Polish agricultural holdings towards climate change and agricultural policy – baseline analysis

INSTITUTE OF AGRICULTURAL
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Polish agricultural holdings towards climate change and agricultural policy – baseline analysis

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FOREWORD

This publication is the first of five volumes devoted to the way domestic agricultural holdings and enterprises operate under conditions dictated by ongoing climate change and expected agricultural policy reframing which may take place in 2021 and its implementation in the next few years.

The first decade of this millennium brought increased frequency of extreme events, floods, hurricanes and oppressive droughts in large areas in Europe. The reason for this is believed to be climate change[1]. However, droughts in Poland intensified earlier and have occurred three times more often in the last three decades than in the previous three decades. The phenomenon is accompanied by no clear long-term trends in the amount of precipitation, but the water balance of arable land is negative, as rain water evaporates due to a rise in both temperature (in the 20th century, the average temperature in Poland increased by approx. 1°C) and total sunshine duration (total time of penetration of Earth's surface by sunrays), which has been identified clearly since the 1960s. In particular, this is evident in a large part of *Niż Polski* areas during spring and early summer, i.e. the time of intensive vegetation of most arable crops. It was found that these negative trends intensified at the beginning of this century which allows to conclude that they may continue to intensify.

The second important factor affecting domestic agriculture is the shape of the Common Agricultural Policy which, of course, depends on the "condition" of the European Union[2]. The EU managed to solve the problem of food security, EU measures aimed at mitigating climate change are well-known and approved. Besides, gaps in living standards between poorer and richer EU Member States are being bridged. However, the EU has been the slowest growing economic area of the world over the last two decades. It must solve the problems with respect to the influx of immigrants, while the last economic recession demonstrated that EU mechanisms related to the introduction of the single currency failed to prevent irregularities. After 2020, the shape of the Common Agricultural Policy may be also affected by some other global phenomena. As a result, future

[1] Kędziora Andrzej: *Natural bases of water management in Poland*, in a collective work edited by L. Ryszkowski and A. Kędziora, entitled *Environmental protection in spatial planning*, Agricultural and Forest Environment Research Centre, Poznań 2005, pp. 77-87.
[2] Józwiak Wojciech: *The World, the European Union and Poland – reflections on the paradoxes of futurology*, Problems of Agricultural Economics, No. 2, 2014.

agricultural policy may differ significantly from the policy pursued until 2013 and in the current financial perspective.

Therefore, we should earlier become aware of effects of changes which occur or may occur in agricultural environment in both types of the conditions referred to above, in order to determine their impact on production efficiency, the competitiveness of domestic agricultural holdings and enterprises as well as opportunities for reducing the impact of domestic agriculture on climate change. It is also important to be able to identify probable national barriers to the development of agricultural holdings and enterprises. When all the five volumes of the upcoming series are published, it will be possible to draw conclusions and, consequently, expert opinions that will allow for: collecting arguments to help negotiate the shape of the Common Agricultural Policy which will begin before 2021, developing appropriate infrastructure, creating appropriate innovation policy, indicating desired changes in agricultural production directions, etc.

This book contains five chapters. The first one presents the possibility of using H.Ch. Binswanger's[3] "growth spiral" idea to analyse how households, households engaged in agricultural production, agricultural holdings with characteristics of enterprises and agricultural enterprises of legal persons operate under market conditions. Furthermore, it characterises economic policy instruments that affect them and that the State can use to drive economic processes in a socially desired direction. It is about employment, opportunities for using natural resources, credit costs, technological and product innovations, etc. The second chapter presents the situation of agricultural holdings which were particularly affected by droughts in 2006-2013, while the third one assesses the organisation and economics of domestic agricultural holdings specialising in crop production in 2010-2012, as opposed to a group of holdings of the same type in Hungary, the Czech Republic, Slovakia and Germany. Materials were developed based on EU-wide monitoring results and monitoring results of the Polish FADN. These source data do not cover the smallest holdings and, in Poland, the largest holdings as well. However, the fourth chapter characterises the profitability of production of selected agricultural products (sugar beets, cow milk, including milk production in organic holdings, and beef) in 2014 and by macroregion, i.e. Pomorze and Mazury, Wielkopolska and Śląsk, Mazowsze and Podlasie as well as Małopolska and Pogórze. The last chapter characterises the smallest and the largest agricultural holdings of natural persons not covered by

[3] Binswanger H.Ch.: *Growth spiral. Money, energy and imagination in the dynamics of the market process*, Zysk i S-ka Press, Poznań 2011.

the monitoring of the Polish FADN. Together with the contents of the third chapter, this provided a basis for having domestic agricultural economic entities owned by natural persons fully characterised.

The contents of all the chapters will be used in works carried out in the years to come.

HOUSEHOLDS ENGAGED IN AGRICULTURAL PRODUCTION AND AGRICULTURAL HOLDINGS OF NATURAL PERSONS WITH CHARACTERISTICS OF ENTERPRISES

Introduction

The concept of “economic growth” gained significance as a result of the reconstruction of national economies after the Second World War. One of the ways of perception of this growth is called the "growth spiral" and its idea formulated in Hans Ch. Binswanger’s “Growth spiral. Money, energy and imagination in the dynamics of the market process” is a basis for this monograph.

Premises, which allow for analysing relationships between the currently most important factors of production and the division of the surplus achieved between owners of these factors, are the essence of the book referred to above. This, in turn, makes it possible to draw conclusions allowing for exerting an effective influence on economic processes which ensure steady, though not necessarily maximum, GDP growth on a transnational scale. The characterised idea indicates premises which allow for reducing the negative impact of economic growth on the environment in a broad sense.

Thus, the chapter briefly characterises the “growth spiral” idea. Theoretical aspects of operation of enterprises of any kind and, against this background, agricultural holdings were given particular emphasis, taking into account the specificity of economic activity of this type. At the same time, the chapter indicates operating conditions for enterprises in a broad sense to be met to prevent economic crises, though not necessarily recessions.

Basic elements of the “growth spiral” idea and their reference to the specificity of agriculture and agricultural holdings

The “growth spiral” idea is based on theses which indicate assumptions relating to its essential elements.

● *Initiation of certain types of production from households being self-sufficient units to craft workshops and then enterprises once led to the emergence of a market and the release of forces that made a certain socially useful phenomenon, i.e. division of labour, expand. The transfer of production from households to enterprises continues, although its scale decreases. This broadens the scope*

of the market's operation, the essence of which is interaction between economic entities specialising in production and households specialising in consumption.

The transfer of production from households to enterprises has continued to this day mostly in agriculture. Thus, most agricultural holdings have currently no characteristics of enterprises, because their contacts with the market are limited. These are simply households that carry out small-scale agricultural production to meet their own specific needs and sell surpluses only (Table 1). Nevertheless, only approx. 28% of such households have agricultural production income higher than half of their total income which indicates that most of them derive their income from other sources, mainly from paid work and partially also from other economic activities.

Table 1. Characteristics of agricultural holdings owned by natural persons (averages as at 2013)

Measures and indicators	National averages	including holdings with production value[a] (PLN '000) of	
		up to 33	at least 33[b]
Number of holdings ('000) Share (%)	1425.4 100.0	1216.4 85.3	209.0 14.7
Employment expressed as the number of full-time employees[b]	1.3	1.0	1.7
Share of households using over 50% of generated final agricultural production value	27.0	35.2	2.9
Share of households with agricultural production income of over 50% of total income (%)	34.9	28.0	90.1

[a] value calculated in a standard way.

[b] in accordance with own estimates made based on monitoring results of the Polish FADN for 5387 holdings in the years 2010-2012.

[c] full employment is 2120 hours of work in a holding per year.

Source: own calculations made based on figures were derived from a CSO study[4].

The average production value per holding with production value of at least PLN 33 thousand in 2010-2012 amounted to approx. PLN 152 thousand and the average income per holding – to approx. PLN 96 thousand. Having this income reduced by costs of own labour calculated in accordance with average labour cost rates in agriculture and management labour cost at the level of parity remuneration, it turned out that these holdings achieved profit as well. Its rate

[4] *Characteristics of agricultural holdings in 2013*, CSO, Information and Statistical Papers, Warsaw 2014.

(amount of profit relative to the value of equity) was approx. 8%, i.e. higher than bank deposit rates. Thus, agricultural holdings of natural persons with production of at least PLN 33 thousand, which was calculated in a standard way, had characteristics of enterprises.

In addition to households engaged in agricultural production and agricultural holdings owned by natural persons and having characteristics of enterprises, also agricultural holdings of companies of legal persons as well as municipal and other holdings operate in Poland. In 2013, their number reached 3.9 thousand, i.e. approx. 0.3% of all these entities in total. Each of them had approx. 11 employees on average and at least some of them achieved profit on equity.

● *Enterprises pay households for work done, which spend the funds thus obtained so as to maximise resulting benefits. Expenditures depend on the hierarchy of needs, but basic needs (livelihood, security) are met on an ongoing basis at a similar level, while additional ones – as far as possible. Decisions on meeting the needs are taken by them alone, but (mostly) additional needs change as a result of the impact of marketing efforts undertaken by enterprises.*

Households engaged in agricultural production derive their income: from paid work, sales of agricultural products, reduced household operating costs as a result of purchasing cheaper foodstuffs and possibly from other sources. Also the households of natural persons with characteristics of enterprises derive specific benefits from reduced household operating costs as a result of purchasing cheaper foodstuffs. Agricultural income is a source of livelihood only for households providing permanent or seasonal work for agricultural holdings with characteristics of enterprises and agricultural holdings of legal persons.

● *To establish an enterprise, an entrepreneur has to make a down payment (of initial capital). The down payment makes it possible to purchase services from households and obtain physical investment funds, with particular emphasis on energy carriers that enable labour replacement. Sales of production thus achieved cover costs, so the production process can be continued.*

In Poland, the assumption referred to above applies in full to agricultural holdings of legal persons only. However, households engaged in agricultural production and agricultural holdings of natural persons with characteristics of enterprises are formed basically as a result of the transfer of ownership of assets from a parent or parents free of charge. Also, those from a new owner's household and sometimes also those from a previous owner's household work free of charge, while paid employment is provided mostly to seasonal employees.

● *Companies are established by using an entrepreneur's equity and borrowed capital (credit). Thus, an enterprise's profit can be divided into net profit (equity fee) and interest rates for access to borrowed capital. Credit interest has to be paid even if an enterprise generates loss and then an entrepreneur can lose equity and hence his/her risk.*

In agriculture, the risk is posed not only by credits, but also by the fact that a significant part of crop production is exposed to the changing weather conditions.

Profit and possibly the rate of profit on equity are taken into account, when it comes to actions of agricultural holdings of legal persons and – most likely – agricultural holdings of natural persons with characteristics of enterprises, as indicated by their profits, which has already been referred to above. Credit-based investment is as important for them as for enterprises from other branches of the economy. This observation applies especially to young people who take over a holding from its previous owner which scale of production is not high enough and technology – outdated, while organisation – adapted to other own labour resources, and product quality leaving much to be desired. Such persons must therefore take huge investment effort, when they face scarcity of funds from gross household income (net income + amount of depreciation charges) and held savings.

Utilised agricultural area is a specific means of production, because it is immobile. In such a situation, even the desire to purchase it cannot be fulfilled if it is located too far away from an economic entity. If it can be purchased in the vicinity, a credit must be taken out, when postponing some other expenses is not enough for the transaction to be effected, because such an opportunity may not repeat soon.

