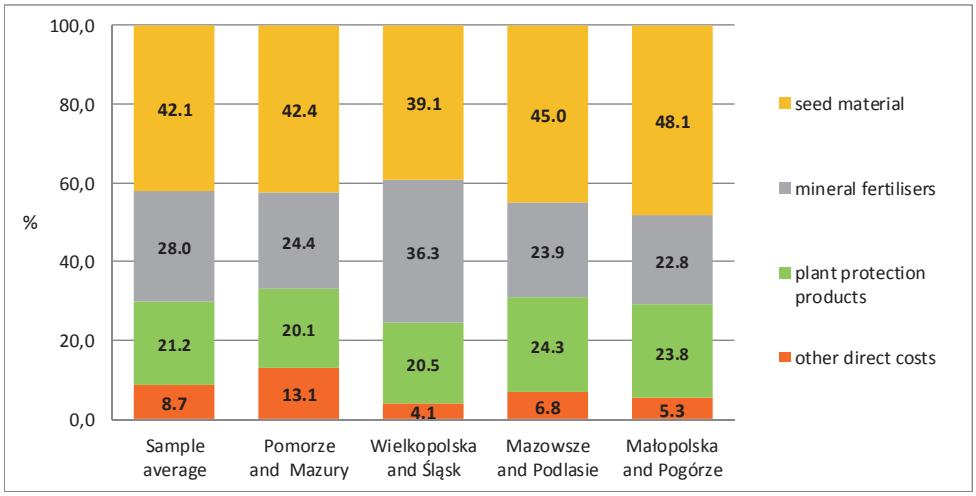
In 2017, on average in the study sample, revenues (production value) from cultivation of 1 ha lupin were PLN 1,303. The highest revenues were obtained by the farms from the region of Mazowsze and Podlasie (PLN 1,531/ha), this was determined by the most favourable seed yield (17.1 dt/ha) and the fairly high selling price (PLN 89.70/dt). On the other hand, the lowest revenues were recorded in the region of Małopolska and Pogórze (PLN 1,209/ha), this was determined by the lowest – when compared to other regions – yield of lupin seeds (12.5 dt/ha).

Direct costs of cultivating sweet lupin on average in the analysed population of farms were PLN 457/ha, and in the groups of farms, idenitified by their regional location, the highest costs (PLN 506/ha) were recorded in the farms from Wielkopolska and Śląsk, while the lowest (PLN 421/ha) – in Pomorze and Mazury. When comparing the extreme values of revenues and direct costs in the regions, it was found that the difference in revenues obtained

from the 1 ha of lupin was PLN 322, and in direct costs incurred – PLN 85. This means that the regional location of the farms differentiated revenues 3.8 times more than direct costs incurred.

In the structure of direct costs, on average in the study sample, the largest share was that of the cost of seed material (42.2%) and then the cost of mineral fertilisers (28.0%) and of plant protection products (21.2%). In the agricultural regions – in terms of the share in the structure of direct costs – the order of the individual cost components was similar, although some differences occurred. For example, in case of the farms from Mazowsze and Podlasie as well as Małopolska and Pogórze, the cost of plant protection products had the greater share than the cost of mineral fertilisers – Fig. 1.

Fig. 1. Structure of direct costs of **sweet lupin** cultivation in 2017 on average in the study sample and in selected farms in the agricultural regions (per 1 ha crop)



Source: study based on own analyses.

The results show that the cost of mineral fertilisers depended mainly on the applied NPK dose. On average, in the study sample 45 kg NPK were applied on 1 ha of sweet lupin. In the agricultural regions, the NPK consumption ranged from 32 kg/ha in the case of farms from Małopolska and Pogórze to 65 kg/ha in the region of Wielkopolska and Śląsk.

Gross margin is a resultant of revenues and direct costs incurred. In 2017, gross margin without subsidies obtained from cultivation of sweet lupin was not high, on average in the study sample it was PLN 847/ha. In the agricultural regions, the amount of gross margin without subsidies was determined by a specific combination of the yield, price and direct costs. However, the impact of revenues, as a resultant of production and price results, has always been

stronger than that of the costs incurred. Consequently, the highest gross margin without subsidies was obtained by producers in the region of Mazowsze and Podlasie (PLN 1,043/ha) and the lowest in the region of Wielkopolska and Śląsk (PLN 714/ha).

Support through subsidies for income from the production is a reason for which economic gross margin being at the disposal of farmers is higher. On average, in the study sample the amount of subsidies for cultivation of 1 ha sweet lupin was PLN 1,450 and in the agricultural regions from PLN 1,419 to 1,496 (the account included payment to protein plants, single area payment, payment for greening and additional payment). As a result, gross margin after adding subsidies on average in the sample was PLN 2,296/ha, and in the groups of farms from the agricultural regions it ranged from PLN 2,178 to 2,462/ha. Presenting the role of subsidies in another way, this means that to PLN 1 of gross margin without subsidies producers of lupin, on average in the sample, received PLN 1.71 of subsidies, and in the regions from PLN 1.36 to 2.05. These results show that in all groups of farms the level of subsidies to lupin cultivation significantly exceeded gross margin from the production, i.e. without subsidies. The share of subsidies in gross margin with subsidies ranged from 57.6% in the region Mazowsze and Podlasie to 67.2% in the case of farms from Wielkopolska and Śląsk.

The direct profitability index (the percentage ratio of the production value to direct costs) has been used to assess the economic efficiency of sweet lupin cultivation. On average, in the sample this index was 285.5% and in the agricultural regions from 241.2% in the case of farms from Wielkopolska and Śląsk to 316.1% in Pomorze and Mazury.

The indicative analysis shows that the most favourable effects were achieved on the farms in the region of Pomorze and Mazury. This is evidenced by the lowest – against a backdrop of other regions – direct costs per 1 dt seeds (PLN 25.24), the highest profitability of labour inputs (PLN 174.56/hour) and the relatively high cost competitiveness – the share of costs in gross margin was lowest and amounted to 46.3%. On the other hand, the profitability of the lupin seed production in these farms was at the average level of PLN 54.56/dt. In the sample of the farms from Wielkopolska and Śląsk, the economic efficiency of the sweet lupin seeds production was lowest. In this region, direct costs per 1 dt of seeds were highest (PLN 36.42/dt) and accounted for as much as 70.8% in gross margin generated. Consequently, the production profitability was lowest (PLN 51.43/dt) – Table 1.

In conclusion, it should be stated that in 2017 on average in the study sample and in the groups of farms from the identified agricultural regions,

sweet lupin cultivation – at the level of gross margin without subsidies – was profitable. On average, in the sample gross margin without subsidies was PLN 847/ha, and in the regions – from PLN 714/ha in Wielkopolska and Śląsk to PLN 1,043/ha in Mazowsze and Podlasie. The regional diversification of gross margin was due to differences in the level of revenues and direct costs incurred. After adding subsidies, gross margin from 1 ha sweet lupin was, on average in the sample, PLN 2,296 and in the regions it ranged from PLN 2,178 to 2,462. On average, in the study sample, the share of subsidies in gross margin was 63.1%, and in the farms from the agricultural regions it ranged from 57.6 to 67.2%. The impact of subsidies on the amount of gross margin was different in the groups of farms. The largest was found in the farms where the gross margin without subsidies was lowest, i.e. in the region of Wielkopolska and Śląsk and the smallest – in the farms where the gross margin without subsidies was highest, i.e. in the region of Mazowsze and Podlasie. This is evidenced by the amount of subsidies per PLN 1 of gross margin without subsidies – PLN 2.05 and 1.36 respectively in the regions.

Fodder pea (field pea). According to the Central Statistical Office (GUS) [*Wyniki...* 2017; *Wyniki...* 2018] studies, the share of fodder pea cultivated for fodder seeds in the sowing structure of fodder legumes is lower in Poland than that of sweet lupin and field beans. In 2017, the total share in the country was 11.5% and 9.1% in the individual farms. Fodder pea was cultivated on 18.9 thousand ha, including 86.9% of the area was in the individual farms. The total yield of fodder pea seeds in the country was 23.2 dt/ha and in the individual farms – 22.3 dt/ha, while the year before it was respectively 21.4 and 21.0 dt/ha, thus increased by 8.4 and 6.2%, respectively, when compared to 2016. On the other hand, the average national buying-in price of fodder pea seeds from the individual farms – according to unpublished GUS data – was PLN 75.15/dt and was similar to the average national buying-in price of these seeds in 2016 (PLN 75.28 zł/dt [*Ceny...* 2017]).

In 2017, as part of the studies conducted in the AGROKOSZTY system, the data describing the production volume and value and direct costs incurred for cultivation of fodder peas was collected. This data was collected in 84 individual farms. The results are presented on average in the study sample and in the groups of farms located in the identified agricultural regions, table 2.

On average, in the sample the yield of fodder pea was 28.0 dt/ha and was by 25.6% higher than on average in individual farms in Poland (22.3 dt/ha). The selling price of seeds was PLN 88.65/dt and was by 18.0% higher than the average buying-in price of fodder peas (PLN 75.15/dt) from individual farms in the country.

Table 2. Production, costs and gross margin obtained in 2017 from **fodder pea** cultivation on average in the study sample and in selected farms in the Polish agricultural regions (actual data)

Specification		Average in holdings cultivating fodder pea	Average in selected holdings in			
			Pomorze and Mazury	Wielkopolska and Śląsk	Mazowsze and Podlasie	Małopolska and Pogórze
Number of surveyed farms		84	18	27	17	22
Area of utilized agricultural area	[ha]	59.70	81.79	65.71	39.70	49.69
Growing area	[ha]	3.28	4.02	3.62	2.94	2.54
Yield of fodder pea	[dt/ha]	28.0	26.2	28.3	27.2	30.5
Selling price of fodder pea	[PLN/dt]	88.65	72.26	112.31	83.64	79.89
		Per 1 ha of growing area				
Total value of production	[PLN]	2481	1891	3177	2277	2438
Total direct costs	[PLN]	808	665	893	745	900
from this: sowing materials		325	322	337	291	340
fertilizers		286	208	311	301	330
plant protection products		185	129	221	153	225
growing regulators		5	2	12	-	-
other		6	4	12	-	5
Gross margin without subsidies	[PLN]	1673	1226	2283	1532	1539
Subsidies[a]	[PLN]	1465	1447	1449	1492	1493
Gross margin	[PLN]	3138	2673	3732	3023	3031
Total labor input	[hours]	7.1	6.4	7.1	6.8	8.1
in this: own labor input		6.9	6.4	6.8	6.8	8.0
Indicators of economic efficiency						
Share of direct costs in gross margin without subsidies	[%]	48.3	54.2	39.1	48.7	58.5
Indicator of profitability	[%]	307.1	284.4	355.6	305.5	271.0
Direct costs per 1 dt of seeds	[PLN]	28.87	25.41	31.59	27.38	29.48
Gross margin without subsidies per 1 dt of seeds	[PLN]	59.78	46.86	80.72	56.26	50.41
Gross margin without subsidies / 1h of total labour input	[PLN]	236.72	190.59	323.69	223.75	189.58
Share of subsidies in gross margin	[%]	46.7	54.1	38.8	49.3	49.2

[a] Subsidies include: payment to protein crops, single area payment, payment for greening and additional payment.
[-] – means that the given phenomenon has not occurred.
Source: Own study based on the AGROKOSZTY system data.