The characterised "growth spiral" idea puts great emphasis on mass production, when one very large enterprise meets demand for a specific good of the entire country or a part of it, which brings significant benefits to that enterprise. Agriculture makes this impossible for obvious reasons. Nevertheless, as agricultural enterprises and agricultural holdings of natural persons with characteristics of an enterprise participate in joint ventures (groups and other producer organisations, alternative networks of production and distribution of certain types of food), the market can be supplied with large batches of homogenous products of a given type and specific quality. The participation of agricultural enterprises of legal persons and agricultural holdings of natural persons with characteristics of

enterprises (economic entities) in a group or another producer organisation allows for not only increasing the scale of production, but also taking over a part of the commercial margin. However, alternative production and distribution networks expand the market offer of agri-food products with distinctive characteristics, thus improving production efficiency and, at the same time, increasing commercial margin income and even processing margin income.

Agricultural enterprises of legal persons and agricultural holdings of natural persons with characteristics of enterprises, to a greater extent than households engaged in agricultural production, develop and run non-agricultural economic activity being: production, service or trade activity [Józwiak 2014].

Income inequality increases profits, but participation in joint ventures or the development of non-agricultural lines of economic activity on one's own requires funds, including those derived from credits incurred.

As for households engaged in agricultural production, it is not the rate of profit on equity but rather agricultural income which is a measure of the effects achieved. Agricultural production income determines household income which is an equivalent for the own labour inputs incurred and the source of funds (usually very limited) for upgrading or expanding assets.

● *The homo oeconomicus principle that entrepreneurs strive for maximising the rate of profit on equity, while households – for maximising performance benefits, should not be construed rigorously, as both have a certain degree of freedom in taking account of ethical or environmental criteria. However, they cannot extend that degree freely.*

The "growth spiral" idea does not provide for concepts of maximum profit or the maximum rate of profit, because they are derived from econometric models that make it possible to determine both these maximums under clear and predefined conditions. Nevertheless, the real world makes some of these conditions difficult and sometimes even impossible to be determined *a priori*. In this situation, reference is made to such a rate of profit on equity which reduces an entrepreneur's risk.

Very high profit or a very high rate of profit on equity may encourage entrepreneurs to take account of objectives of social interest and actions undertaken with regard to objectives pursued in the long term. Nevertheless, funds in support of these objectives cannot undermine an economic entity's competitive position. Additionally, most economic entities in agriculture are characterised by

the scale of production which is so small that they are unable to cover even costs of own labour in a holding at the parity level, meaning no interest in objectives other than those profitable. Pro-social and pro-environmental actions can, however, be "purchased" from them by paying them for rendering adequate services.

● *Competition in the modern economy does not lead to an overall balance and optimal allocation of scarce resources, but rather causes a constant tendency to upgrade and increase production carried out by enterprises as a result of investments made thanks to own funds secured earlier, bank credits and the use of increasing inputs, i.e. energy, other physical raw materials and innovations being a product of human creativity.*

This argument applies, in principle, only to agricultural holdings of natural persons with characteristics of an enterprise and agricultural enterprises (agricultural holdings owned by legal persons).

● *An enterprise cannot accurately predict the price of a good to be produced, when it enters the market. The market price must, however, be high enough (so-called reproduction price) to prevent capital withdrawal to start looking for investment in the production of another good (commodity). Thanks to the reproduction price in place (in fact, the minimum price), a specific good continues to be produced at a socially necessary level, although not necessarily in the same enterprise or enterprises.*

The a*ctual market prices do not result from a symmetry between income and expenditures, but rather they are determined based on the supply of (sometimes) several enterprises and the demand reflected at a time in the market by numerous households. In each period, the demand curve intersects the vertical supply curve determined in the previous period. In order not to run into debt, each market participant must, therefore, ensure that expenditures do not exceed income or credit funds. However, goods are sold and purchased in the market, irrespective of whether prices led to a balance between the demand and the supply, as the market operates when no such balance exists. If the demand exceeds the supply, purchasers compete with each other, at the same time increasing the market price which becomes higher than the reproduction price, while entrepreneurs' profits grow. But if the demand is below the supply, the market price is lower than the reproduction price and, consequently, the profit may be lost and even the loss may be generated.*

The threat of future loss is an important motive for enterprises' activities, because they not only seek to achieve a sufficiently high rate of profit, but also they want to avoid bankruptcy. To this end, companies use strategies of two types. One of them is called a restrictive strategy and involves hampering market access for others. It provides for: forming a cartel, taking over a smaller or poorly operating enterprise, ensuring oneself state or local government orders, etc. The second one, known as an expansive strategy, involves increasing the scale of production and implementing innovations to reduce unit costs of goods produced and/or extending the market offer to include goods which have not been produced so far (so-called product innovation). By reducing its costs, an enterprise benefits in two ways, i.e. the margin per unit of a good increases, so does the demand, because the price is lower. Product innovation enables an increase in the volume of production, as it generates the new demand. The expansive strategy prevails at present.

The restrictive strategy cannot be used in agriculture to reduce risk for obvious reasons, but agricultural enterprises of legal persons and agricultural holdings with characteristics of enterprises owned by natural persons apply the expansive strategy which is conducive to achieving a high rate of profit on equity. This reduces the risk of equity loss due to an unexpected downturn, because profit loss is a kind of buffer which allows for making it through a difficult period. Risk can also be mitigated by insuring assets against fortuitous events, while the use of hedging is an insurance against adverse price changes.

Nevertheless, there are phenomena that restrict the use of the expansive strategy. One such restriction in our country is shortage of water for irrigation of crops. Moreover, there is significant social resistance to the use of products made from plant and animal GMOs.

Households engaged in agricultural production respond to market threats differently. At that time, they give up investing and meeting additional needs and focus on meeting basic needs.

● *Addressing environmental protection is based on solutions of two types. The first one provides that environmental protection should depend on local purchases and sales of rights to pollute a particular environmental medium or rights to use the unimpaired environment amongst local communities and enterprises whose activities are of environmental concern. Both of these types of rights lead to the same results, while local communities are in a position to enforce the quality of relevant actions undertaken to protect the environment.*

However, the State faces problems in this regard, as there are multiple enterprises whose activities are of environmental concern and generate high costs of specialist research carried out to prove that introducing new production methods and new products cause damage. The second solution for improving the environment is innovation to protect its specific media, i.e. soil, surface and subsurface water, air, etc. The most important is innovation that enables low-carbon energy production. The innovation can help solve perhaps the biggest global problem, i.e. unfavourable climate change caused largely by emissions of the so-called greenhouse gases.

Environmental protection practice contradicts the recommendations set forth in the characterised "growth spiral" idea. EU Member States pay agricultural producers predetermined rates for voluntary actions that meet specific requirements. These actions: reduce soil erosion and water pollution, protect biodiversity, including growing old varieties of arable crops, rearing old production animal breeds, extensive production on meadows and pastures of rich floral composition along with their rare species of birds, etc. Moreover, the Natura 2000 European Ecological Network creates real conditions for protecting unique natural habitats bordering agricultural areas. However, costs of overseeing the implementation of relevant recommendations in agricultural economic entities, which use appropriate subsidies, are a problem if there are hundreds of thousands of such entities (as in Poland in 2013). Besides, it is hard with regard to certain undertaken actions to determine measures and indicators for assessing to what extent requirements have been implemented.

It is desirable to, as far as possible, spread technologies to reduce costs per unit of agricultural production and, at the same time, the negative environmental impact of ongoing production[5]. Such technologies have already been applied in agriculture, as evidenced by the so-called precision agriculture which makes it possible to reduce costs of mineral fertilisation and chemical plant protection products with a relatively smaller decline in production value. The so-called economical production technologies, which may be applied on a large scale, serve this purpose as well. They involve giving up certain production steps (e.g. annual ploughing), thus reducing carbon dioxide emissions resulting from fuel combustion. Another example is the use of compound mineral fertilisers which seep into the soil slowly. As a result, fewer production steps are involved and

[5] Vaclav Smil [Smil 2014], who has been already several times quoted, reported that, on a global scale, 1/3 of energy used today by households and businesses can be saved.

minerals do not leach into surface or subsurface water. In this case, waste of resources and environmental pollution are reduced as well.

Besides, research is ongoing in the world's leading research centres engaged in genetic research on whether annual crops can be converted into perennials, thus reducing the amount of fuel needed for production steps, as perennials do not require annual cultivation and sowing. Perennials may also reduce cultivation risk, because their root system is deeper which allows them to access groundwater from rainfall longer during periods of drought.

The fact that environmental policy has so far shown little interest in reducing the adverse impact of agricultural production on climate change does not remain unnoticed. It is, however, possible[6] to reduce greenhouse gas emissions (carbon dioxide and nitrous oxide) in agriculture by applying organic fertilisers in the form of manure, appropriately prepared straw, catch crops, etc. At the same time, the use of fertilisation of this kind clearly improves economic effects of agricultural holdings and enterprises, because it improves physical characteristics of the soil.

A controversial issue is the use of biofuels as one of the remedies for reducing greenhouse gas emissions, because the deliberate production of raw material for their manufacturing competes with other crops for water. Additionally, the transport of that raw material over longer distances is expensive, as its water content is high (share of dry matter is low). Therefore, those purchasing raw material for biofuel production appreciate a waste product of crop production, i.e. compressed straw. However, sales of straw compete with its use in agricultural holdings and enterprises for organic fertilisation and may lead to a situation in which fertilisation is not or ceases to be well-balanced.

● *At present, economic activity is about making use of appropriately skilled labour resources and natural resources, by making and using money, while benefiting from products of human creativity.*

An important characteristic of economic growth is achieving the so-called net surplus and then dividing it. To make the economy function smoothly:

[6] Zieliński M., *Effects of holdings specialising in cultivation of cereals, oilseeds and protein crops sequestering CO_2*, Scientific Annals of the Association of Agricultural and Agribusiness Economists, Vol. XIV, No. 5, Warsaw 2012; Zieliński M., *Possible impact of holdings specialising in cultivation of cereals on climate change*, [in:] *From the research on socially sustainable agriculture (20). Selected aspects of sustainable development of agriculture*, IAFE-NRI, Multi-Annual Programme 2011-2014, No. 95, Warsaw 2013.

- *those running enterprises must achieve the rate of profit on equity which compensates for risk, i.e. 2-3 times higher than credit interest. This is possible if the government ensures a stable value of money;*
- *remuneration should allow employees and their families to satisfy not only their basic but also additional needs. Otherwise, there will be no basic condition enabling saving money in banks which, consequently, will make credit interest higher. Remuneration should therefore grow and that growth should keep pace with labour productivity growth;*
- *banks must charge credit interest, taking account of costs incurred, resources of money deposited by people, demand for credits and credit risk;*
- *those owning natural resources must receive rent, the amount of which depends on costs of making these resources available, searching for undiscovered deposits of non-renewable resources, restoring exploited renewable resources and their rarity;*
- *inventors must receive rent covering costs of created innovations and providing an incentive for continuing inventive activities.*

What is also necessary is the regulatory role of the government (the State). It should:

- *pursue stable monetary policy which means that the value of money should not fall faster than by 2% per year;*
- *maintain educational infrastructure creating the foundation of human creativity and control: patent law, the size of banks' liquidity reserve and appropriation of natural resources;*
- *use the fiscal system to encourage enterprises to run their own R&D activity and, if it is impossible due to their poor financial capacity, finance R&D activities from the budget. The latter applies especially to research aimed at environmental protection issues, with particular regard to the possibility of reducing greenhouse gas emissions.*

● *The process of economic growth is a widening spiral in shape. Activity of free capital holders and credits make production grow through investments that increase the scale of production, the intensity of using natural resources together with products of human creativity. This in turn, by increasing both the number of employees and remuneration as a result of growing requirements with respect to the level of qualifications, increases household wealth and, at the same time, savings which increase bank money resources being a source of cheap credits.*

The foregoing makes it clear that the modern economy must grow constantly not to fall into crisis. It is not about maximising the rate of this growth, but rather maintaining the minimum rate of GDP growth, on a global scale, at 1.8% per year.

Can global growth be continued indefinitely? The answer will be negative if at least two significant barriers are not removed. The first one is exceeding the environment's capacity to absorb emissions and waste. Therefore, it will be increasingly hard to follow the principle of sustainable economic growth due to the rising costs of environmental restoration. The second significant barrier is the existence of national currencies which, if the rate of economic growth declines, encourages the specific countries to devalue the national currency faster than it is apparent from the rate recommended. Nevertheless, the dwindling natural resources are no such a barrier, as human creativity makes it possible to create their substitutes.

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To sum up, it can be stated that the "growth spiral" idea presented by H.Ch. Binswanger can be applied in agriculture, despite its identified shortcomings. The idea puts an end to chaos in the way households, households engaged in agricultural production, agricultural holdings with characteristics of an enterprise and agricultural enterprises of legal persons, whose owners intend to find a permanent place in the market of agricultural products and the labour market or, if their position is already well-established, retain it, are perceived. It also presents mechanisms that create farming conditions in a broad sense (crediting, supply of innovation, access to natural resources, etc.). Nevertheless, the characterised "growth spiral" idea has two weaknesses. The first one is a rather one-sided overview of opportunities for reducing the negative impact of economic activity on the environment. The idea addresses this issue diametrically, i.e. on the one hand, as regards options for actions of a small organised community and, on the other hand, it requires waiting for innovation, which serves low-carbon energy production, to be created. This will help solve the global problem of unfavourable climate change. The second weakness is that no single global currency exists.

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ECONOMIC STANDING AND INVESTMENT ACTIVITY OF AGRICULTURAL HOLDINGS PARTICULARLY VULNERABLE TO AGRICULTURAL DROUGHT AND OTHER HOLDINGS IN 2006-2013

Introduction

A major challenge of climate change in agriculture is adaptation to more and more frequent droughts. In 1951-1981 and 1982-2012, there were respectively six and eighteen cases of droughts in Poland at different times of the year[7]. As for most crops, the greatest deficit in precipitation occurs in central Poland[8]. Any drop in precipitation in that region is particularly undesirable, as it covers mostly light soils with low water-holding capacity, thus making them even more vulnerable to effects of drought.

The Agricultural Drought Monitoring System, which has been operated by the Institute of Soil Science and Plant Cultivation – National Research Institute in Puławy on behalf of the Ministry of Agriculture and Rural Development (MARD) since 2006, reveals that Wielkopolskie, Kujawsko-Pomorskie, Lubuskie, Łódzkie and Wielkopolskie voivodeships are particularly vulnerable to agricultural drought[9], the threat of which was extremely frequent there in the years 2006-2013.

The purpose of this chapter is therefore to identify potential differences in the way agricultural holdings, be it those located in areas particularly vulnerable to agricultural drought and other ones, which kept accounts for the Polish FADN in 2006-2013 on an ongoing basis, operate.

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[7] Lorenc H., *Drought in Poland – 2006*, Institute of Meteorology and Water Management, Warsaw 2006; Lorenc H., *Droughts and maximum precipitation in Poland*, Institute of Meteorology and Water Management, presentation at a seminar of the Polish Committee of the Global Water Partnership, 16 December 2011, Warsaw 2011; *Strategic adaptation plan for sectors and areas vulnerable to climate change by 2020*, Ministry of the Environment, Warsaw 2013.

[8] *Climatic and oceanographic conditions in Poland and the south Baltic Sea*, Institute of Meteorology and Water Management, Warsaw 2012.

[9] In accordance with the definition referred to in the Act on agricultural crop and livestock insurance, "agricultural drought" is construed as damage as a result of a drop in a climatic water balance below the critical value specified for particular species of arable crops and soils in any six-decade period from 1 April to 30 September [MARD 2005]. The climatic water balance indicator is determined as the difference between total atmospheric precipitation and potential evapotranspiration for a given period [Doroszewski et al. 2012, Durło 2007, Mizak et al. 2011].

Method

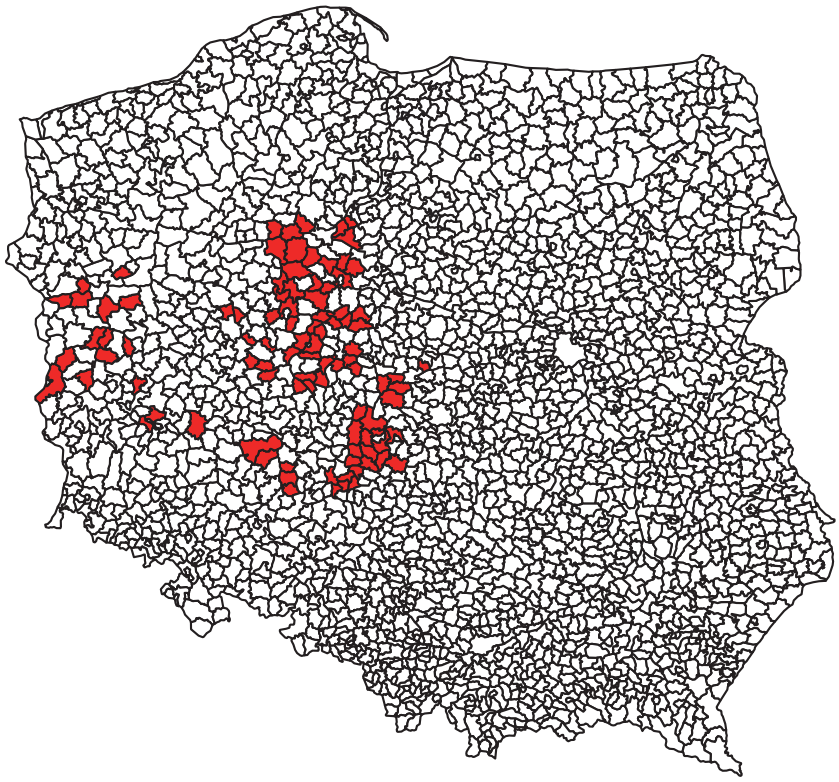
In order to achieve the purpose of research, 293 holdings particularly vulnerable to agricultural drought and 4286 other holdings, which kept accounts for the Polish FADN in 2006-2013 on an ongoing basis, were selected. Then, bearing in mind that soil quality, in addition to climatic conditions, is also an important factor for an agricultural holding in determining the quality of its production space, both groups of holdings were divided into four subgroups by quality of own soils. The first two of them included respectively 108 holdings particularly vulnerable to agricultural drought and 1608 other holdings operating on lower-quality soils (quality of own soils: =<0.7). However, the last two subgroups included respectively 185 holdings particularly vulnerable to agricultural drought and 2678 other holdings operating on higher-quality soils (quality of own soils: >0.7). The purpose of this study is a comparative assessment of their production potential, production organisation, economic and technical efficiency as well as investment opportunities.

The analysis does not include holdings whose production value is at least PLN 1 million per 1 ha of UAA. These were horticultural holdings growing vegetables and flowers under cover and those breeding granivores whose agricultural production was based on using purchased fodder. As for these holdings, it was found that the risk of agricultural drought is not strictly connected with their agricultural production.

Holdings, which were located in municipalities where at least one species or group of arable crops[10] in at least one of 13 six-decade plant vegetation periods was under threat of agricultural drought in at least seven out of eight years under analysis, were considered particularly vulnerable to agricultural drought. In 2006-2013, such municipalities were found in the following voivodeships: Dolnośląskie, Kujawsko-Pomorskie, Lubuskie, Łódzkie and Wielkopolskie. There were 30 such municipalities in the Wielkopolskie Voivodeship (9.5% of all municipalities in the voivodeship), while in Łódzkie, Kujawsko-Pomorskie, Lubuskie and Dolnośląskie voivodeships – 23 (11.4%), 21 (11.7%), 14 (12.1%) and 8 (3.6%), respectively (Map 1).

[10] The Agricultural Drought Monitoring System covered the following species and groups of arable crops: winter and spring cereals, legumes, maize for silage and grain, oilseed rape and turnip rape, potatoes, sugar beets, hop, tobacco, field vegetables, fruit trees, bushes and strawberries.

Map 1. Municipalities particularly vulnerable to agricultural drought in Poland in 2006-2013



Source: own study based on the Agricultural Drought Monitoring System from 2006-2013.

In order to assess how holdings from the selected subgroups operate, the following factors were analysed:

1) production potential:

- share of LFA holdings;
- soil quality index;
- UAA (ha) including: own land, land rented for at least one year, land utilised under sharecropping arrangements as well as fallow and uncultivated land;
- share of rented land (%);

- total labour inputs per 1 ha of UAA, including total human labour inputs under an agricultural holding's operating activity expressed in hours[11];
- share of hired labour (%);
- capital-labour ratio representing the value of total assets, including agricultural land, an agricultural holding's buildings, forest planting, machinery and equipment, breeding and non-breeding herd animals as well as working capital (stocks of agricultural products and other current assets) per 1 AWU;

2) production organisation:

- share of arable land (AL) in utilised agricultural area (UAA) (%);
- share of cereals in AL (%);
- share of green manure in AL (%);
- stocking density expressed as livestock units per 1 ha of AL (LU/ha of AL);

3) production results, productivity, economic and technical efficiency as well as investment opportunities:

- wheat yield (dt/ha);
- milk yield of cows (kg/cow/year);
- productivity of land (PLN/ha of AL) determined as the ratio of total on-farm production value to AL;
- productivity of capital (%) determined as the ratio of total on-farm production value to average capital value;
- productivity of labour (PLN/AWU) determined as the ratio of total production value to the number of full-time employees;
- agricultural holding income (PLN) per 1 ha of UAA;
- agricultural holding income (PLN) per 1 ha of UAA without the Less Favoured Areas subsidies;
- competitiveness index (Wk) determined as the quotient of agricultural holding income and total estimated costs of using own factors of production, i.e. own labour, land and capital (Equation 1). The cost of own labour was adopted based on average costs of hired labour applied for the selected subgroups of holdings. An analogical solution was adopted in relation to costs of using own land, taking the amount of lease rent as a basis for estimates. However, the cost of equity was assumed to be the average interest

[11] In accordance with the Polish FADN methodology, 1 AWU (FWU) equaled 2200 labour hours until 2010, while since 2011 it has been 2120 hours [Polish FADN 2011, 2012, 2014].

on long- and short-term credits. The competitiveness index indicates the competitive capacity of an agricultural holding. If the value of the competitiveness index is one or more, costs of own factors of production are fully covered by income. In this situation, an agricultural holding is found to be competitive. However, if the value of the competitiveness index is below one, these costs are not fully covered by income, thus meaning that an agricultural holding is uncompetitive (Kleinhanss 2015).

$$Wk = \frac{Dzgr}{(K_{wp} + K_{wz} + K_{wk})} \quad (1)$$

where:

Dzgr – agricultural holding income,
K_{wp} – estimated cost of own labour,
K_{wz} – estimated cost of own land,
K_{wk} – estimated cost of equity (excluding own land).