When examining the results in regional terms, it was found that the lowest yield of pea seeds (26.2 dt/ha) and their lowest selling price (72.26/dt) were obtained by the farms from Pomorze and Mazury. On the other hand, the largest yield (30.5 dt/ha) – from Małopolska and Pogórze, and the price (PLN

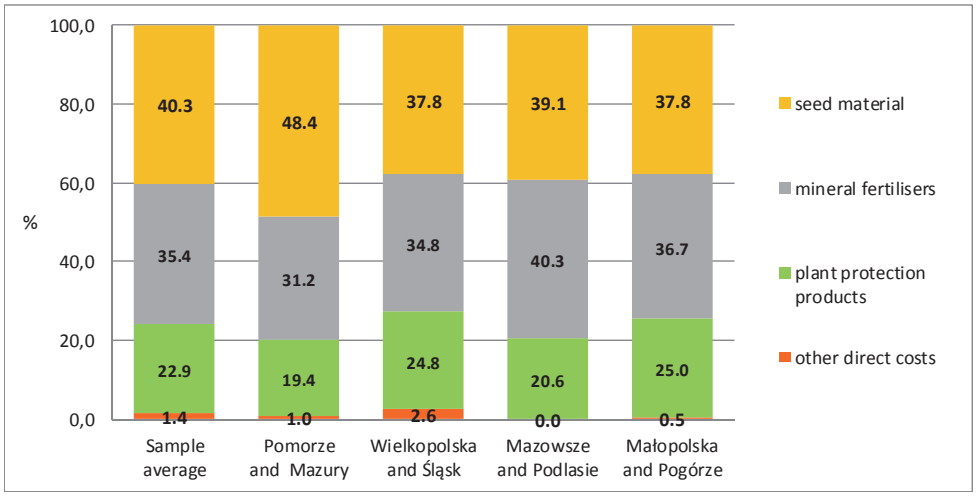
112.31/dt) – from Wielkopolska and Śląsk. The regional disparities between the highest and lowest yields were 16.4% and between the highest and lowest price – 55.4,%, thus the price of seeds had a greater impact on the regional diversification of income.

Based on previous studies in the AGROKOSZTY system [*Agricultural*... 2016; *Agricultural*... 2017], it was found that in 2017 the yield of fodder pea in the identified regions was generally higher than in the two previous years. It is, therefore, necessary to consider that in the analysed year the agrometeorological conditions promoted cultivation of this crop and the locally occurring adverse weather phenomena were not much significant.

The production value of fodder pea cultivation was determined by the seed yield and its selling price. On average, in the sample the production value from cultivation of 1 ha of pea was PLN 2,481 and in the agricultural regions – from PLN 1,891 in Pomorze and Mazury to PLN 3,177 in Wielkopolska and Śląsk. In the region of Pomorze and Mazury its level, in addition to the lowest seed selling price, was also determined by the lowest yield, while in the region of Wielkopolska and Śląsk the highest level of revenues was determined primarily by the highest price of seeds, and to a significantly smaller extent, by the yield.

Direct costs of fodder pea cultivation on average in the sample amounted to PLN 808/ha and in the agricultural regions they ranged from PLN 665/ha in the farms of Pomorze and Mazury to PLN 900/ha in Małopolska and Pogórze.

Fig. 2. Structure of direct costs of **fodder pea** cultivation in 2017 on average in the study sample and in selected farms in the agricultural regions (per 1 ha crop)



Source: study based on own studies.

In analysing the structure of direct costs of pea cultivation, it was noted that on average, in the study sample the largest share was that of the cost of seed material (40.3%) and then the cost of mineral fertilisers (35.4%) and of plant protection products (22.9%). In the agricultural regions, the share of the individual direct cost components was similar – Fig. 2.

In 2017, the economic results of fodder pea cultivation were quite favourable, as evidenced by the amount of gross margin without subsidies. On average in the study sample the gross margin was PLN 1,673/ha and in the agricultural regions from PLN 1,226/ha – in Pomorze and Mazury to PLN 2,283/ha – in Wielkopolska and Śląsk. Its level was determined mainly by revenues and, to a much lower extent, by direct costs.

In 2017, it was possible to receive financial support to fodder pea cultivation, in a form of subsidies. They consisted of payment to protein plants, single area payment, payment for greening and an additional payment. On average, in the study sample, subsidies to fodder pea cultivation were PLN 1,465/ha. However, in the agricultural regions they ranged from PLN 1,447/ha in Pomorze and Mazury to PLN 1,493/ha in the farms from Małopolska and Pogórze. On average, in the sample the share of subsidies in the direct (counted together with subsidies) was 46.7%. In the case of the regions, the lowest share was in Wielkopolska and Śląsk (38.8%) and the highest in the farms from Pomorze and Mazury (54.1%). It should be noted that in Pomorze and Mazury subsidies exceeded gross margin obtained from production by 18.0%, which means that producers of pea received support of PLN 1.18 to 1 PLN of gross margin without subsidies. For comparison, in the region of Wielkopolska and Śląsk this support was PLN 0.63.

In 2017, the fodder pea cultivation was economically effective, as illustrated by the direct profitability index. On average, in the sample this index was 307.1%, while in the agricultural regions its highest level (355.6%) was found in Wielkopolska and Śląsk and lowest (271.0%) in the farms from Małopolska and Pogórze.

In the farms from Wielkopolska and Śląsk, the results of most economic efficiency indices were most favourable. The highest was gross margin without subsidies per 1 dt of fodder pea seeds (PLN 80.72) and per 1 hour of total labour inputs (PLN 323.69). The share of costs in gross margin without subsidies was also lowest (39.1%), which attests to the high cost competitiveness of pea cultivation in this region. On the other hand, in the farms from Małopolska and Pogórze – against a backdrop of other regions – fodder pea cultivation was not cost-competitive, the share of costs in generated gross margin without subsidies was highest and amounted to 58.5%. In this region, also the production

profitability, i.e. gross margin without subsidies per 1 dt seeds was quite low (PLN 50.41). The results show that the lowest pea seed production profitability was recorded in the farms from Pomorze and Mazury, gross margin without subsidies was PLN 46.86/dt.

Summing up, it must be noted that in 2017 fodder pea cultivation at the level of gross margin without subsidies was profitable. On average, in the sample the gross margin was PLN 1,673/ha and in the agricultural regions from PLN 1,226/ha in Pomorze and Mazury to PLN 2,283/ha in Wielkopolska and Śląsk. Its level was mainly determined by revenues, but also, to some extent, by direct costs. After adding subsidies, gross margin from pea cultivation was, on average in the sample, PLN 3,138/ha and in the regions – from PLN 2,673 to PLN 3,732/ha. The share of subsidies in gross margin on average in the study sample was 46.7% and in the regions it ranged from 38.8% in Wielkopolska and Śląsk to 54.1% in the farms from Pomorze and Mazury. The lowest impact of subsidies on gross margin was, therefore, found in the first above-mentioned region and the largest – in the second. The amount of subsidies per PLN 1 of gross margin without subsidies was, respectively, PLN 0.63 and 1.18.

Field beans and **soybean.** In 2017, in the AGROKOSZTY system the data describing the results of field beans and soybean cultivation was collected. It came from, respectively, 24 and 30 individual farms located throughout Poland. As a result, due to the small number of farms involved in the study, the production and economic results from field beans and soybean cultivation were shown only on average in the study sample – Table 3.

According to the Central Statistical Office (GUS) data, in 2017 the share of cultivation area of **field beans** for fodder seeds in the total sowing structure of fodder legumes in Poland was 18.1% and in the individual farms – 14.0%. The area sown with field beans was 29.8 and 25.2 thousand ha, respectively and compared to the sweet lupin area it was more than 3 times smaller. The yield of fodder field beans seeds on average in the country was 26.8 dt/ha and in the individual farms – 25.9 dt/ha while in 2016 in both cases it was at the level of 26.9 dt/ha. As a result, when compared with 2016, it decreased by 0.4 and 3,7%, respectively [*Wyniki...* 2018]. Nevertheless, according to the literature of the subject, it was relatively high [*Szczegółowa...* 2003].

According to unpublished GUS data in 2017 the average Polish buying-in price of field beans seeds from individual farms was PLN 67.54/dt, therefore, when compared to the average national buying-in price of field beans seeds of 2016 (PLN 63.94/ha) it rose by 5.6% [*Ceny...* 2017]. The studies in the AGROKOSZTY system showed that, on average, in the study sample,

the yield of field beans seeds was 29.6 dt/ha and was by 14.3% higher than on average in the individual farms in Poland (25.9 dt/ha). The seed price was PLN 69.40/dt and exceeded by 2.8% the average price obtained in the individual farms (according to the unpublished GUS data – PLN 67.54/dt) – Table 3.

Table 3. Production, costs and gross margin obtained in 2017 from **field beans** and **soybean** cultivation on average in the study sample (actual data)

Specification		Average in selected holdings cultivating	
		Field beans	Soybean
Number of surveyed farms		24	30
Area of utilized agricultural area	[ha]	67.82	66.79
Growing area	[ha]	5.08	6.62
Yield of seeds	[dt/ha]	29.6	20.5
Selling price of seeds	[PLN/dt]	69.40	126.34
		Per 1 ha of growing area	
Total value of production	[PLN]	2057	2585
Total direct costs	[PLN]	750	867
from this: sowing materials		255	357
fertilizers		262	316
plant protection products		232	143
growing regulators		-	12
other		2	39
Gross margin without subsidies	[PLN]	1308	1718
Subsidies[a]	[PLN]	1454	1450
Gross margin	[PLN]	2761	3168
Total labor input	[hours]	7.1	6.5
in this: own labor input		6.8	6.4
Indicators of economic efficiency			
Share of direct costs in gross margin without subsidies	[%]	57.3	50.5
Indicator of profitability	[%]	274.4	298.1
Direct costs per 1 dt of seeds	[PLN]	25.29	42.38
Gross margin without subsidies per 1 dt of seeds	[PLN]	44.11	83.96
Gross margin without subsidies / 1h of total labour input	[PLN]	184.90	266.04
Share of subsidies in gross margin	[%]	52.6	45.8

[a] Subsidies include: payment to protein crops, single area payment, payment for greening and additional payment.

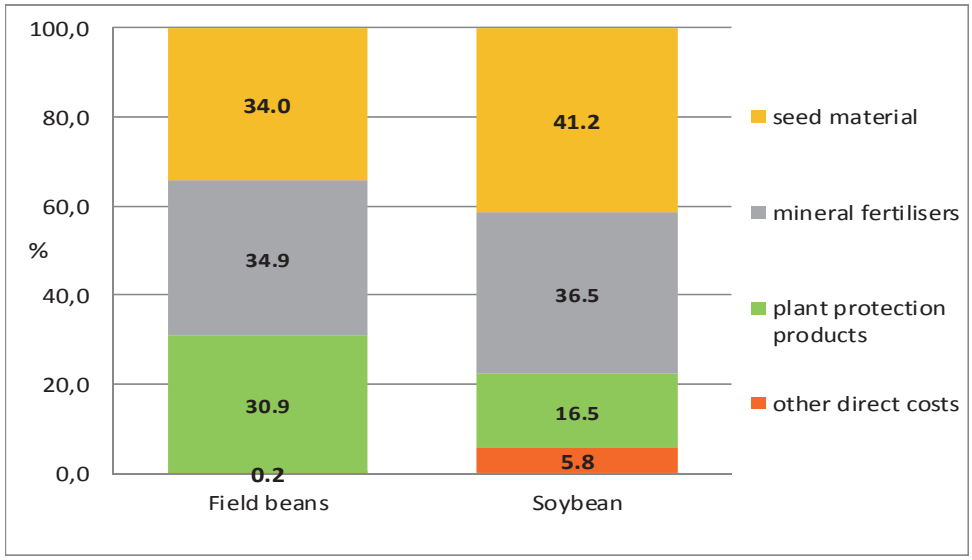
[-] – means that the given phenomenon has not occurred.

Source: Own study based on the AGROKOSZTY system data.

The yield and the selling price of field beans seeds determined revenues, i.e. the value of the potentially commercial production. In the analysed sample of the farms, revenues from cultivation of 1 ha of field beans were PLN 2,057 and had a decisive influence on the amount of gross margin without subsidies. The second factor, which also had some influence on the amount of gross margin, was direct costs amounting to PLN 750/ha.

It is worth noting that in the total structure of direct costs of the field beans cultivation, the share of the cost of seed material, of mineral fertilisers and of the plant protection products was similar to each other and amounted to, respectively, 34.0, 34.9 and 30.9% – Fig. 3.

Fig. 3. Structure of direct costs of **field beans** and **soybean** cultivation in 2017 on average in the study sample (per 1 ha crop)



Source: study based on own studies.

Gross margin without subsidies obtained from 1 ha of field beans was PLN 1,308, and after taking subsidies into account it rose 2.1 times, to the level of PLN 2,761. Therefore, in the case of field beans cultivated for seeds, subsidies (including payment to protein crops, single area payment, payment for greening and additional payment) played a significant role. Total subsidies were PLN 1,454/ha and in gross margin (counted together with subsidies) they accounted for 52.6%. This means that producers of field beans received support of PLN 1.11 to PLN 1 of gross margin without subsidies.

According to the analysis, gross margin without subsidies per 1 dt of field beans seeds and per 1 hour of total labour inputs was PLN 44.11 and PLN

184.90, respectively. The share of direct costs in gross margin without subsidies amounted to 57.3% and direct costs incurred on producing 1 dt field beans seeds were at the level of PLN 25.29.

The indicator of the economic efficiency of the field beans seed production was the direct profitability index, calculated as a percentage ratio of the production value to total direct costs. On average, in the farms cultivating field beans this index was 274.4%. Bearing in mind that cultivation is profitable when the amount of this index exceeds 100%, it should be noted that the above result attests to the relatively high direct profitability of field beans cultivation in 2017.

According to the Central Statistical Office data, in 2017 – when compared to 2016 – cultivation area of **soybean** in Poland increased, in total in the country by 24.2% (it was 9.3 thousand ha) and in the individual farms by 34.1% (it was 7.6 thousand ha). The production results of soybean were also more favourable than the year before. In 2017, the average national yield of soybean seeds was 21.7 dt/ha and in the individual farms 21.2 dt/ha, therefore, when compared to 2016 it increased respectively by 10.7 and 9.8% [*Wyniki*... 2018]. The results of the conducted research indicate the large possibilities of cultivating non-GMO soybean in the western part of Poland [Kania, Zając, Śliwa 2016]. The information on buying-in prices of soybean seeds were not provided due to the lack of data.

As already mentioned, the soybean cultivation studies have been carried out in 30 individual farms. The average seed yield was 20.5 dt/ha and when compared to the average yield in the individual farms across the country (21.2 dt/ha) it was by 3.3% lower. In contrast, the average selling price of soybean seeds was at the level of PLN 126.34/dt and was the main factor determining the level of revenues. The results of the studies showed that revenues derived from cultivation of 1 ha soybean were PLN 2,585 and direct costs incurred – PLN 867. The level of revenues and direct costs determines the amount of gross margin without subsidies. In the case of soybean, as in the case of field beans, the amount of gross margin was determined more by revenues – Table 3.

Considering the structure of direct costs, it was found that the largest share was that of the cost of seed material (41.2%) and, subsequently, of mineral fertilisers (36.5%), of plant protection products (16.5%) and other direct costs (5.8%) – Fig. 3.

On average, in the farms participating in the studies, gross margin without subsidies obtained from cultivation of 1 ha soybean was PLN 1,718, and subsidies for its cultivation – PLN 1,450. As a result, gross margin counted together with subsidies was PLN 3,168, except that subsidies accounted for 45.8% of its level.

Producers of soybean received support of PLN 0.84 to PLN 1 of gross margin without subsidies, which means that subsidies significantly determined the improvement in the economic efficiency of its cultivation.

The calculations show that the soybean cultivation at the level of direct costs was economically efficient, the indicator was the direct profitability index, which amounted to 298.1%. The soybean cultivation results can be considered favourable, although direct costs incurred on the production of 1 dt seeds (PLN 42.38) were higher when compared to other legumes (field beans, lupin, pea). However, the production profitability was also higher, gross margin without subsidies per 1 dt soybean was PLN 83.96. This was determined mainly by revenues, whose level was determined by the relatively high selling price of seeds (PLN 126.34/dt). The share of direct costs in generated gross margin without subsidies was 50.5%, thus soybean cultivation was moderately competitive at the direct cost level (the relatively high cost of seed material has a significant impact) – Table 3.

Summing up the previous considerations, it should be stated that in 2017, at the level of gross margin without subsidies, cultivation of field beans and soybean was profitable. Gross margin without subsidies obtained from 1 ha field beans was PLN 1,308 and from soybean cultivation – PLN 1,718. This means that soybean has provided income, measured by gross margin without subsidies, higher by PLN 410 (i.e. by 31.4%). The comparison of the results of both activities points to a slight advantage of soybean. This is evidenced by the fact that the index of the share of gross margin without subsidies in the production value, i.e. the ratio illustrating the efficiency at the production and technical level, is higher by 2.9%. This index for field beans was 63.6% and for soybean – 66.5%. The economic efficiency of the soybean production was also higher – by 23.7 p.p. The direct profitability index, which was the indicator of this efficiency, for field beans was 274.4% and for soybean – 298.1%. The production of soybean was also characterised by the higher cost competitiveness, the share of direct costs in gross margin without subsidies was 50.5%, whereas in the case of field beans production – 57.3%. Soybean is characterised by the higher cost competitiveness, although direct costs of producing 1 dt soybeans – when compared to field beans – were by 67.6% higher. The factor that had a positive effect on the gross margin without subsidies from soybean cultivation was the price of seeds (PLN 126.34/dt), which exceeded the price of field beans by 82%.

Cow's milk. In Poland, for many farms the milk production is the most important source of income, it is an important branch of the agricultural production. It requires a certain size of the farm, adequate equipment and the large knowledge and involvement of the farmer. The profitability of the milk production is one of the more complex issues in farm economics. The reason are the close relations between rearing dairy cattle and the crop production. This relation, and thus the agrarian size of the farms, largely determine the size of cow herds.

In 2017, as part of the studies conducted in the AGROKOSZTY system, the source data describing the production of cow's milk was collected. The results were presented on average in the study sample of farms and, in order to show the diversification of the effects of the milk production in regional terms, the results were demonstrated for four regions of Poland (i.e. Pomorze and Mazury, Wielkopolska and Śląsk, Mazowsze and Podlasie, Małopolska and Pogórze). The results show that, on average, in the sample, the size of dairy cow herd was 33.0 heads, and in the regions it ranged from 26.3 to 37.8 heads.

The development of the milk production is most often related to the increased milk yield of cows. On average, in the participating farms the milk yield was 6,457 litres and exceeded the average level in the individual farms in the country (5,683 litres[3]) by 13.6%. However, there were differences in the regions, when comparing the extreme values, the difference was 1,967 litres. The highest milk yield of cows was recorded in the farms of Wielkopolska and Śląsk – 7,543 litres, and the lowest in the region of Pomorze and Mazury – 5,576 litres. It should be noted that in Pomorze and Mazury the milk yield was by 1.9% lower than the average level in the individual farms in the country.

The regional location of the farms also differentiates the milk price. On average, in the sample the selling price of milk was PLN 1.38/litre and was by 0.7% lower than the average buying-in price of milk in the country (according to GUS – PLN 1.39/litre [*Skup...* 2018]). The highest price of milk was obtained by producers in the region of Mazowsze and Podlasie – PLN 1.41/litre, it was by 1.4% higher than the average price of milk according to GUS. In the region of Wielkopolska and Śląsk, the price of milk was at the level of the national average (PLN 1.39/litre). On the other hand, in the other two regions it was lower, in the farms from Małopolska and Pogórze it was PLN 1.37/litre, and in Pomorze and Mazury PLN 1.33/litre – Table 4.

[3] Own calculations based on [*Rynek mleka..* 2018].

Table 4. Production, costs and gross margin obtained in 2017 from the **cow's milk** production on average in the study sample and in selected farms in the Polish agricultural regions (actual data)

Specification		On average in holdings with dairy cows	On average in selected holdings in			
			Pomorze and Mazury	Wielkopolska and Śląsk	Mazowsze and Podlasie	Małopolska and Pogórze
Number of surveyed holdings		156	47	35	41	33
Area of utilized agricultural area	[ha]	52.38	59.30	61,00	43.85	43.97
Permanent grassland area	[ha]	17.01	16.72	17.86	14.70	19.37
Fodder area[a]	[%]	0.52	0.56	0.48	0.47	0.57
Average annual number of dairy cows	[ha]	33.0	34.3	37.8	32.9	26.3
Milk yield of cows	[litre]	6457	5576	7543	6799	5907
Sales price of milk	[PLN/litre]	1.38	1.33	1.39	1.41	1.37
Sales price of calves weaned from cows	[PLN/kg]	10.83	9.86	11.51	10.24	12.23
Sales price of cull dairy cows	[PLN/kg]	4.12	4.07	4.14	4.04	4.26
		Per 1 dairy cow				
Total value of production	[PLN]	9883	8325	11 845	10 453	9062
from this: milk		8954	7415	10811	9599	8107
calf weaned from a dairy cow		574	576	603	507	634
cull dairy cow		355	334	432	347	321
Total direct costs	[PLN]	3505	3154	3898	3648	3358
from this: herd replacement		631	542	684	707	619
off-farm fodder		1597	1467	2002	1556	1281
on-farm fodder from commercial products		554	590	497	540	596
on-farm fodder from subsistence products		323	288	281	417	307
other direct costs		400	267	434	428	555
Gross margin without subsidies	[PLN]	6378	5171	7947	6805	5703
Subsidies[b]	[PLN]	636	675	591	590	705
Gross margin	[PLN]	7014	5846	8538	7395	6409
Total labor input	[hours]	77.0	71.9	61.4	75.9	112.0
in this: own labor input		70.6	65.9	54.8	72.3	101.0
Indicators of economic efficiency						
Share of direct costs in gross margin without subsidies	[%]	55.0	61.0	49.1	53.6	58.9
Indicator of profitability	[%]	281.9	263.9	303.9	286.5	269.8
Direct cost per 1 liter of milk	[PLN]	0.54	0.57	0.52	0.54	0.57
Relation of direct cost to price of 1 liter of milk	[%]	39.1	42.9	37.4	38.3	41.6
Gross margin without subsidies per 1 liter of milk	[PLN]	0.99	0.93	1.05	1.00	0.97
Gross margin without subsidies per 1 hour of total labour inputs	[PLN]	82.81	71.92	129.41	89.64	50.91
Share of subsidies in gross margin	[%]	9.1	11.6	6.9	8.0	11.0

[a] Area intended for the production of own non-commercial feed.
[b] Subsidies include: payment to cows (i.e. to animals eligible for support) per 1 dairy cow and single area payment, payment for greening and additional payment per involved forage area.
Source: Own study based on the AGROKOSZTY system data.

The results of the studies show that the order of the regions in terms of gross margin without subsidies per 1 cow is the same as in terms of the production value, the milk yield of cows and direct costs incurred. This means that the breeding quality of cows introduced into the herd and their diet has an impact on the milk yield but also determines the level of costs. The highest direct costs – per 1 cow – were incurred by farmers in the region of Wielkopolska and Śląsk (PLN 3,898) and the lowest by those from Pomorze and Mazury (PLN 3,154), i.e. in the regions where the milk yield of cows was highest (7,543 litres) and lowest (5,576 litres). The results indicate the large role of the milk yield throughout the milk production process. Its higher level stimulated the increase in gross margin, despite the higher costs of keeping the animals.