- reproduction rate of fixed assets (%) determined as the ratio of net investment to the value of fixed assets, including agricultural land, an agricultural holding's buildings, forest planting, machinery and equipment as well as breeding herd animals;
- technical efficiency ratio determined based on the Stochastic Frontier Analysis (SFA), oriented towards effects and determined as the quotient of the actual effect and the achievable desired effect which an agricultural holding could achieve if the inputs incurred remained unchanged. In order to determine the technical efficiency ratio of agricultural holdings, an econometric model in the form of the Cobb-Douglas function was constructed. Total production value plus operating subsidies (PLN) was taken as an effect category (y) for the construction of the model, while in terms of inputs (x_i): own and hired labour inputs expressed in AWU, value of utilised agricultural area[12] (PLN), inputs of fixed assets expressed through depreciation (PLN) and total costs minus depreciation and remuneration (PLN). Furthermore, the analysis of the technical efficiency of the selected subgroups of agricultural holdings took account of a factor that might significantly affect their technical inefficiency. The *soil quality index* of own soils was found to be that factor.

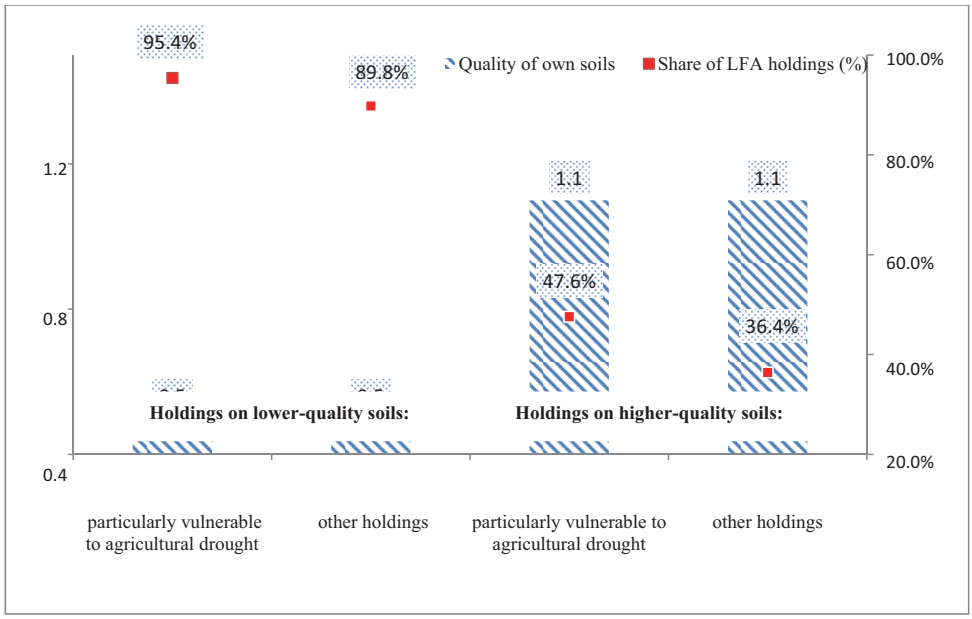
[12] The value of utilised agricultural area was determined by using information on the average purchase price of 1 ha of UAA in agricultural holdings keeping accounts for the Polish FADN 2006-2013.

Findings

The share of agricultural holdings particularly vulnerable to agricultural drought and other ones in the structure of lower- and higher-quality soils was similar. Holdings particularly vulnerable to agricultural drought, whose share in lower- and higher-quality soils was respectively 6.3 and 6.5%, constituted a smaller subgroup (Table 1).

The quality of own soils for holdings operating on lower-quality soils was 0.5 on average, i.e. lower than the quality of own soils for holdings operating on higher-quality soils by 54.5%. Nevertheless, these holdings had a higher share of LFA holdings, i.e. respectively 95.4 and 89.8% for holdings particularly vulnerable to agricultural drought and other ones operating on lower-quality soils, while holdings operating on higher-quality soils had this share lower, i.e. 47.6 and 36.4%, respectively (Figure 1).

Figure 1. Quality of own soils and the share of LFA holdings (%) in the holdings under analysis (2006-2013 averages)



Source: own study based on Polish FADN data from 2006-2013.

The figures compiled in Table 1 indicate that the utilised agricultural area of holdings particularly vulnerable to agricultural drought on higher-quality soils was larger than that of other ones by 2.2% on average. The situation was different among holdings operating on lower-quality soils, as the utilised agricultural area of those particularly vulnerable to agricultural drought was smaller than that of other holdings by 15.6% on average.

It was found that holdings from the analysed subgroups carried out their production in part on rented land, although its share in utilised agricultural area in holdings particularly vulnerable to agricultural drought, which operated on lower- and higher-quality soils, was smaller than in other holdings by 9.5 and 3.9 percentage points (pp), respectively. This situation should be considered as unfavourable, because agricultural holdings often find land rental to be an important way of improving efficiency in the use of other factors of production.

Total labour inputs per 1 ha of UAA in holdings particularly vulnerable to agricultural drought, which operated on lower- and higher-quality soils, were higher than those incurred in other holdings by respectively 7.2 and 5.8%, although their capital-labour ratio was lower by 8.4 and 5.8%, respectively. To run their economic activity, holdings from the selected subgroups used mostly own labour of their managers and their family members.

Table 1. Production potential in the holdings under analysis (2006-2013 averages)

Specification	Unit	Holdings on lower-quality soils (quality of own soils: =<0.7)		Holdings on higher-quality soils (quality of own soils: >0.7)	
		particularly vulnerable to agricultural drought	other holdings	particularly vulnerable to agricultural drought	other holdings
Number of holdings	-	108	1 608	185	2 678
Utilised agricultural area, including:	ha	30.2	35.8	37.8	37.0
- rented land	%	12.3	21.8	18.5	22.4
Total labour inputs per 1 ha of UAA, including:	h	133.4	124.4	117.8	111.3
- hired labour	%	4.2	6.0	9.5	10.4
Value of assets per 1 AWU	PLN '000	256.9	280.4	347.4	368.7

Source: cf. Figure 1.

Having analysed production organisation, it was found that holdings operating on lower- and higher-quality soils differ (Table 2). The arable land of holdings operating on lower-quality soils was of lower importance in the structure of utilised agricultural area than that of holdings operating on higher-quality soils, while in the structure of arable land, cereals were of greater importance. The situation of holdings particularly vulnerable to agricultural drought, which operated on lower-quality soils, was a matter of concern, as the share of cereals in arable land exceeded 75%[13] and probably made it hard to select forecrops.

Table 2. Production organisation in the holdings under analysis (2006-2013 averages) (%)

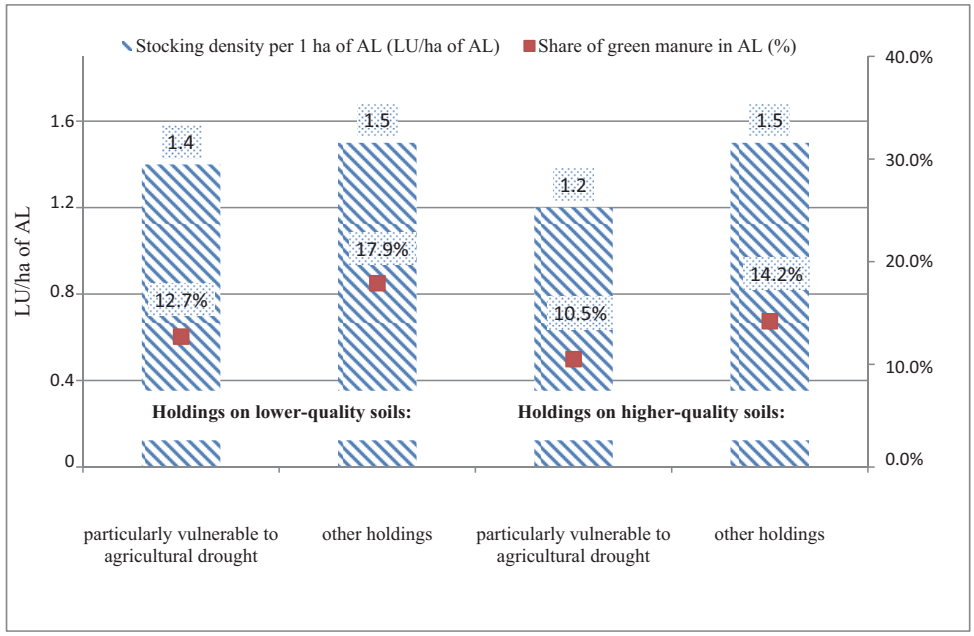
Specification	Holdings on lower-quality soils (quality of own soils: =<0.7)		Holdings on higher-quality soils (quality of own soils: >0.7)	
	particularly vulnerable to agricultural drought	other holdings	particularly vulnerable to agricultural drought	other holdings
Share of arable land in utilised agricultural area	74.3	61.1	92.4	90.5
Share of cereals[a] in arable land	75.3	69.0	67.0	67.1

[a] Common wheat, rye, barley, oats, mixed cereals, maize and other cereals were considered.
Source: cf. Figure 1.

Applying green manure on arable land and having a relatively high stocking density are especially important in holdings particularly vulnerable to agricultural drought (Figure 2).

[13] In accordance with A. Harasim [Harasim 2006], an allowable share of cereals in the crop structure is 75%.

Figure 2. Stocking density per 1 ha of AL (LU/ ha of AL) and the share of green manure in AL (%) in the holdings under analysis
(2006-2013 averages)

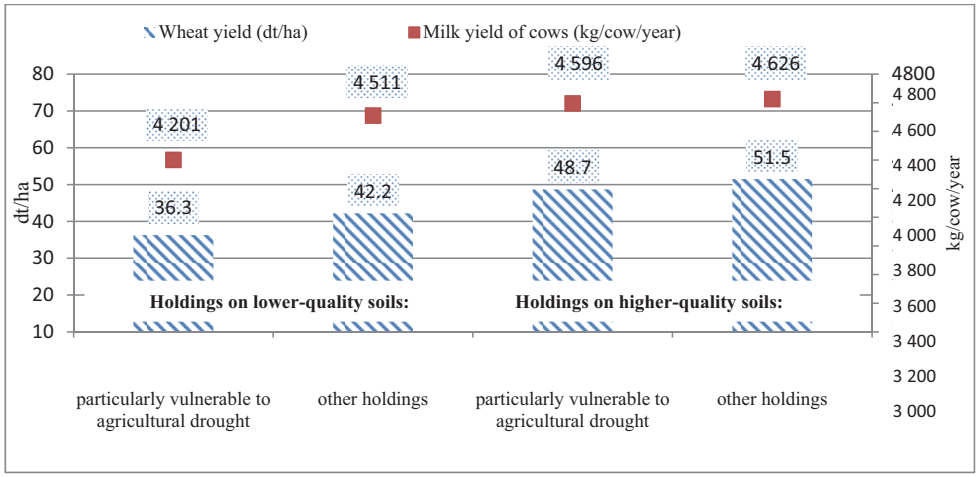


Source: cf. Figure 1.

As a matter of fact, these holdings can reduce negative effects of soil water shortages during the plant vegetation season by ploughing green manure and natural animal fertilisers. High organic matter content in the soil not only improves its structure and increases the content of nutrients available to plants, but also improves water-holding capacity.