In this way, the impact of direct costs on the results became evident.

In the structure of direct costs, the largest share was that of feedstuffs, in total they accounted for from 65.1 to 74.4%. The second position was occupied by the cost of animals introduced into the herd as part of its replacement, the share was within the limits of 17.2-19,4%. On the other hand, the remaining direct costs accounted for from 8.5 to 16.5 of direct costs – Fig. 4.

Fig. 4. Structure of direct costs of the **cow's milk** production in 2017 on average in the study sample and in selected farms in the agricultural regions (per 1 dairy cow)

Source: study based on own studies.

When examining the total structure of the costs of feedstuffs, it was found that the share of purchased feedstuffs was highest, ranging from 58.6 to 72.0%, and the cost of own feedstuffs was within the range of 17.9-27.3% and of own non-commercial feedstuffs – from 10.1 to 16.6%. This means that the amount of direct costs was mostly determined by the cost of purchased feedstuffs.

The cost of feedstuffs reflects their consumption in animal nutrition, the results show significant differences in the regions. In the case of concentrate feedstuffs (both own and purchased), the highest consumption per 1 dairy cow was found in the farms from Wielkopolska and Śląsk – 22.08 dt, and the lowest in those from Małopolska and Pogórze – 15.52 dt (in the region of Pomorze and Mazury it was 19.64 dt, in Mazowsze and Podlasie – 20.15 dt, and on average in the sample – 19.71 dt). On the other hand, in the case of non-commercial feedstuffs (both own and purchased) – per 1 cow – the consumption was, on average in the sample, as follows: green forage – 27.80 dt, hay – 6.55 dt, straw – 2.73 dt, silage and haylage – 95.00 dt. In the regions it was as follows: green forage – 15.09-43.54 dt, hay – 4.28-9.02 dt, straw – 1.81-4.83 dt, silage and haylage – 74.01-111.29 dt.

The consequence of the diversification in the milk yield of cows, price of milk and direct costs were the differences in the profitability of milk. In the studies carried out, the profitability was expressed by gross margin without subsidies and the profitability index. On average, in the study sample of farms, the gross margin without subsidies per 1 cow was PLN 6,378. Its amount was varied regionally, it was lowest – PLN 5,171 in the farms from Pomorze and Mazury, and highest – PLN 7,947 in the region of Wielkopolska and Śląsk (in the region of Mazowsze and Podlasie it was PLN 6,805 and Małopolska and Pogórze – PLN 5,703). The amount of gross margin was determined by revenues (i.e. the production value) and their level was more affected by the milk yield of cows than the selling price of milk.

Support in a form of subsidies had no major impact on the improvement in the economic results. This is evidenced by their small share in gross margin value, including subsidies, which, on average in the sample, was 9.1%, and in the regions – from 6.9% in the farms from Wielkopolska and Śląsk to 11.6% in Pomorze and Mazury. This means that on average in the sample to PLN 1 of gross margin without subsidies producers received PLN 0.10, while in regions – from PLN 0.07 to 0.13.

The order of the regions in terms of gross margin without subsidies and the production profitability expressed as a quotient was the same. The direct profitability index (ratio of the production value to direct costs) was most favourable in the farms from Wielkopolska and Śląsk (303.9%) and Mazowsze and Podlasie (286.5%). In the other two regions, i.e. Małopolska and Pogórze (269.8%) and Pomorze and Mazury (263.9%), the economic efficiency of the milk production was weaker.

When analysing the data per 1 litre of milk, it must be stated that direct costs of its production were lowest with the highest milk yield of cows, i.e. in the region of Wielkopolska and Śląsk – PLN 0.52. The second position was occupied by the farms in the region of Mazowsze and Podlasie, where these costs were PLN 0.54/litre. In these regions, gross margin without subsidies per 1 litre milk was also high, in the former it was PLN 1.05 and in the latter – PLN 1.00. In the other two regions, i.e. Pomorze and Mazury and Małopolska and Pogórze the results of the indices were less favourable.

The advantage of milk producers from the region of Wielkopolska and Śląsk as well as Mazowsze and Podlasie is clear. This is also evidenced by the relatively high cost competitiveness – the indicator was the share of direct costs in gross margin without subsidies which was lower than in the other regions (it was 49.1 and 53.6%, respectively, while in the other regions it was 58.9 and 61.0%). The ratio of the unit direct cost to the price of milk was also more favourable (it was 37.4 and 38.3%, respectively, while in the other regions it was 41.6 and 42.9%) – Table 4.

Summing up the results of the studies, it must be stated that the higher milk yield of cows was accompanied by the increased production intensity measured by the level of direct costs of keeping 1 cow. The rise in these costs was determined by cost of feedstuffs and the other factor was the cost of animals introduced into the herd as part of its replacement. The studies show that with the certain level of milk yield, in order to obtain its increase by one unit, higher inputs are necessary. The higher milk yield entailed the increased consumption of concentrate feedstuffs, but also the higher frequency of cow killing. The milk yield of cows is very important, its higher level stimulated the increased production profitability despite the higher cost of keeping animals.

Beef cattle. In Poland, in December 2017 the cattle population aged 1-2 was 1,668.7 thousand heads and when compared to December 2016 it increased by 1.9% [*Pogłowie...* 2018]. The rearing of cattle for slaughter is an alternative to the milk production. This applies particularly to farms with a lot of grassland and poorly used land (sometimes set aside).

Bearing in mind that the rearing of cattle for slaughter for many farms is an important production type, in 2017 the studies on the beef production profitability were carried out. The source data was collected in 84 individual farms located throughout the country and conducting the rearing of cattle for slaughter. It should be noted, however, that the studies were not carried out on farms keeping typically meat cattle. In Poland there is no tradition of rearing meat cattle, therefore the production of beef is mostly linked to the dairy use of cattle.

Table 5. Production, costs and gross margin obtained in 2017 from the **beef cattle** production on average in the study sample and in selected farms in the Polish agricultural regions (actual data)

Specification		On average in beef holdings	On average in selected holdings in			
			Pomorze and Mazury	Wielkopolska and Śląsk	Mazowsze and Podlasie	Małopolska and Pogórze
Number of surveyed holdings		84	27	21	20	16
Area of utilized agricultural area	[ha]	54.50	75.77	54.77	37.97	38.90
Permanent grassland area	[ha]	13.15	18.49	9.59	10.19	12.51
Net livestock production (gain)[a]	[dt/farm]	66.12	68.13	107.06	50.99	31.55
Gross livestock production[b]	[dt/farm]	108.81	107.94	166.99	92.01	61.10
Average weight of fattened animals	[kg/head]	611.4	586.9	623.2	633.6	605
Average annual sales price of livestock	[PLN/kg]	6.58	6.25	6.73	6.60	6.98
		Per 100 kg of gross live weight				
Total value of production	[PLN]	658	625	673	660	698
Total direct costs	[PLN]	447	446	406	454	587
from this: herd replacement		289	261	264	307	430
off-farm fodder		37	52	35	22	30
on-farm fodder from commercial products		90	99	79	91	100
on-farm fodder from subsistence products		23	23	21	26	22
other direct costs		9	11	8	9	5
Gross margin without subsidies	[PLN]	211	180	267	206	111
Subsidies[c]	[PLN]	80	81	88	75	76
Gross margin	[PLN]	291	260	354	281	187
Total labor input	[hours]	12.5	13.3	12.5	11.3	11.8
in this: own labor input		11.7	11.5	12.4	11.1	10.9
Indicators of economic efficiency						
Share of direct costs in gross margin without subsidies	[%]	2.1	2.5	1.5	2.2	5.3
Indicator of profitability	[%]	147.1	140.3	165.7	145.3	118.8
Relation of direct cost to price of 1 kg of beef	[%]	67.9	71.4	60.3	68.8	84.1
Gross margin without subsidies per 1 hour of total labour inputs	[PLN]	16.91	13.45	21.33	18.26	9.34
Subsidies per 1 PLN of gross margin without subsidies	[PLN]	0.38	0.45	0.33	0.36	0.69
Share of subsidies in gross margin	[%]	27.6	31.0	24.7	26.7	40.8

[a] Net production of beef cattle is the annual weight gain obtained in a herd of cattle for slaughter older than 1 year.
[b] Gain + weight of purchased animals.
[c] Subsidies include: payment to cows (i.e. to animals eligible for support) per 1 dairy cow and single area payment, payment for greening and additional payment per involved forage area.
Source: Own study based on the AGROKOSZTY system data.

The economic results of beef are shown on average in the sample of participating farms and in the groups of farms divided by location in four Polish agricultural regions. The objective was to assess the regional diversification of gross margin obtained from the production of beef cattle. Gross margin is the

first income category, which reflects the surplus of the production value (revenues) over direct costs incurred on producing it – Table 5.

In analysing the economic results, the price situation of beef cattle was assessed. According to the Central Statistical Office (GUS) data, in 2017 the buying-in price of beef cattle was PLN 6.35/kg [*Biuletyn...* 2018]. On average, in the analysed farms, the price obtained for beef cattle was PLN 6.58/kg and exceeded the domestic buying-in price of beef cattle by 3.6%. In the regions, its amount was more diversified. The highest prices were obtained by beef producers in the region of Małopolska and Pogórze – PLN 6.98/kg, and the lowest in Pomorze and Mazury – PLN 6.25/kg. This means that in the former the selling price of beef cattle was by 9.9% higher than the average domestic buying-in price, while in the latter – by 1.6% lower.

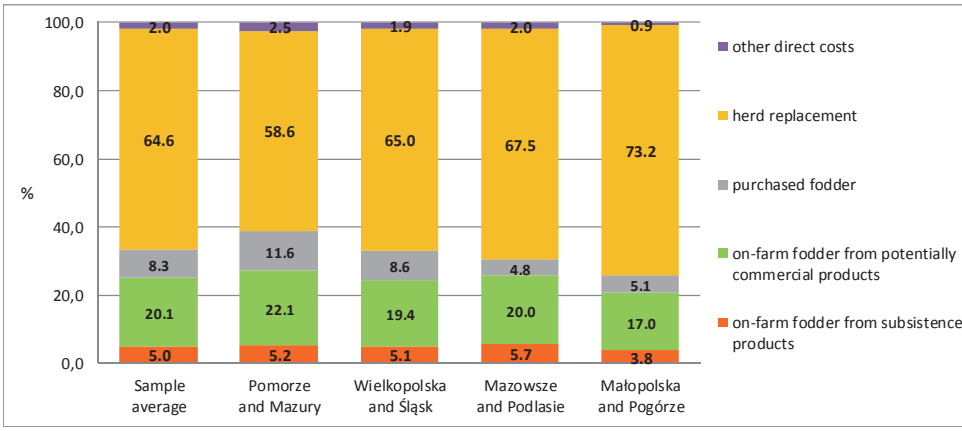
The results of the studies show that the order of the regions organised in terms of 100 kg beef cattle revenue and gross margin obtained was different. In this way, the impact of direct costs on the results became evident. Their level per 100 kg gross beef cattle ranged from PLN 406 in the farms from Wielkopolska and Śląsk to PLN 587 in the region of Małopolska and Pogórze. The regional location of the farms from the study sample differentiated direct costs of producing 100 kg beef cattle more strongly than revenues obtained. In the first case, the difference between the highest and lowest level was PLN 181, and in the second PLN 73.