It was typical of holdings particularly vulnerable to agricultural drought that their production results were poorer than those of other holdings, i.e. wheat yield and milk yield of cows were, in fact, lower in those operating on lower-quality soils by respectively 14.0 and 6.9%, while in those operating on higher-quality soils – by 5.4 and 0.6%, respectively (Figure 3).

Figure 3. Wheat yield (dt/ha) and milk yield of cows (kg/cow/year) in the holdings under analysis (2006-2013 averages)



Source: cf. Figure 1.

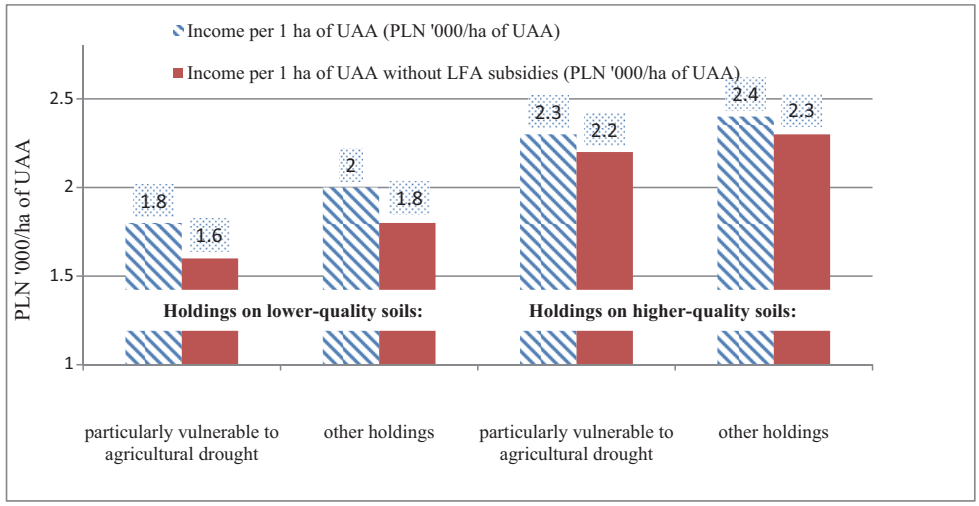
Holdings particularly vulnerable to agricultural drought and other ones differed in the level of productivity of factors of production. It was found that the former had lower productivity of factors of production, i.e. production value per 1 ha of UAA, production value per PLN 1 of capital value and production value per 1 AWU were, in fact, lower in those operating on lower-quality soils by 8.2%, 2.5 pp and 16.9%, respectively. It was no different among holdings operating on higher-quality soils, because the values of those particularly vulnerable to agricultural drought were lower by 8.8%, 3.3 pp and 6.8%, respectively (Table 3).

Table 3. Productivity of factors of production in the holdings under analysis (2006-2013 averages)

Specification	Unit	Holdings on lower-quality soils (quality of own soils: =<0.7)		Holdings on higher-quality soils (quality of own soils: >0.7)	
		particularly vulnerable to agricultural drought	other holdings	particularly vulnerable to agricultural drought	other holdings
Productivity of land	PLN '000/ha of UAA	5.6	6.1	6.2	6.8
Productivity of capital	%	34.6	37.1	32.1	35.4
Productivity of labour	PLN '000/AWU	86.4	104.0	111.6	119.8

Source: cf. Figure 1.

Figure 4. Income per 1 ha of UAA (PLN '000/ha of UAA) and per 1 ha of UAA without LFA subsidies (PLN '000/ha of UAA) in the holdings under analysis (2006-2013 averages)

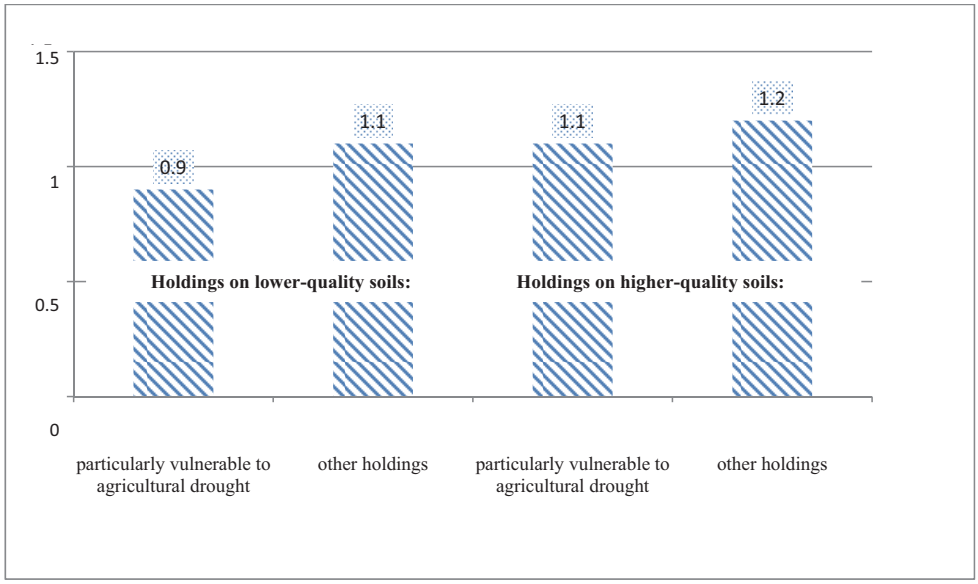


Source: cf. Figure 1.

Differences to the disadvantage of holdings particularly vulnerable to agricultural drought were also visible in income per 1 ha of UAA. Those operating on lower-quality soils had that income lower by 10.0% on average, while those on higher-quality soils – by 4.2%. Importantly, as far as these holdings are concerned, direct LFA subsidies did not make these differences smaller (Figure 4).

The differences referred to above between holdings particularly vulnerable to agricultural drought and other ones in income per 1 ha of UAA were also revealed in the value of the competitiveness index (Wk) (Figure 5). It was found that competitive capacity was typical of other holdings operating on soils of lower quality (Wk=1.1), holdings particularly vulnerable to agricultural drought (Wk=1.1) and other ones (Wk=1.2) operating on higher-quality soils, whereas holdings particularly vulnerable to agricultural drought, which operated on lower-quality soils, had no competitive capacity (Wk=0.9).

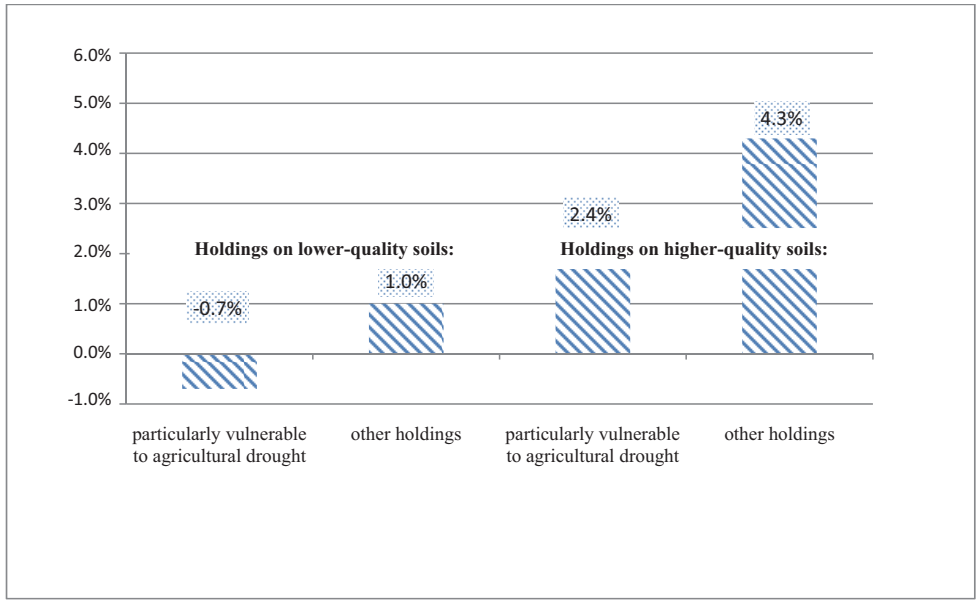
Figure 5. Value of the competitiveness index in the holdings under analysis (2006-2013 averages)



Source: cf. Figure 1.

Holdings vulnerable to agricultural drought had their development capacity limited due to the worse economic situation (Figure 6). The situation of holdings which operated on lower-quality soils was a matter of concern, as their reproduction rate of fixed assets was negative, i.e. the investment amount, spent by these holdings to purchase new or reproduce existing fixed assets was not enough so that they could retain the assets held at that time. In this regard, the situation of holdings vulnerable to agricultural growth, which operated on higher-quality soils, was better, i.e. their completed investments allowed them not only to maintain the existing fixed assets, but also to further develop.

Figure 6. Reproduction rate of fixed assets (%) in the holdings under analysis (2006-2013 averages)

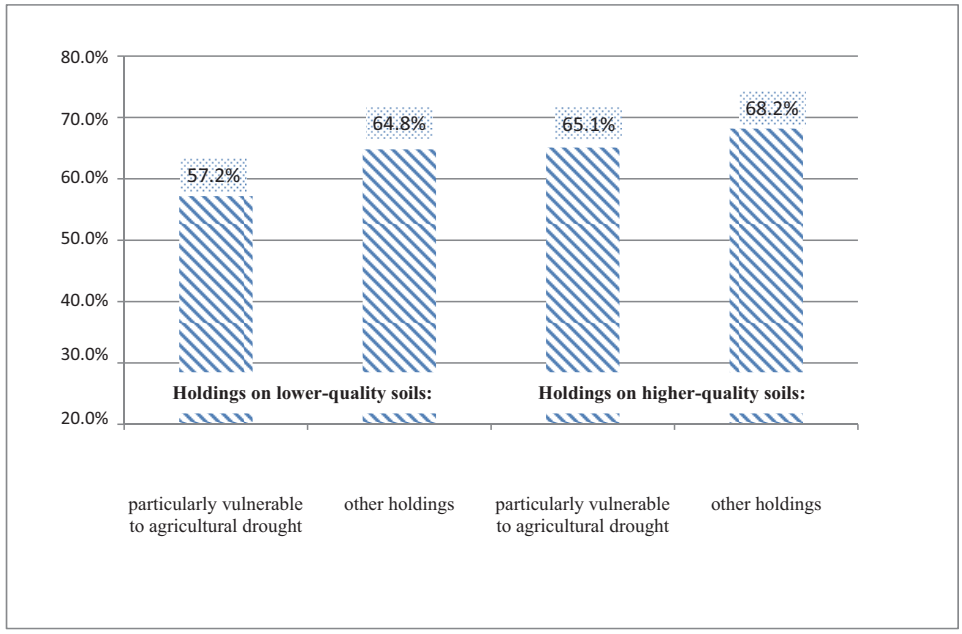


Source: cf. Figure 1.

The selected subgroups of holdings were also evaluated as to their technical efficiency. The figures presented in Figure 7 reveal that holdings particularly vulnerable to agricultural drought and other holdings used their inputs unreasonably to achieve potential production value.

Holdings particularly vulnerable to agricultural drought, which operated on soils of lower quality, achieved the average production value at 57.2% of the potential production value, i.e. lower than that of other holdings by 7.6 pp. The situation of holdings operating on higher-quality soils was similar. In fact, the average technical efficiency of holdings particularly vulnerable to agricultural drought was lower and reached 65.1%, while in the case of other holdings it amounted to 68.2%.