The amount of direct costs was determined by the herd replacement cost (according to the methodology, animals introduced into the herd of cattle for slaughter are aged 1 year and more). The difference between the highest (PLN 430 in the region of Małopolska and Pogórze), and the lowest (PLN 261 in Pomorze and Mazury) herd replacement cost was PLN 169. On the other hand, the difference between the highest (PLN 174 in the region of Pomorze and Mazury) and the lowest (PLN 135 in the region of Wielkopolska and Śląsk) cost of feedstuffs (both foreign and own) was PLN 39. The regional diversification of the cost of animals introduced into the herd was 4.3 times higher than that of the cost of feedstuffs – Table 5.

In the structure of direct costs, the herd replacement cost was from 58.6 to 73.2%, while further positions were occupied by (Fig. 5):

- cost of own commercial feedstuffs – from 17.0 to 22.1%,
- cost of purchased feedstuffs – from 4.8 to 11.6%,
- cost of own non-commercial feedstuffs – from 3.8 to 5,7%,
- other direct costs – from 0.9 to 2.5%.

Fig. 5. Structure of direct costs of the **beef cattle** production in 2017 on average in the sample and in selected farms in the agricultural regions (per 100 kg gross beef cattle)



Source: study based on own studies.

The results of the calculations point to differences in the amount of concentrate feedstuffs consumed per 100 kg beef cattle gain. On average, in the sample of farms, the consumption was 2.76 dt, while in the agricultural regions it was within the range of 2.42-3.60 dt (Wielkopolska and Śląsk – 2.42 dt, Pomorze and Mazury – 2.81 dt, Mazowsze and Podlasie – 3.04 dt, Małopolska and Pogórze – 3.60 dt).

In the case of non-commercial feedstuffs (both own and purchased) – per 100 kg beef cattle gain – on average, in the sample the consumption was: green forage – 3.38 dt, hay – 1.0 dt, straw – 0.31 dt, silage and haylage – 10.78 dt. In contrast, in the regions the consumption was as follows: green forage – 1.43-4.62 dt, hay – 0.44-1.56 dt, straw – 0.00-0.49 dt, silage and haylage – 8.4-13.62 dt.

A reflection of the share and amount of various feedstuffs in the animal feed dose is their cost. The results show that, irrespective of the cost of animals introduced into the herd as part of its replacement, the animal nutrition process was a factor which had a significant impact on the beef cattle production profitability.

Following the differentiation of the selling price and direct costs of the beef cattle production there were significant differences in the amount of gross margin obtained without subsidies. On average, in the sample, gross margin per 100 kg beef cattle was PLN 211. However, when comparing its amount in the regions, the difference resulting from the comparison of extreme values was PLN 156. The highest gross margin without subsidies was obtained by beef producers in the region of Wielkopolska and Śląsk (PLN 267/100 kg) and the lowest in the region of Małopolska and Pogórze (PLN 111/100 kg).

The advantage of the farms from Wielkopolska and Śląsk is clear, the cost of obtaining PLN 1 of gross margin was lowest – it amounted to PLN 1.52. However, in the region of Małopolska and Pogórze obtaining PLN 1 of gross margin cost PLN 5.31 (3.5 times more than in the farms from Wielkopolska and Śląsk). In addition, in the farms of Wielkopolska and Śląsk, the direct profitability index was highest (165.7%), while in the farms from Małopolska and Pogórze it was lowest (118.8%). This means that in the former the economic efficiency of beef production was significantly higher (by 46.9 percentage points). It is estimated that the main factor determining the best results of the beef production in the farms from Wielkopolska and Śląsk were the relatively low direct costs. Their share in the price of 1 kg beef cattle, compared to other groups of farms, was 60.3%. However, in the region of Małopolska and Pogórze, although the price of beef cattle was highest, the high costs made the share of direct costs in the price of beef cattle highest (84.1%).

The factor supporting income obtained from the beef production are subsidies, their level per 100 kg gross beef cattle was within the range of PLN 75-88 (the account included: payment to cattle per 100 kg beef cattle and single area payment, payment for greening and additional payment per involved forage area [*Płatności.*. 2018]). The greatest impact on the amount of gross margin was that of subsidies in the regions where the level of gross margin without subsidies was relatively low, i.e. in the regions of Małopolska and Pogórze and Pomorze and Mazury. To PLN 1 of gross margin, farmers in those regions received, respectively, PLN 0.69 and 0.45, while in the farms from Mazowsze and Podlasie – PLN 0.36, and from Wielkopolska and Śląsk – PLN 0.33. This means that the share of subsidies in gross margin with subsidies was lowest in the region of Wielkopolska and Śląsk (24.7%) and highest in Małopolska and Pogórze (40.8%) – Table 5.

Summing up the results of the studies, it should be stated that the regional diversification of gross margin from the cattle beef production stemmed from the interrelations between the selling price and the production costs. Consequently, the highest gross margin without subsidies was obtained by producers from Wielkopolska and Śląsk (PLN 267/100 kg). The economic efficiency of the beef production in this region was also highest (the direct profitability index was 165.7%). On the other hand, the poorest results were recorded in the Małopolska and Pogórze. The lowest were gross margin without subsidies (PLN 111/100 kg) and the economic production efficiency (118.8%). The beef production in the farms in this region was not cost competitive and high costs are a factor which adversely affected the economic results.

Cereals in organic farms. The agricultural production in the organic farm is a demanding activity, mainly due to a need to meet a number of requirements contained in the legislation on organic farming [*Act*… 2018]. In the case of the crop production, the recommendations focus mainly on the soil cultivation, which is limited to the necessary minimum and the treatments used should serve to increase the fertility [*Zasady*... 2018]. Another important element is crop rotation, preferably several years' rotation with legumes in the main crop and the use of undersown crops and catch crops to protect the soil from erosion. The organic farm is not permitted to use any herbicides[4]. As regards fertilisation, which is intended to maintain or increase the fertility and biological activity of the soil, mainly basic organic fertilisers are used, i.e. manure, compost, slurry and green fertilisers, and mineral fertilisers approved for use in organic farming are used only as a supplement[5]. On the other hand, unpermitted fertilisers include synthetic nitrogen fertilisers, guano, industrial fertilisers, slow-action fertilisers and industrially produced organic and mineral fertilisers.

In the case of the organic crop production, the quality of seed material which should come from own farm or from other organic farm is important. What is often used are local forms of crops which are characterised by the higher resilience and competitiveness towards weeds in the given region. Cultivation of genetically modified plants and the use of synthetic products is not permitted. The more detailed crop production description on the organic farm has been given in the previous study [*Agricultural*... 2017].

According to statistical data, the agricultural area with the organic production has decreased in Poland in recent years. The total agricultural area in certified farms and during the conversion period in 2017 was 495.0 thousand ha and was lower by 26.1% when compared to 2013, in which the largest area of organic crops was recorded [*Raport*... 2017; *Powierzchnia*... 2018]. At the same time, there has been a decrease in the number of organic entities involved in the agricultural production (accounting for 94.7% of all organic producers). In 2017, the number of organic farms was 20,257 and was by 9.7% less than the year before [*Liczba*... 2017; *Liczba*... 2018].

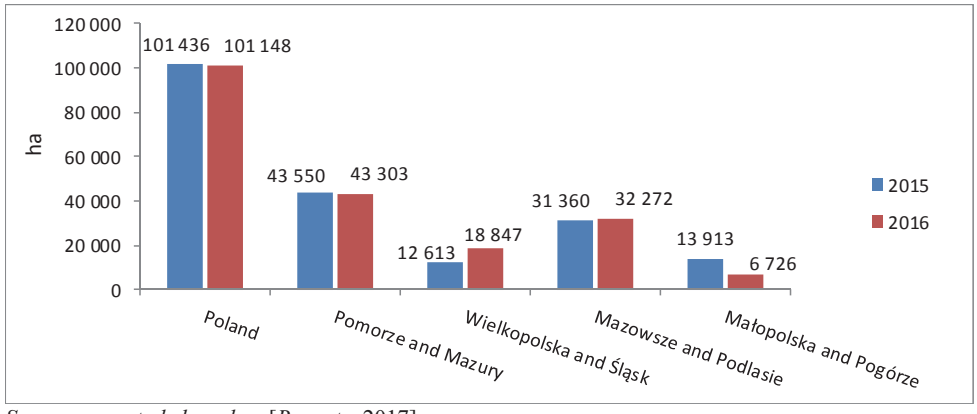
One of the reasons for the reduction in the area, indicated by the experts, is the legislation which allows to report only a part of the farm to the organic

[4] The list of plant protection products eligible for use in organic farming is published on the website of the Institute of Plant Protection - National Research Institute in Poznań.
[5] The list of fertilisers and soil improvers eligible for use in organic farming can be found on the website of the Institute of Soil Science and Plant Cultivation - National Research Institute in Puławy.

farming system [*Gospodarstw...* 2018]. The percentage of farms conducting the parallel production (i.e. organic and non-organic crop and/or livestock production) is gradually growing. In 2015, such farms accounted for 41.0% among all organic farms in Poland, while in 2016 – 49.2% [*Raport...* 2017]. In the opinion of organic producers, a barrier to the development of organic farming may be too large bureaucracy related to the process of certification and control of farms. The financial support system in a form of grants, as the experts say, is no longer a sufficient stimulator for the development of organic farming [*Kolejny...* 2018].

Cultivation of cereals in organic farming is a popular activity, as evidenced by their large share in the structure of utilised agricultural area in certified organic farms in the years 2015-2016. The cultivation area of cereals in 2015 accounted for 17.5% of total utilised agricultural area in organic farms (101.4 thousand ha) and in 2016 – 18.9% (101.1 thousand ha) [*Raport...* 2017]. We can observe a clear regionalisation of cereal cultivation in organic farms, and two agricultural regions were leaders here: Pomorze and Mazury and Mazowsze and Podlasie. In those regions in the years 2015-2016 to 2006, the total cereal cultivation area represented more than 74% of the total domestic area – Fig. 6.

Fig. 6. Cereal cultivation area (in ha) in organic farms in Poland and in the identified agricultural regions in the years 2015-2016



Source: own study based on [*Raport...* 2017].

Cereals produced on organic farms were also popular among the Polish processors. In 2016, 17.2% of all organic processing plants worked in the industry "processing of cereal milling products" (in 2015, it was 20.3%). In 2016 years, the production volume (milling of cereals from organic farms) amounted to 8.9 thousand tonnes and was higher by 13.7% than in 2015 (5.4 thousand tonnes) [*Raport...* 2017].

In its assumptions, organic farming is a farming system that aims at reducing the negative environmental impact of agriculture, but is also an attempt to associate environmental and economic objectives at the level of the farm [Rumowski 2000]. By attempting to carry out a comprehensive assessment of the agricultural production in organic farms, it is worth not only analysing the production and economic results, but also assessing the environmental impact of this production.

Methodological assumptions of environmental sustainability assessment describe the conditions to be met by organic farms cultivating cereals. For the initial assessment of the environmental friendliness of the agricultural production we can use the basic indices [Wrzaszcz 2012] e.g.:

- The share of cereals in the crop structure on arable land,
- Number of crop groups cultivated on arable land,
- The index of vegetation coverage of arable lands in the winter period.

The share of cereals in arable land sowings is a statistical determinant of the environmental friendliness of the agricultural production, which describes the proper crop rotation and the degree of biodiversity of agrocenoses [Faber 2010]. In the case of cereal cultivation (wheat, rye), we should avoid their share of more than 66% in the sowing structure [Kuś 1995]. The high share of cereals in sowings makes it impossible to apply proper crop rotation, which results in the development of weeds, the spreading of diseases, the greater risk of pests and the depletion of organic matter in the soil [Grabiński 2011].

The number of crop groups cultivated on arable land informs about the degree of diversity of the crop structure [Majewski 2002], which attest to the possibility of the crop selection and rotation, as a result of which the population of pests is reduced, weeds are reduced and nitrogen losses are minimised. What is indicated is a need to cultivate at least 3 crops groups from among the following: cereals, legumes, root crops, oilseeds/industrial crops, grasses on arable land and other crops (not classified into the above groups).

The index of vegetation coverage of arable lands in the winter period (included among agri-ecological indices) determines the degree of implementing the sustainable production system in agriculture [Harasim 2009]. Maintaining the vegetation coverage in winter prevents the negative effects of climate factors, reduces water pollution and protects the soil from erosion. The best soil protection is guaranteed by the largest possible vegetation coverage in winter, but it is possible to assume a minimum level of this index, i.e. cover on 33% of arable land. This index is calculated as a ratio of the total area of winter

crops, cover crop on arable land, grass in field cultivation for green forage and small-seed legumes to the total area of sowings on arable land.

Table 6. Production, costs and gross margin obtained in 2017 from **winter wheat** and **winter rye** cultivation on average in the study sample of organic farms (actual data)

Specification		Average in selected organic farms cultivating	
		winter wheat	winter rye
Number of surveyed farms		12	43
Area of utilized agricultural area	[ha]	23.58	37.55
Growing area	[ha]	2.01	9.23
Yield of grain	[dt/ha]	25.3	17.9
Selling price of grain	[PLN/dt]	79.58	71.58
Selling price of straw		8.41	13.89
		Per 1 ha of growing area	
Total value of production	[PLN]	2038	1279
Total direct costs	[PLN]	274	168
from this: sowing materials		261	133
organic fertilisers		-	34
growing regulators		12	1
other		-	1
Gross margin without subsidies	[PLN]	1764	1111
Subsidies[a]	[PLN]	1657	1682
Gross margin	[PLN]	3421	2793
Total labour input	[hours]	10.1	6.1
in this: own labor input		9.7	6.1
Inidicators of economic efficiency			
Share of direct costs in gross margin without subsidies	[%]	15.5	15.1
Indicator of profitability	[%]	744.7	761.8
Direct costs per 1 dt of grain	[PLN]	10.82	9.38
Gross margin without subsidies per 1 dt of grain	[PLN]	69.72	62.09
Gross margin without subsidies per 1h of total labour input	[PLN]	174.65	182.21
Share of subsidies in gross margin	[%]	48.4	60.2

[a] Subsidies include: eco-payment, single area payment, payment for greening and additional payment.

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

Source: Own study based on the AGROKOSZTY system data.

In 2017, the studies in the AGROKOSZTY system included **winter wheat and winter rye cultivated in the farms holding a certificate of conformity in organic farming.** The studies involved 12 farms cultivating wheat and 43 farms cultivating rye. Due to a small test sample, inference is strongly limited and the findings are mainly cognitive in nature. The study presents a preliminary assessment of the environmental sustainability of organic farms and a comparative analysis of the level of production, inputs and costs incurred and income obtained in a form of gross margin per 1 ha crop. The results of the studies on winter wheat and winter rye are shown on average in the study sample.

The studies show that, on average, in the analysed sample of organic farms cultivating:

- **winter wheat –** The grain yield was 25.3 dt/ha and was by 47.6% lower than the average yield (48.3 dt/ha [*Wyniki*... 2018]) in the individual farms in the country; the selling price of grain was PLN 79.58/dt and exceeded by 0.9% the average price of wheat grain obtained by farmers on marketplaces (according to GUS – PLN 78.86/dt [*Skup*... 2018]),
- **winter rye** – The grain yield was 17.9 dt/ha, so it was by 40.5% lower than its level (30.1 dt/ha [*Wyniki*... 2018]) on average in the individual farms in the country; The selling price of rye grain was PLN 71.58/dt and exceeded by 13.2% the average marketplace price of this grain (according to GUS – PLN 63.23 zł/dt [*Skup*… 2018]).

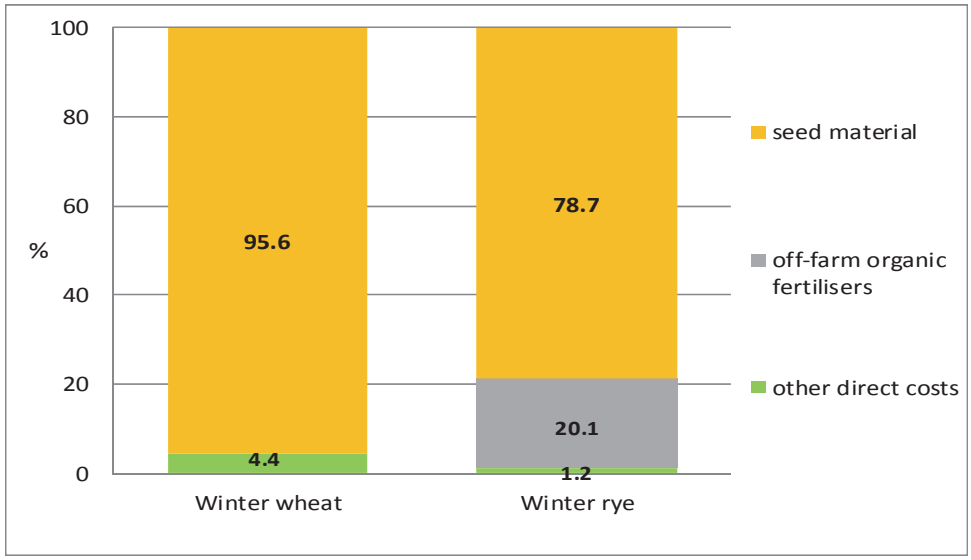
It is worth noting that the grain yield and its selling prices were a factor determining the level of the production value (revenues) from cultivation of the cereals concerned. On average, in the study sample from 1 ha of winter wheat, the production value of PLN 2,038 was obtained, while from 1 ha of rye – it was by 37.2% less, only PLN 1,279. The production value was a major factor determining the amount of gross margin, although the level of production costs was also relevant. Gross margin without subsidies obtained from cultivation of 1 ha of winter wheat was PLN 1,764 zł, and of winter rye – PLN 1,111 (Table 6).

On average in the analysed group of farms, direct costs per 1 ha of wheat amounted to PLN 274 and per 1 ha of rye – PLN 168. For both of these cereals, the main component of direct costs was the cost of seed material. Its share of the direct cost structure (in total) incurred for the wheat cultivation was 95.6, 3% and for the rye cultivation – 78.7, 1% (Fig. 7).

As the studies indicate, significant support for income obtained from the production of winter wheat and winter rye were subsidies. In 2017, to cultivation of these cereals in organic farms single area payment, payment for greening,

additional payment and eco-payment were available[6]. Financial support per 1 ha of wheat and rye was similar – PLN 1,657 and 1,682, respectively. However, in the case of rye, the share of subsidies in gross margin together with subsidies was higher and amounted to 60.2%, and in the case of winter wheat – 48.4%.

Fig. 7. Structure of direct costs of **winter wheat** and **winter rye** cultivation in 2017 on average in the study sample and in selected farms in the agricultural regions (per 1 ha of crop)



Source: study based on own studies.

The economic efficiency of the winter wheat and winter rye production has been assessed using the direct profitability index (ratio of the production value to direct costs). On average, in farms cultivating wheat, this ratio was 744.7% and in those cultivating rye – 761,8%. The high result of this index was mainly due to very low direct costs incurred for cultivation of these cereals.

The calculations also show that direct costs of producing 1 dt of rye grain were lower (by 13.3%) than in the case of wheat grain. The profitability of the production of rye, whose measure was gross margin without subsidies per 1 dt of grain, was also lower in the case of rye (by 10.9%). This was determined by the production value per 1 dt of grain lower by 11.2%.

The studies also indicate that labour inputs have been used more effectively in cultivation of winter rye as evidenced by the greater profitability of total labour inputs (PLN 182.21/hour, whereas in the case of wheat – PLN 174.65/hour).

[6] The available eco-payment is carried out under the European Agricultural Fund for Rural Development, measure "Organic farming", Package 7. Agricultural crops after the conversion period.

In line with the organic farming objectives, it is important to reduce the negative environmental impact of agriculture. Therefore, using information on the crop structure, utilised agricultural area and arable land an **initial assessment of the environmental sustainability of organic farms producing winter wheat and winter rye** has been carried out. For this purpose, the following indicators have been used.

1. The share of cereals in sowings of arable land in the farm (as previously mentioned, it should not exceed 66%), this indicator was, on average, in the sample of organic farms cultivating:

- winter wheat – 71.24%,
- winter rye – 70.98%.

This means that the requirement has not been met in the analysed population of the farms and proper crop rotation in organic farms has been distorted.

2. The number of crop groups cultivated on arable land – this indicator describes the level of diversity of the crop structure in the farm (it is advisable to cultivate at least 3 crop groups); from the calculations made based on the variables from the databases it results that these requirements have been met by:

- 91.7% of farms cultivating winter wheat,
- 95.3% of farms cultivating winter rye.

This means that the vast majority of the analysed farms meet the requirement of the diversified crop structure in the farm.

3. The index of vegetation coverage of arable lands in the winter period (index included in the group of agri-ecological indices) determines the degree of implementing the sustainable agricultural production system (a minimum level of the index is assumed – coverage of 33% of the arable land area); the calculated index of vegetation coverage of arable lands in the winter period was, in the case of cultivating:

- winter wheat – 63.5%,
- winter rye – 52.2%.

This means that, on average, in the groups of organic farms cultivating these cereals, the presence of crops during the winter (vegetation coverage) significantly exceeded the assumed minimum level. On average, in the sample more than half of the arable land area was under the vegetation coverage during the winter.

Summing up, it should be noted that the production of winter wheat and winter rye in organic farms provided income for producers in a form of gross margin without subsidies. The differentiation of its level was due to the relations between revenues and direct costs. On average, in the study sample of organic farms, gross margin without subsidies from cultivation of 1 ha of winter wheat

was PLN 1,764, and of 1 ha winter rye – PLN 1,111, while after taking account of support through subsidies it was, respectively, PLN 3,421 and 2,793. It is worth noting that the yield of grain, both wheat and rye, was at a lower level than on average in the individual farms, while the selling price of grain was higher than the average price obtained by farmers on the marketplace. In addition, the results of the direct profitability index showed clearly than revenues from the production of winter wheat and winter rye significantly exceeded direct costs incurred (7.4 and 7.6 times, respectively).

In addition, as part of the initial environmental sustainability assessment a significant degree of adaptation of the farms involved in the studies to the agri--environmental requirements has been demonstrated. In the groups of farms cultivating winter wheat and winter rye, the high degree of implementing the sustainable production system has been maintained, but there has also been some imbalance in proper crop rotation and the degree of crop diversification on the farm.

Summary

The chapter presented the economic results describing the activities of the crop and livestock which in 2017 were covered by the studies in the AGROKOSZTY system. In conventional farms, the subject of the studies were: sweet lupin, fodder pea, field beans, soybean and cattle for slaughter (i.e. beef cattle) and dairy cows, while in organic farms – winter wheat and winter rye. The study sample of the farms has been selected intentionally from a representative sample of the farms which was in the field of observation of Polish FADN.

The objective of the study was to identify the factors determining the regional diversification in the profitability of analysed agricultural products. The results, in regional terms, were presented against a background of the average results in the whole study sample of the farms (the exception was field beans and soybean, due to the low number of the farms in the studies).

In 2017, **sweet lupin** cultivation at the level of gross margin without subsidies was profitable. On average, in the sample, gross margin without subsidies obtained from 1 ha was PLN 847. In the groups of farms classified by their location in the regions, the diversification of its amount was 1.5-fold. The highest gross margin without subsidies was obtained by lupin producers in the region of Mazowsze and Podlasie – PLN 1,043/ha. Poorer results were recorded in the farms from Pomorze and Mazury and Małopolska and Pogórze, gross margin was, respectively, PLN 910 and 786/ha. On the other hand, the lowest gross margin without subsidies was obtained by lupin producers in the region of Wielkopolska and Śląsk – PLN 714/ha.