Figure 7. Value of the technical efficiency ratio in the holdings under analysis (2006-2013 averages)



Source: cf. Figure 1.

Summary and conclusions

The chapter indicated the differences in production potential, production organisation, economic and technical efficiency as well as investment opportunities of holdings particularly vulnerable to agricultural drought and other ones operating on lower- and higher-quality soils. To this end, 293 holdings particularly vulnerable to agricultural drought and 4286 other holdings, which kept accounts for the Polish FADN in 2006-2013 on an ongoing basis, were analysed. Then, both groups of holdings were divided into four subgroups by quality of own soils. The first two of them included respectively 108 holdings particularly vulnerable to agricultural drought and 1608 other holdings operating on lower-quality soils (quality of own soils: =<0.7). However, the last two subgroups included respectively 185 holdings particularly vulnerable to agricultural drought and 2678 other holdings operating on higher-quality soils (quality of own soils: >0.7).

It was found that, on average in 2006-2013, holdings particularly vulnerable to agricultural drought, as opposed to other holdings:

- had higher employment per 1 ha of UAA and the lower capital-labour ratio. It cannot be ruled out that their lower capital-labour ratio prevented them from using techniques and technologies to reduce effects of agricultural drought;
- made less use of the external factors of production, i.e. hired labour and land rental. This situation should be considered as unfavourable, because making greater use of those factors in agricultural holdings often demonstrates their managers' tendency to use other factors of production more effectively;
- achieved poorer production results which resulted in lower productivity of land, labour and capital;
- achieved lower agricultural holding income per 1 ha of UAA which was reflected in their lower incentive to invest. This situation is of particular concern in holdings vulnerable to agricultural drought, which operate on lower-quality soils, whose reproduction rate of fixed assets was found to be negative. In fact, these holdings operating on soils with low water--holding capacity should all the more introduce new production techniques and technologies aimed not only at improving their volume of production, but also reducing effects of agricultural drought.

This study proves that worse natural farming conditions, under which agricultural holdings operate, limit the size of their production and economic effects as well as development opportunities. Holdings vulnerable to agricultural drought, which operate on lower-quality soils, are particularly disadvantaged in this regard, because higher-quality soils offer effective farming opportunities, even in case of particular vulnerability to agricultural drought. Nevertheless, these opportunities are smaller than in other holdings.

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ORGANISATION AND EFFICIENCY OF POLISH AGRICULTURAL HOLDINGS SPECIALISING IN FIELD CROPS AGAINST HOLDINGS FROM SELECTED COUNTRIES

Introduction

After market economy principles were introduced in 1989, there were far--reaching changes in the agricultural production structure, especially in the crop structure. The share of cereals in the crop structure did not exceed 60% until 1990, but it started increasing steadily in the subsequent years to reach approx. 73% in 2013. The shares of other crops in that year were as follows: 3.7% for potatoes, 1.9% for sugar beets, 8.9% for rape and turnip rape and only 1.6% for legumes. In environmental terms, such a crop structure is very unfavourable. The high share of cereals in the crop structure makes it harder to carry out farming in accordance with requirements of good agricultural practices[14].

The changes in the crop structure affected the number and share of holdings specialising in crop production. In accordance with the FADN[15] scheme, they can be divided into two groups by type of farming, i.e. field crop holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds (Type 15) and holdings specialising in the field cultivation of different crop species (Type 16).

The figures given in Table 1 indicate that holdings oriented towards crop production represent a very significant share in the total number of holdings. In 2002, their share was 47% and increased in subsequent years to reach 53% in 2013. The group of crop holdings was dominated by field crop holdings specialising in the cultivation of cereals, oilseeds and legumes. In 2002, their share was 78.3% and increased to 93.5% in 2013. Their number was stable and amounted to approx. 700 thousand. The share and number of mixed crop holdings (Type 16) decreased from 21.7% in 2002 to 6.5% in 2013. These changes indicate a tendency to intensify processes of specialisation of holdings. The group of field crop holdings (Type 15) underwent structural changes. The share of very small holdings (up to 1 ha of utilised agricultural area) declined significantly from 38% in 2002 to 2.1% in 2013. However, the share of holdings with 1-20 ha of UAA increased from 59.1% in 2002 to 90% in 2013, so did the share of holdings with an area of at least 20 ha, i.e. from 2.9% in 2002 to 6.5% in 2013.

[14] Kuś J., Jończyk K., *Good agricultural practice*, Agricultural Advisory Centre Radom 2005.
[15] FADN (Farm Accountancy Data Network)

A characteristic feature of these holdings is that they have no draft force in the form of tractors. In 2002, 73% of these holdings owned no tractors, while in 2013 – 45%. In 2013, these holdings used 154.5 kg of NPK/ha of UAA, i.e. 14.5% above the average in agriculture.

Table 1. Number of field crop holdings (Type 15) and mixed crop holdings (Type 16) in 2002-2013 ('000)

Specification	2002		2010		2013	
	Number of holdings	%	Number of holdings	%	Number of holdings	%
Field crop holdings (Type 15)	726.20	78.3	658.85	86.9	702.95	93.5
Mixed crop holdings (Type 16)	202.20	21.7	98.60	13.1	49.20	6.5
Crop holdings in total	928.4	100.0	757.46	100.0	752.15	100.0
Share of crop holdings in the total number of holdings (%)	47.0		52.0		53.0	
Structure of field crop holdings (Type 15)						
Up to 1 ha	275.97	38.0	109.00	16.6	15.20	2.1
1-20 ha	429.66	59.1	515.76	78.3	639.49	90.0
at least 20 ha	20.57	2.9	34.09	5.1	48.26	6.8
Average holding area (ha of UAA)	4.60		7.10		9.50	
Share of holdings without tractors (%)	73.30		53.20		45.90	
Level of mineral fertilisation (kg of NPK/ha of UAA)	-		-		154.5	

Source: Characteristics of agricultural holdings in 2013. CSO 2014, pp. 372-386. A collective work edited by: W. Józwiak and W. Ziętara. Changes in agricultural holdings in 2002-2010. National Agricultural Census, CSO, Warsaw 2013, pp. 26-33.

Crop holdings were characterised by a very low stocking density which resulted in no sustainable balance of organic matter in the soil and led to the unilateral use of the soil. Additionally, these holdings had a higher load of mineral fertilisers and chemical plant protection products. It can be assumed with high probability that holdings oriented towards crop production will remain a permanent element of Polish agriculture. There is a need to examine the organisation and economics of crop holdings to determine the direction in which they develop, while meeting the requirement of eco-friendliness. The fulfillment of this requirement guarantees maintaining and even increasing the production potential of land [Urban 1984, Górny 1991, Grzelak 2010].

1. Purpose of research, sources and methods

The main purpose of research is to evaluate the organisation and economics of holdings oriented towards crop production and determine the direction in which they develop. In accordance with the FADN scheme, they can be divided into two groups by type of farming:

- the agricultural holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds (Type 15),
- the agricultural holdings specialising in the field cultivation of different crop species (Type 16).

The intended purpose of research will be achieved through the following research tasks:

- evaluation of the production potential of Polish crop holdings against holdings from selected countries,
- evaluation of the level of production intensity and the efficiency of Polish holdings against holdings from selected countries,
- determination of the competitive position of Polish crop holdings and directions in which they develop against holdings from selected countries.

The research addresses Polish crop holdings covered by the Polish and European FADN in 2010-2012. Holdings of the same type from Hungary, the Czech Republic, Slovakia and Germany were covered by research for reference purposes. These countries were selected for research in a purposeful manner. They border Poland and have similar climatic conditions. The holdings under analysis were evaluated by taking into account their economic size, i.e. their Standard Output (SO)[16] value.

A comparative method was applied in research, by using the following groups of indicators:

- production potential,
- organisation of production and holdings,
- costs,
- productivity and efficiency[17].

[16] SO – Standard Output in thousand EUR.

[17] For a detailed list and description of the indicators applied, please refer to: Ziętara W., Zieliński M. 2012. *Efficiency and competitiveness of Polish agricultural holdings oriented towards crop production*, Problems of Agricultural Economics 1/2012, pp. 40-62.

Efficiency and competitiveness were evaluated based on the "management income" category which corresponds to the "entrepreneur's profit" category[18]. Table 2 presents opportunity costs of land, labour and capital in the holdings under analysis, taking into account their economic size.

Table 2. Costs of using own factors of production in agricultural holdings specialising in the cultivation of cereals, oilseeds and high-protein crops (Type 15) and the field cultivation of different crop species (Type 16) in 2010-2012

Countries	Holding size in SO (EUR '000) Type 15/16					
	<8	8-25	25-50	50-100	100-500	at least 500
Costs of land (EUR/ha)						
Poland	50.97/56.24	61.32/65.12	55.01/67.52	54.67/80.03	86.10/ 100.67	75.90*/117.13*
Hungary	73.59/-	63.73/59.22	78.65/65.29	90.74/75.17	104.7/135.38	127.70/150.00
Czech Rep.	-/-	76.09/-	57.95/-	67.87/72.15	69.81/96.19	76.51/89.21
Slovak Rep.	-/-	-/-	61.01/-	67.43/-	78.27/56.96	57.75/48.35
Germany	-/-	-/-	204.11/245.43	217.40/289.98	218.33/324.45	296.53/283.85
Costs of labour in agriculture (EUR/h)						
Poland	1.99/1.81	2.43/1.90	2.36/1.87	2.60/2.03	3.76/2.50	5.43*/4.64*
Hungary	2.00/-	2.53/2.26	2.83/2.23	3.08/3.06	3.90/3.14	5.18/4.94
Czech Rep.	-/-	4.06/-	3.26/-	4.04/3.90	5.38/4.79	6.46/6.06
Slovak Rep.	-/-	-/-	3.48/-	3.69/-	4.02/3.56	5.14/3.89
Germany	-/-	-/-	6.78/7.7	9.92/7.75	9.95/7.55	14.74/11.27
	Cost of labour in the national economy (EUR/h)			Cost of capital by 10-year bonds (%)		
Poland	4.70			5.57		
Hungary	4.48			7.60		
Czech Republic	5.41			3.41		
Slovak Rep.	4.76			4.29		
Germany	18.73			2.28		

*holdings of legal persons

Source: Own calculations based on data from the FADN, the Central Statistical Office, the National Bank of Poland, the Hungarian Central Statistical Office, the Czech Statistical Office, the Statistical Office of the Slovak Republic, Statistisches Bundesamt, the European Central Bank.

[18] Management income = agricultural holding income – opportunity costs of own factors of production, i.e. land, labour and capital.

It was assumed that costs of land equal rent paid by holdings in respective economic size classes. Costs of own labour were calculated based on costs of hired labour, taking into account the economic size. Costs of labour thus determined formed a basis for calculating parity income index A1 which is calculated as the ratio of holding income per own labour unit (FWU)[19] to cover the cost of hired labour in holdings of the same economic size. Furthermore, Table 2 presents the cost of labour in the national economy which is a basis for calculating parity income index A2, i.e. the ratio of agricultural holding income per own labour unit (FWU) to remuneration in the national economy. Index A2 forms a basis for determining the competitive capacity of a holding. The cost of equity was determined based on the interest on 10-year State Treasury bonds.