Support through subidies was of great importance, their level available for 1 ha lupin ranged from PLN 1,419 to 1,496. Subsidies would significantly exceed gross margin obtained from the production (i.e. without subsidies). After adding subsidies, gross margin (including subsidies) amounted to from PLN 2,178 in the region of Wielkopolska and Śląsk to PLN 2,462 for Mazowsze and Podlasie. This means that the share of subsidies in gross margin in the first of the above-mentioned regions was 67.2% and in the second – 57.6%.

The factor which determined the amount of gross margin without subsidies was revenues, although the impact of direct costs is also evident. The results of the studies show that the regional location of farms differentiated revenues more (3.8 times) than direct costs incurred for lupin cultivation, when comparing the extreme values in the first case the difference per 1 ha was PLN 322 and in the second – PLN 85.

In all regions, there has been a high span of the direct profitability index, this means that the group included the farms characterised by the very high and also much lower profitability. The average value of the direct profitability index was highest in the regions of Pomorze and Mazury and Mazowsze and Podlasie, it was, respectively, 316.1 and 313.6%. However, in some entities from these regions the profitability threshold has not been exceeded, as evidenced by the percentile of 5% (67.0 and 70.9%, respectively). In these regions, lowest were also direct costs of producing 1 dt lupin seeds and generating PLN 1 of gross margin without subsidies. However, in the farms from Wielkopolska and Śląsk, most economic indices used in the analysis had the poorest results. Among other things, highest was the cost of producing 1 dt seeds (PLN 36.42) and of generating PLN 1 of gross margin without subsidies (PLN 0.71), and lowest was the profitability of production (PLN 51.43/dt) and its economic efficiency (241.2%).

Gross margin without subsidies obtained in 2017 from 1 ha of **fodder pea**, on average in the study sample of the farms was PLN 1,673 and in regional terms from PLN 1,226 in the farms from Pomorze and Mazury to PLN 2,283 in the farms from Wielkopolska and Śląsk. The regional differentiation of gross margin without subsidies was 1.9-fold. Its amount was determined by the production and price results and the direct cultivation costs. Considering the impact of two factors, i.e. revenues and costs, it has been found that revenues have a decisive impact. Direct costs may change the order of the regions if the assessment criterion is the amount of revenues and gross margin without subsidies, however, the amount of gross margin is determined mostly by this first factor. This is confirmed by the previously conducted studies which have shown that gross margin without subsidies from the crop production is not positively correlated with direct costs, that is, they are not a factor determining

its level. The regional location of farms cultivating fodder pea differentiated revenues 5.5 times more than direct costs (when comparing the extreme values in the first case, the difference per 1 ha was PLN 1,286 and in the second – PLN 235).

Including support through subsidies (from PLN 1,447 to 1,493/ha) in the accounts, gross margin with subsidies per 1 ha fodder pea was, on average in the sample, PLN 3,138 and in the regions from PLN 2,673 in the farms from Pomorze and Mazury to PLN 3,732 in the region of Wielkopolska and Śląsk.

In terms of the economic efficiency of the fodder pea seeds production, the region of Wielkopolska and Śląsk can be positively distinguished. This is evidenced by the highest profitability of production (PLN 80.72/dt) and its economic efficiency (355.6%). Cultivation of pea in this region was also highly cost-competitive as indicated by the smallest share of costs in generated gross margin without subsidies (39.1%). Moreover, the highest revenues resulted in the highest economic labour productivity (PLN 450.34/hour). On the other hand, in the farms from the regions of Pomorze and Mazury and Małopolska and Pogórze – compared to other regions – the results of the indices were least favourable. In the first region – despite the fact that direct costs of producing 1 dt of seeds were lowest (PLN 25.41/dt) – the lowest profitability of production (PLN 46.86/dt) and economic labour productivity (PLN 293.93/hour) were found. Moreover, in some farms, the direct profitability index did not exceed the profitability threshold (the 5% percentile was 36.7%). In the Małopolska and Pogórze, the economic efficiency of seed production was lowest (271.0%) and the share of direct costs in gross margin without subsidies was highest (58.5%), which points to the relatively low cost competitiveness of pea production.

In 2017, the analysis of the economic results of producing **field beans** and **soybean** was carried out only on average in the study sample. The reason for this was the small number of the farms involved in the studies and, therefore, the regional division which was not justified methodologically. The results indicate that both activities allowed to obtain gross margin without subsidies, which in the case of field beans was PLN 1,308/ha and of soybean – PLN 1,718/ha. Its level was determined by revenues (value of the potentially commercial production) – in the case of soybean they were by 25.6% higher than those obtained from field beans cultivation. This was determined by the selling price of soybean seeds which exceeded the price of field beans seeds by 82%. Although direct costs incurred for cultivation of soybean were higher than in the case of field beans (by 15.7%), gross margin without subsidies obtained from the production of soybean was also higher (by 31.4%). Subsidies contributed significantly to the improvement in the economic results. In the case of field beans to PLN 1 of gross margin without subsidies producers received support in

the amount of PLN 1.11 and in the case of soybean – PLN 0.84. As a result, gross margin together with subsidies was PLN 2,761 and 3,168/ha, respectively.

The economic indicators used in the analysis also indicate the advantage of soybean. This is evidenced by the fact that the share of gross margin without subsidies in the production value, i.e. the ratio illustrating the efficiency at the production and technical level, is higher by 2.9 pp. In addition, the direct profitability index, which was a measure of the economic efficiency of soybean production, was higher by 23.7 pp. (for field beans it was 274.4% and for soybean 298.1%). The production of soybean was also characterised by the higher cost competitiveness, the share of direct costs in gross margin without subsidies was 50.5%, whereas in the case of the field beans production – 57.3%. As a consequence of these circumstances, the profitability of production, i.e. gross margin per 1 dt soybean seeds was by 90.3% higher than that obtained from cultivation of field beans.

In 2017, the **cow's milk** production was profitable at the level of gross margin. On average, in the study sample of the farms, gross margin without subsidies per 1 cow was PLN 6,378. Its amount was regionally diversified, the lowest – PLN 5,171 was recorded in the farms from Pomorze and Mazury, and the highest – PLN 7,947 in the region of Wielkopolska and Śląsk. The regional location of the farms differentiated revenues more (1.4 times) than direct costs of maintaining 1 cow (1.2 times).

The amount of gross margin was determined by revenues (i.e. the production value), their level was more affected by the milk yield of cows than the selling price of milk. Both variables were lowest in the farms from Pomorze and Mazury while highest: the milk yield of cows in the region of Wielkopolska and Śląsk and the selling price of milk in Mazowsze and Podlasie. When referring the highest values to the lowest ones, the advantage in terms of the milk yield was 35.3% and of the price of milk – 6.0%. The higher milk yield of cows was accompanied by the increased production intensity measured by direct cost of maintaining 1 cow. This means that in the region of Wielkopolska and Śląsk those costs were highest, and in Pomorze and Mazury – lowest, the difference resulting from their comparison was PLN 744/cow. The rise in direct costs determined the cost of feedstuffs, their share in the structure ranged from 65.0 to 74.4%. The results of the study show the role of the milk yield of cows throughout the milk production process. The higher level of the milk yield stimulated the increase in gross margin, despite the higher costs of keeping animals.

Gross margin without subsidies per 1 litre milk was as follows: in the region of Wielkopolska and Śląsk PLN 1.05, Mazowsze and Podlasie – PLN 1.00, Małopolska and Pogórze – PLN 0.97, and Pomorze and Mazury – PLN 0.93.

The advantage of producers from Wielkopolska and Śląsk and Mazowsze and Podlasie is clear, this is also evidenced by the relatively small share of direct costs in generated gross margin, respectively, 49.1 and 53.6%, while in the remaining two regions it was 58.9 and 61.0%. The economic efficiency of milk production, which is described by the direct profitability index, was also highest in the regions of Wielkopolska and Śląsk and Mazowsze and Podlasie – the index was, respectively, 303.9 and 286.5%, while in the remaining regions it was 269.8 and 263.9%.

Support in a form of subsidies had no major impact on improving the economic results from the milk production, their share in gross margin (counted together with subsidies) per 1 cow ranged from 6.9 to 11.6%. This means that to PLN 1 of gross margin without subsidies producers received from PLN 0.07 to 0.13 of subsidies (respectively in the farms from the regions of Wielkopolska and Śląsk and Pomorze and Mazury).

In 2017, the study on the profitability of the **beef cattle** production was carried out in the farms where its production was related to the use of cattle for dairy purposes. Therefore, the results obtained are inferior to those which could have been obtained by farmers were breeding meat cattle. On average in the sample, gross margin without subsidies obtained from 100 kg of beef cattle was PLN 211, and in regional terms it was within the range of PLN 111-267, respectively, in the farms from Małopolska and Pogórze and Wielkopolska and Śląsk. The regional location of the farms differentiated direct costs of production of 100 kg of beef cattle more than revenues obtained. In the first case, the difference between the highest and lowest level was PLN 181 and in the second – PLN 73.

The amount of direct costs was determined by the cost of stock replacement and the cost of feedstuffs, especially purchased and own commercial feedstuffs. In the first case, the regional differences stemmed mainly from the different weight of animals introduced into the herd. By contrast, in the second case, they resulted from the structure of feedstuffs in the feed dose and the source of origin. Taking into account concentrate feedstuffs, all regions were dominated by the use of grains and pellets made of own cereals, complemented by purchased feedstuffs. The highest share of purchased feedstuffs in total concentrate feedstuffs was recorded in the region of Wielkopolska and Śląsk (13.2%) and the lowest in Mazowsze and Podlasie (10.5%).

Beef producers from Wielkopolska and Śląsk incurred the lowest direct costs to obtain PLN 1 of gross margin without subsidies – PLN 1.52. In the region of Mazowsze and Podlasie, generation of 1 PLN of gross margin cost PLN 2.21, in Pomorze and Mazury – PLN 2.48 and in Małopolska and Pogórze – as much as PLN 5.31. The advantage of producers from Wielkopolska and

Śląsk is clearly, this is also demonstrated by the high economic efficiency of production – the measure was the direct profitability index, which was 165.7%. The poorest results were recorded in the region of Małopolska and Pogórze. The lowest was gross margin without subsidies and the economic efficiency of production (118.8%). The beef production in the farms in this region was not cost competitive and high costs are a factor which adversely affected the economic results.

The factor supporting income from the production are subsidies, their level per 100 kg of gross beef cattle was within the range of PLN 75-88. Subsidies had the highest impact on the results in the regions where gross margin without subsidies was relatively low, i.e. in the region of Małopolska and Pogórze, then in Pomorze and Mazury. Farmers in these regions received PLN 0.69 and 0.45, respectively, to PLN 1 of gross margin without subsidies. In the region Mazowsze and Podlasie they received PLN 0.36 and in Wielkopolska and Śląsk – PLN 0.33.

In 2017, **winter wheat** and **winter rye cultivated in organic farms** allowed to obtain gross margin without subsidies. From cultivation of 1 ha of wheat, producers obtained gross margin without subsidies amounting to PLN 1,764 and of 1 ha of rye – PLN 1,111. The factor, which determined the amount of gross margin without subsidies were revenues (i.e. production value). The level of revenues was particularly strongly affected by the selling price of grain, which was quite high – it exceeded the average buying-in price in the country as well as the average price obtained by farmers in marketplaces. On the other hand, the grain yield of both cereals was lower than the average level in the individual farms in the country. Subsidies (in total) to 1 ha of wheat and rye were PLN 1,657 and 1,682 respectively. This means that to PLN 1 of gross margin without subsidies obtained from cultivation of wheat farmers received support of subsidies amounting to PLN 0.94 and from cultivation of rye – PLN 1.51. As a result, gross margin together with subsidies per 1 ha of wheat per hectare was PLN 3,421, and per 1 ha of rye – PLN 2,793. The direct profitability index of wheat production was 744.7% and of rye – 761.8%. Its amount were determined by low direct costs incurred for cultivation of these cereals.