In order to determine the competitiveness of the crop holdings under analysis, also the competitiveness index referred to by W. Kleinhanss[20] was applied, in accordance with the formula below (Equation 2):

$$\mathrm{Wk} = \frac{\mathrm{Dzgr}}{\mathrm{Kwz+Kwp+Kwk}} \qquad (2)$$

where:
Wk – competitiveness index,
Dzgr – agricultural holding income,
Kwz – opportunity cost of own land,
Kwp – opportunity cost of own labour,
Kwk – opportunity cost of equity.
The value of competitiveness index Wk>=1 indicates that costs of own factors of production are covered in full, while Wk <1 indicates that the costs are covered in part.

Wk was further classified as referred to by Kleinhanss and thus the following classes were distinguished:
Wk (-) – if *Dzgr* (*Wk1*) is negative,
0<*Wk*<1 – costs of own factors of production are covered in part (*Wk2*),
1=Wk<2 – costs of own factors of production are covered in full (*Wk3*),
Wk>=2 – costs of own factors of production are covered twice (*Wk4*).

[19] FWU – Family Work Unit – a unit of own labour of a farmer and his/her family members which is equal to 2120 labour hours per year.
[20] Kleinhanss W., *Competitiveness of the major types of agricultural holdings in Germany*, Problems of Agricultural Economics No. 1/2015.

Competitiveness index Wk4 indicates that an agricultural holding enjoys full competitive capacity. This finding is consistent to some extent with Binswanger's view that an enterprise capable of development should achieve the rate of profit two times higher than credit interest[21].

In order to better evaluate Polish holdings oriented towards crop production, also the technical efficiency of holdings was determined by using the Stochastic Frontier Analysis.

2. Production potential and organisation, costs and effects of Polish crop holdings against holdings from selected countries in 2010-2012

The holdings under analysis will be characterised by economic size expressed in Standard Output (SO) in EUR '000. Six economic size classes were distinguished. The discussed characteristics of holdings are the 2010-2012 average. Changes in the value of characteristics in that period were insignificant. Class I (with less than EUR 8 thousand) included Polish and Hungarian holdings only. Class II (EUR 8-25 thousand) comprised Czech holdings as well. Finally, Class III (EUR 25-50 thousand) and subsequent classes included holdings from all the countries under analysis.

2.1. Production potential of Polish crop holdings against holdings from selected countries

Table 3 presents figures that characterise the production potential of the holdings under analysis. Their economic size was correlated with utilised agricultural area (UAA) in holdings of both types of farming. Polish and Hungarian holdings of Type 15 had a similar area at their disposal in each class. Their size ranged between 12.13 ha of UAA (Hungary) and 1412.58 ha of UAA (Hungary). The area of German holdings in Classes III-VI was by far the smallest. The holdings of Type 16 followed similar patterns, but their area was smaller than that of the holdings from the previous group. The largest differences were found in Polish holdings, i.e. they ranged between 20% (Classes I and VI) and 52% (Class V), and in the case of German holdings in Classes V and VI – 50 and 62%, respectively.

[21] Binswanger H.Ch., *Growth spiral. Money, energy and imagination in the dynamics of the market process*, Zysk i S-ka Press, Poznań 2011.

In all the holdings, the share of rented land increased as the economic size grew. Polish holdings of Type 15 had the lowest shares, i.e. between 13.8% and 64.2%, while Hungarian holdings had the shares between 28.5% and 96.1%. The share of rented land exceeded 50% in Czech, Slovak and German holdings in Classes III-VI.

Except for Polish holdings, the share of rented land was the highest in holdings in Classes V and VI, i.e. between 71% (Germany) and 96.1% (Hungary). Holdings of Type 16 followed similar patterns, but their share of rented land was smaller by a few percentage points.

Table 3. Production potential of the crop holdings under analysis (averages)

Countries	Economic size classes of holdings (EUR '000 of SO)											
	I (<8)		II (8 – 25)		III (25 – 50)		IV (50 – 100)		V (100 – 500)		VI (>=500)	
	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16
Utilised agricultural area (ha)												
Poland	**12.71**	**9.97**	**23.39**	**15.22**	**59.38**	**34.23**	**109.57**	**67.41**	**318.57**	**153.18**	**1 271.54**	**1 001.62**
Hungary	12.13	-	32.18	29.69	68.09	50.28	127.86	78.56	329.08	229.09	1 412.58	1 296.06
Czech	-	-	17.70	-	53.50	-	110.68	68.21	324.47	176.45	1 227.85	1 119.06
Slovak Rep.	-	-	-	-	59.50	-	116.75	-	339.93	238.44	1 646.39	1 317.75
Germany	-	-	-	-	40.38	36.63	75.70	63.77	219.29	110.75	1 035.35	390.71
Share of rented land (%)												
Poland	**13.84**	**12.30**	**23.00**	**19.18**	**35.48**	**28.44**	**39.71**	**33.47**	**44.86**	**43.22**	**64.17**	**57.49**
Hungary	28.49	-	31.04	17.41	42.27	38.17	52.06	55.68	72.40	75.98	96.06	96.10
Czech	-	-	40.55	-	54.72	-	67.74	60.71	84.87	78.53	91.98	87.58
Slovak Rep.	-	-	-	-	82.82	-	79.45	-	91.45	95.58	94.89	95.13
Germany	-	-	-	-	55.46	52.05	62.33	60.17	71.00	65.55	79.08	77.20
Total labour inputs (AWU/100 ha of utilised agricultural area)												
Poland	**8.89**	**13.04**	**5.43**	**11.30**	**2.71**	**6.95**	**1.76**	**3.68**	**1.50**	**2.91**	**1.75**	**2.89**
Hungary	3.54	-	1.83	3.31	1.48	4.39	1.30	3.17	1.39	2.26	1.45	2.72
Czech	-	-	3.77	-	2.43	-	1.66	2.69	1.34	2.24	1.48	2.81
Slovak Rep.	-	-	-	-	4.12	-	1.86	-	1.41	2.33	1.70	3.89
Germany	-	-	-	-	2.33	2.68	1.59	1.99	0.91	1.89	0.80	2.10
Share of own labour in total labour inputs (%)												
Poland	**97.34**	**97.43**	**98.42**	**89.15**	**92.75**	**75.17**	**83.06**	**71.68**	**26.51**	**39.72**	**0.00**	**0.50**
Hungary	79.84	-	86.44	74.19	76.23	43.14	58.35	41.58	20.1	20.52	0.08	0.70
Czech	-	-	99.67	-	92.05	-	80.58	88.99	36.45	42.02	1.80	1.52
Slovak Rep.	-	-	-	-	60.82	-	70.86	-	27.28	22.48	1.00	1.00
Germany	-	-	-	-	97.87	94.81	94.18	86.58	66.16	61.66	11.32	16.06

Source: European FADN.

Table 3. cont. Production potential of the crop holdings under analysis (averages)

Countries	Economic size classes of holdings (EUR '000 of SO)											
	I (<8)		II (8 – 25)		III (25 – 50)		IV (50 – 100)		V (100 – 500)		VI (>=500)	
	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16
Value of assets (EUR '000/ha of utilised agricultural area)												
Poland	**7.44**	**7.58**	**6.83**	**8.21**	**5.71**	**7.86**	**5.55**	**7.34**	**4.01**	**6.32**	**2.27**	**3.46**
Hungary	3.91	-	3.09	3.35	2.68	2.91	2.44	3.02	2.24	2.99	1.72	2.02
Czech	-	-	3.86	-	3.12	-	2.76	3.78	1.91	2.75	2.55	3.60
Slovak Rep.	-	-	-	-	1.75	-	1.50	-	1.23	1.73	1.52	1.82
Germany	-	-	-	-	11.31	14.28	10.13	12.37	4.97	10.99	3.45	6.44
Share of fixed assets in assets (%)												
Poland	**91.86**	**91.73**	**90.88**	**89.54**	**89.08**	**88.12**	**88.97**	**89.10**	**80.09**	**85.01**	**52.84**	**55.42**
Hungary	59.48	-	62.81	64.32	63.07	66.70	66.26	57.27	64.34	65.81	45.16	54.52
Czech	-	-	85.19	-	81.74	-	78.39	81.73	74.21	76.29	68.34	70.55
Slovak Rep.	-	-	-	-	52.00	-	54.75	-	55.43	54.22	55.92	50.07
Germany	-	-	-	-	93.12	93.33	92.34	90.57	87.06	89.03	68.12	75.69
Share of equity in liabilities (%)												
Poland	**98.82**	**98.58**	**96.13**	**97.16**	**91.26**	**93.94**	**87.76**	**90.02**	**82.23**	**88.08**	**67.83**	**60.99**
Hungary	93.12	-	90.51	90.29	88.49	85.99	85.08	81.31	80.30	78.22	77.65	72.64
Czech	-	-	96.27	-	93.94	-	85.25	94.02	73.53	81.54	73.74	77.07
Slovak Rep.	-	-	-	-	90.93	-	91.80	-	87.75	80.26	87.71	79.06
Germany	-	-	-	-	92.15	92.15	89.80	90.32	76.22	87.59	66.96	70.10

Source: European FADN.

Labour inputs in all the holdings decreased as the economic size increased. Polish holdings of Type 15 had them between 8.9 and 1.75 AWU/100 ha of UAA and were the highest among the holdings under analysis. The lowest labour inputs were found in Hungarian holdings, excluding Classes V and VI and in German holdings, i.e. 0.9 and 0.8 AWU/100 ha of UAA, respectively. Holdings of Type 16 had their level higher. Those from Poland, the Czech Republic and Germany had them higher by an average of 75%, while those from Slovakia – by 50%. Differences in holdings in Classes III-V were larger. The share of own labour in total labour inputs declined as the economic size of holdings grew. Considering both types, it was the highest in German holdings in which it ranged between 97.9 and 66.2% (Classes III-V). In Class VI, it reached 11.3% in holdings of Type 15 and 16% – of Type 16, while it did not exceed 2% in other holdings of that class.

The value of assets per 1 ha of UAA decreased as the economic size of holdings increased. Polish holdings of Type 15 had it between EUR 7.4 and 2.3 thousand/ha of UAA and it was higher than in Hungarian, Czech and Slovak holdings. The value of assets was much higher, i.e. twice higher compared to other countries, in German holdings. Similar trends were found in holdings of Type 16 in which the value of assets was higher than in holdings of Type 15. The largest differences were found in German holdings. They reached 60% on average, approx. 40% in Polish and Czech holdings, 30% in Slovak holdings and 18% in Hungarian holdings. The largest share in assets was that of fixed assets which decreased as the economic size of holdings of both types increased. It was the highest in German holdings which had it between 93% (Class III) and 68% (Class VI). Polish and Czech holdings had it lower by a few pp. It was the lowest in Hungarian and Slovak holdings in which it ranged between 63 and 45%. The highest share in liabilities was that of equity. Similarly, it declined as the economic size of holdings grew. Polish holdings had it similar in both types. In Classes I-V, it ranged between 98 and 88%. In Class VI, it was lower and amounted to 68% in holdings of Type 15 and 61% in those of Type 16. Other holdings had the share of equity in liabilities at a similar level.

2.2. Production organisation in the crop holdings under analysis against holdings from selected countries

Production organisation in the holdings under analysis was characterised based on the following indicators: share of cereals in utilised agricultural area, stocking density in LU/100 ha of UAA, share of crop production in total production and share of other production in total production. Corresponding figures were given in Table 4. In holdings of Type 15, the share of cereals was dominant. It was the largest in Polish holdings which had it between 78% (Class I) and 67% (Class VI). Other holdings had it lower by a few pp. The share of cereals in holdings of both types decreased as the economic size increased. In holdings of Type 16, the share of cereals in UAA was lower and did not exceed 50%.