An initial assessment of the environmental sustainability of organic farms producing winter wheat and winter rye points to a significant degree of adaptation of these entities to the agri-environmental requirements. In the production organisation in the groups of farms cultivating the cereals in question, a high degree of implementing the sustainable production system was observed, however, a distortion has been demonstrated which applies to proper crop rotation and crop diversification on the farm.

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SUMMARY AND CONCLUSIONS

Presented monograph includes research results of the fourth stage of implementation of the subject "Agricultural company and agricultural holding towards climate and agricultural policy changes".

The first substantive chapter of the monograph outlines the conditions in which Polish farms are operating currently and will operate in the next decade. In accordance with the subject, focus was on the effects of climate change and broadly understood social changes which affect and may affect national agricultural policy. The source of information were scientific outputs of the authors quoted in the substantive chapters of the monograph.

In the eighties of the last century, perceptible climate change was noticed in the world, including Europe and Poland. In the first decade of this century, however, there was an increased occurrence of intense weather phenomena: droughts, floods and hurricanes. In Europe, droughts which intensify in the southern part of the continent and in the summer also in its latitudinal and central part receive special attention. On the basis of collected observations, it was estimated that nowadays in Poland, droughts reduce agricultural income on average around 10% annually, with fluctuations from 6 to 16% depending on the part of the country. In 2016, these 10% meant PLN 3.4 billion. The effects of hurricanes are also expensive. Forecasts based on model calculations indicate that these phenomena will intensify.

Agricultural producers can limit the effects of drought using appropriate agricultural measures, such as the right amount of organic fertilisation, irrigation of crops, etc. However, the latter is hampered due to limited water resources. Only about 6% of the available fresh water resources are stored in artificial and natural reservoirs, and each year as much as 32% flow to the sea by rivers unproductively. This unfavourable phenomenon may be stopped by the repairs of the existing and construction of new large retention reservoirs on rivers and reconstruction, renovation and construction of devices of the so-called small--scale water retention (weirs on streams, flood polders alongside the so-called river-canals, etc.). It is also advisable to use the so-called agro-drainage on solid soils, which enables the increase of deep-water resources.

In this situation, it will be in Poland's interest to strive for the European Union to become the redistributor of agricultural producers' income between the countries of this group. The budget spending of our country supporting measures limiting the negative effects of climate change and the elimination of damage resulting from them will also grow. This will force the intensification of work on

the introduction of a universal property insurance system for agricultural holdings. The risk caused by invasions of previously unknown diseases and pests will also lead to a more rigorous organisation of agricultural production and will probably accelerate changes in the production structure. The emphasis will be placed on the implementation of agricultural production technologies limiting greenhouse gas emissions. It is a probable thesis that these new processes will accelerate the decline in the number of small farms because they will not be able to meet the growing requirements of the production regime.

The second part of the first chapter indicates the conditions of the occurrence of broadly understood social phenomena in the next decade. Two studies referring to generation cycles were used for this purpose. They show that it is not possible to rule out the emergence of territorial and political changes in the world, as well as the creation of new systems of international relations. If they do occur, they will have an impact on the social situation of EU countries, but they will not diminish the economic importance of food production, including agricultural production. On the other hand, in agriculture, similarly to the entire economy, the use of information technologies enabling development of resource-efficient directions and ways of conducting agricultural production, saving the land, clean water and means of production produced from non--renewable raw materials, will intensify.

The second chapter analyses labour productivity (efficiency) on large farms, conducting agricultural production on at least 30 hectares of utilised agricultural area, in ten selected European Union countries located on a similar latitude as Poland (Austria, Belgium, Denmark, the Netherlands, Germany, the Czech Republic, Lithuania, Latvia, Poland, Slovakia and Hungary). It was determined that the analysed countries differed significantly in the average labour productivity in agriculture. In the country with the smallest analysed indicator (Lithuania), in 2016, it amounted to only 7.7% of the productivity level of Denmark where it was the largest. Moreover, there was a large difference in the indicator between the countries of the EU-15 and post-communist countries. The latter were additionally characterised by a small stocking of animals expressed in livestock units per 100 ha of utilised agricultural area. Besides Poland, this indicator was ranging from 35.3 to 89.8 units, while in the EU-15 the corresponding indicator was ranging from 48.5 to 203.4 units.

Polish farms looked favourably compared to farms from the post--communist countries. In terms of labour productivity, those with an area of 30--49.9 ha and 50-99.9 ha of utilised agricultural area were in the second place,

and those with 100 ha and more in the first place. Large stocking of animals, which amounted to 113.3, 104.6 and 121.3 units, respectively, had a large and positive share in it.

It was also noted that in the majority of the analysed EU-15 countries there was a decrease in the number of farms with 30-49.9 ha of utilised agricultural area and in some of them with an area of 50-99.9 ha. In those conditions, these farms were too small to provide agricultural producers and their family members with a satisfactory standard of living and funds for investments enabling them to adapt to changing farming conditions.

In comparison with other analysed countries, Poland stood out with the smallest rate of decline in the total number of farms. Moreover, it was among those, along with the Czech Republic, Slovakia, Hungary and Austria, in which the number of large farms grew in all analysed size classes. However, there are factors which indicate that this situation will continue in our country in the next decade only for farms with at least 50-99.9 hectares of utilised agricultural area.

The third chapter draws attention to Natura 2000 areas. In Poland, in these areas, biodiversity is currently particularly protected by 22.6 thousand farms which, on the area of 249.9 thousand hectares, implement one of the packages of "Agro-environment-climate measures under RDP 2014-2020," which is "Valuable habitats and endangered species of birds in Natura 2000 areas." So far, the amount of subsidies paid for this purpose amounted to PLN 515.9 million, including 64.8% in the framework of RDP 2007-2013 and 35.2% in the framework of RDP 2014-2020.

Farms carrying out measure "valuable habitats and endangered species of birds in Natura 2000 areas" had a slightly larger utilised agricultural area, worse soil quality and almost identical share of leased land, lower labour input and lower production costs per unit area, and had a lower average value of capital used. In addition, they had a slightly lower return on equity, but thanks to subsidies to operating activity, achieved only slightly lower income per person in the farmer's family working full-time on the farm. It forced them to intensive investment activity.

Farms implementing the activity in question were managed by older persons, and their farms had a larger share of permanent agricultural area in the utilised agricultural area. Therefore, these features prompted farmers to undertake the implementation of the measure "valuable habitats and endangered species of birds in Natura 2000 areas."

However, the analysed farms conducting such activity had average utilised agricultural area 38.6% larger than the total number of farms being the beneficiaries of this measure. Therefore, it should be concluded that the results of the presented analysis differ from the situation of the national beneficiaries of the measure at large. The results should then be considered preliminary.

The fourth chapter of the presented monograph includes an analysis of the competitiveness of domestic farms specialising in pig farming. Source materials from 2014-2016 were used for this purpose, and the characteristics of Polish farms were presented compared to Danish, Dutch, Spanish and German farms.

It was pointed out that 40.3% decline of pig population in Poland in 2007--2016 was accompanied by a decrease in the share of pig livestock production in animal livestock production by several per cent. Moreover, the negative balance of foreign trade in pig livestock was growing and the concentration of rearing of animals of this species continued in five provinces of our country.

The competitiveness of farms was assessed using the competitiveness index which is the ratio of income from a farm to the costs of using own production factors (labour, land and capital). Those farms in which the competitiveness index was greater than one unit were considered competitive.

The lack of competitiveness of Polish small, medium-small and medium--large farms was determined, with an average number of 14.2, 31.0 and 62.1 pig livestock units, respectively. In this respect, Polish farms of this size did not differ from corresponding groups of farms in other EU countries. Medium-large Spanish and German farms were also non-competitive.

On the other hand, large Polish (with an average of 172.4 pig livestock units) and Spanish farms were competitive. Farms of the same size class belonging to the Danish, Dutch and German farmers were distinguished by lack of competitiveness. Apart from that, very large Polish farms (with an average of 838.6 LU) as well as Spanish and German farms of the same size class were also competitive. Lack of competitiveness was felt by very large pig holdings in Denmark and the Netherlands.

The above findings suggest that the process of decline in the pig population in our country is coming to an end.

In the fifth chapter, the regional diversification of the production profitability of selected agricultural products in farms of natural person in 2017 was indicated. Attention was focused on the most important factors determining this diversity in conventional production of: sweet lupines, fodder peas, horse beans, soya, cow milk and live bovine animals, and in organic production of

winter wheat and winter rye. However, the chapter presents only findings about products obtained on a large scale.

The average amount of gross margin in the cultivation of sweet lupines was PLN 847 per 1 ha. It was the largest in the region of Mazowsze and Podlasie (PLN 1043 per ha), and the smallest Małopolska and Pogórze (PLN 786 per 1 ha). The regional differences in the amount of gross margin calculated without subsidies were determined mainly by the value of production because the difference between extreme values was PLN 322 per 1 ha, while the amounts of direct costs differ by only PLN 85.

Support in the form of subsidies exceeded the average amount of gross margin in the cultivation of sweet lupines and, therefore, the share of subsidies in gross margin calculated with subsidies amounted to 63.1%. The average amount of gross margin calculated with subsidies amounted to PLN 2,297 per 1 hectare of cultivation.

The average amount of gross margin in the production of cow milk from one head was PLN 6,378. It was the largest in Wielkopolska and Śląsk (PLN 7947), and the smallest in the areas of Pomorze and Mazury (PLN 5171). Regional positions of farms with milk production differentiated income slightly more (1.4 times) than direct costs of maintaining a cow (1.2 times).

Support through subsidies had a small impact on the results obtained because the share of subsidies in the amount of gross margin calculated with subsidies amounted to only 9.1%. The average area of fodder crops per one cow was 0.52 hectares, so the average amount of gross margin calculated with subsidies was PLN 13,488 per one hectare of roughage needed to feed one head. This large amount of gross margin, however, was created only in part from feed produced on farms, in part from purchased feed. The estimate using the results of other research conducted within the same research issue indicates that the amount of gross margin calculated together with subsidies and generated only from own feed was higher (about 71%) than in the case of sweet lupines. However, this amount had to be used to pay for own work of agricultural producers and their family members with the animals, and direct outlays (excluding general economic ones) of this production factor were about 27 times higher than in the case of cultivation of sweet lupines.

Information on organic farming was given only in average values due to the small size of the analysed sample. The average amount of gross margin obtained as a result of cultivation of winter rye amounted to PLN 1,764 per 1 ha. Support in the form of subsidies exceeded this amount, similarly to the case of

sweet lupine. The share of subsidies in gross margin calculated with subsidies amounted to 60.2%.

The role of subsidies in the organic production of winter wheat – a typical species grown on good quality soil – was smaller. The average amount of gross margin obtained from this crop was PLN 1,764, and the share of subsidies in gross margin calculated with subsidies amounted to 48.4%.

The above findings provide the basis for the conclusion that possible restrictions in the level of subsidies in the next EU financial perspective will limit the effects of conducting organic agricultural production and crop production obtained on poor quality soils. This will also reduce the size of production of leguminous seeds, which could be substitutes for imported soya meal.

The authors of the chapter emphasise that the above findings do not reflect the average national or regional situation. They refer only to the group of farms which were the source of information used in the analyses.

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