Stocking density in the holdings under analysis was very low and did not exceed 6 LU/100 ha of UAA in Type 15 and 16 LU/100 ha of UAA in Type 16. Considering both types, it was the lowest in Hungarian holdings in which it was only 0.9 LU/100 ha of UAA (Class VI; 15). The production structure was dominated by crop production. Its share in holdings of both types ranged between 90 and 80% and declined as the economic size of holdings grew, the only exception being Slovak holdings in Class III in which the share of crop production in total production was 61%. The share of animal production was marginal, i.e. not higher than 5%. The share of other production was more significant, mostly in Slovak and German holdings. The former had it between 38% (Class III) and 13% (Class VI), while the latter – between 16% (Class III) and 9.7% (Class VI).

To generalise the assessment of production organisation in the holdings under analysis, the dominant share of cereals in utilised agricultural area, which decreased as the economic size of holdings increased, should be emphasised. The second group of crops included other crops whose share grew and reached approx. 28% in the two largest classes. The production structure was dominated by crop production whose share was approx. 90%, excluding Slovak holdings which had it lower. The share of animal production was very low, i.e. approx. 4%. Production organisation in larger holdings (Classes IV-VI) was characterised by a more sustainable and thus more eco-friendly crop structure.

Table 4. Production organisation in the crop holdings under analysis (averages)

Countries	Economic size classes of holdings (EUR '000 of SO)											
	I (<8)		II (8 – 25)		III (25 – 50)		IV (50 – 100)		V (100 – 500)		VI (>=500)	
	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16
Share of cereals in utilised agricultural area (%)												
Poland	77.65	**57.58**	76.38	**55.54**	71.36	**53.30**	67.97	**55.62**	67.97	**50.14**	67.17	**47.51**
Hungary	72.93	-	66.62	31.34	64.24	35.52	64.37	44.88	64.37	52.39	64.97	51.48
Czech	-	-	64.79	-	66.49	-	63.10	51.07	63.10	49.64	65.34	52.47
Slovak Rep.	-	-	-	-	71.93	-	61.63	-	61.63	31.53	59.37	44.41
Germany	-	-	-	-	65.77	43.96	64.45	47.29	64.45	48.33	60.92	44.72
Stocking density (LU/100 ha of utilised agricultural area)												
Poland	4.48	**11.63**	4.13	**12.86**	3.82	**14.80**	3.06	**12.34**	2.21	**9.39**	5.23	**9.66**
Hungary	3.27	-	2.90	4.1	2.99	4.09	2.72	2.08	1.74	5.56	0.92	9.05
Czech	-	-	5.42	-	6.42	-	5.46	10.60	3.59	6.65	5.13	16.15
Slovak Rep.	-	-	-	-	2.60	-	2.39	-	1.98	6.25	7.58	13.73
Germany	-	-	-	-	3.93	3.90	4.04	4.97	3.64	7.82	4.53	14.41
Share of crop production in total production (%)												
Poland	93.29	**85.81**	94.59	**91.17**	94.84	**91.93**	94.47	**91.52**	94.47	**93.49**	**92.98**	**91.53**
Hungary	87.52	-	92.99	88.54	93.87	97.19	93.41	91.11	93.41	87.44	88.16	79.53
Czech	-	-	90.68	-	92.56	-	93.03	90.74	93.03	90.00	86.87	83.07
Slovak Rep.	-	-	-	-	61.06	-	79.14	-	79.14	67.76	81.75	76.29
Germany	-	-	-	-	81.31	73.37	84.55	82.40	84.55	86.96	87.85	84.08
Share of other production in total production (%)												
Poland	**2.65**	**3.09**	**1.63**	**1.29**	**1.60**	**0.90**	**1.09**	**0.94**	**1.09**	**0.73**	**2.37**	**3.59**
Hungary	9.06	-	3.83	5.52	3.31	0.53	5.03	7.67	5.03	9.79	10.88	13.54
Czech	-	-	4.22	-	2.77	-	3.13	4.22	3.13	6.92	9.49	6.93
Slovak Rep.	-	-	-	-	38.04	-	19.63	-	19.63	30.72	13.26	15.05
Germany	-	=	-	-	16.09	24.46	12.42	13.03	12.42	9.56	9.67	8.69

Source: European FADN.

2.3. Production intensity and the efficiency of Polish cereal holdings against holdings from selected countries

The level of production intensity was determined by the amount of total costs, direct costs and certain types of costs per 1 ha of UAA. Corresponding figures were given in Table 5. Total costs in EUR '000/ha of UAA in Polish and Hungarian holdings of Type 15 were similar throughout specific economic size classes. They grew as the economic size of holdings increased and ranged between EUR 0.67 thousand/ha (Class I) and EUR 1.1 thousand/ha (Class VI). In Classes II-IV, Czech and Slovak holdings had them higher by approx. 20%. These differences were less significant in the other two classes, i.e. by approx. 13% in Class V and less than 3% in Class VI. German holdings had the highest level of production intensity. Compared to Polish and Hungarian holdings, it was higher by approx. 120% in Class III. The difference narrowed in subsequent classes and reached 37% in Class VI. Holdings of Type 16 followed similar trends, but the level of costs was higher, particularly in Classes IV-VI.

An increase in total costs per 1 ha of UAA in larger-area crop holdings followed a different pattern from the previous one, whereby the level of production intensity decreased as the area of holdings increased due to limited labour resources [Manteuffel 1984]. Labour in crop holdings ceased to be a limiting factor because of the production technologies applied. Direct costs followed similar trends. They increased as the economic size grew. Direct costs of Polish holdings were higher than those of Hungarian, Czech and Slovak holdings, but lower than those of German holdings. Special emphasis should be given to the ratio of direct costs to total costs. The share of direct costs in Polish holdings ranged between 40-50%, while other groups of holdings had it lower, as it ranged between 30-35%. The higher share of direct costs in total costs in Polish holdings should be perceived as favourable, as it indicates that the burden of direct costs, which are most often fixed costs, is smaller. Direct costs were dominated by costs of mineral fertilisers and plant protection products.

Special emphasis should be given to the ratio of costs of plant protection products to those of mineral fertilisers. It was similar in all the groups and classes of holdings, i.e. approx. 40%.

Costs of external factors of production, including costs of hired labour, lease rent and borrowed capital interest, grew as the economic size of holdings of both types increased. These costs were dominated by costs of both lease rent and hired labour. As regards Polish holdings of Type 15, costs of external fac-

tors ranged between EUR 0.021 (Class I) and EUR 0.380 thousand/ha of UAA (Class VI). They were higher in holdings of Type 16 in all the groups. Polish holdings had them between EUR 0.23 (Class I) and EUR 0.66 thousand/ha (Class VI), i.e. higher than in Hungarian holdings, but lower than in other ones, particularly German holdings which had them higher than those in Polish holdings by approximately 100%.

Costs of own factors of production, i.e.: labour, land and capital, played a material role. In both types of holdings, these costs per 1 ha of UAA decreased as the economic size of holdings increased. Polish holdings of Type 15 had them between EUR 0.554 (Class I) and EUR 0.078 thousand/ha of UAA (Class VI). Their level was similar to the one in Hungarian, Czech and Slovak holdings. The highest costs of own factors of production were found in German holdings which had them between EUR 0.451 (Class III) and EUR 0.109 thousand (Class VI), i.e. higher than in Polish holdings by 71% in Class III and 40% in Class VI. Holdings of Type 16 followed similar trends, but the costs were higher. Polish holdings had them higher by an average of 45%, while other holdings – by not that much, i.e. approximately 20%.

To generalise the assessment of the level of production intensity, it should be stated that its level increased as the economic size of holdings grew. It was higher in Polish holdings than in Hungarian, Czech and Slovak holdings. The highest level of costs was found in German holdings. The level of costs of own factors of production declined as the economic size of holdings grew. German holdings had them at the highest level.

Table 5. Production intensity in the crop holdings under analysis (averages)

Countries	Economic size classes of holdings (EUR '000 of SO)											
	I (<8)		II (8 – 25)		III (25 – 50)		IV (50 – 100)		V (100 – 500)		VI (>=500)	
	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16
Total costs (EUR '000/ha of utilised agricultural area)												
Poland	**0.675**	**0.71**	**0.666**	**0.95**	**0.660**	**1.01**	**0.669**	**0.93**	**0.847**	**1.09**	**1.119**	**1.64**
Hungary	0.657	-	0.568	0.55	0.618	0.85	0.662	0.92	0.849	1.23	1.047	1.59
Czech	-	-	0.874	-	0.819	-	0.894	1.17	0.961	1.33	1.164	1.76
Slovak Rep.	-	-	-	-	1.097	-	0.892	-	0.959	1.25	1.149	1.61
Germany	-	-	-	-	1.417	1.57	1.356	1.62	1.336	2.03	1.446	2.57
Direct costs (EUR '000/ha of utilised agricultural area)												
Poland	**0.238**	**0.23**	**0.269**	**0.38**	**0.269**	**0.45**	**0.336**	**0.45**	**0.380**	**0.50**	**0.380**	**0.66**
Hungary	0.207	-	0.210	0.21	0.210	0.32	0.241	0.34	0.277	0.41	0.277	0.54
Czech	-	-	0.265	-	0.265	-	0.317	0.42	0.328	0.46	0.328	0.57
Slovak Rep.	-	-	-	-	-	-	0.323	-	0.324	0.34	0.324	0.49
Germany	-	-	-	-	-	0.39	0.445	0.47	0.474	0.67	0.474	0.88
Costs of external factors of production (EUR '000/ha of utilised agricultural area)												
Poland	**0.021**	**0.040**	**0.028**	**0.070**	**0.047**	**0.110**	**0.060**	**0.100**	**0.146**	**0.140**	**0.270**	**0.390**
Hungary	0.025	-	0.035	0.050	0.062	0.160	0.097	0.170	0.195	0.260	0.307	0.460
Czech	-	-	0.007	-	0.215	-	0.094	0.070	0.172	0.240	0.350	0.480
Slovak Rep.	-	-	-	-	-	-	0.103	-	0.172	0.210	0.253	0.430
Germany	-	-	-	-	0.154	0.191	0.191	0.260	0.261	0.370	0.443	0.730
Costs of own factors of production (EUR '000/ha of utilised agricultural area)												
Poland	**0.554**	**0.700**	**0.456**	**0.650**	**0.263**	**0.430**	**0.205**	**0.300**	**0.138**	**0.240**	**0.078**	**0.110**
Hungary	0.273	-	0.242	0.270	0.213	0.250	0.182	0.230	0.145	0.200	0.099	0.110
Czech	-	-	0.435	-	0.247	-	0.188	0.290	0.106	0.180	0.650	0.100
Slovak Rep.	-	-	-	-	0.246	-	0.160	-	0.077	0.009	0.057	0.006
Germany	-	-	-	-	0.451	0.570	0.425	0.430	0.203	0.340	0.109	0.180

Source: European FADN.

2.4. Efficiency of Polish crop holdings against holdings from selected countries

The efficiency of the crop holdings under analysis was evaluated based on the following indicators: productivity and profitability of factors of production and efficiency. Corresponding figures were given in Tables 6 and 7.

The productivity of land was determined as production value in EUR '000/ha. In all the groups, the productivity of land in holdings of both types increased as the economic size of holdings grew. Considering both types, the highest productivity of land was found in German holdings. In holdings of Type 15, it reached EUR 1.37 thousand/ha on average in the period under analysis and was higher than in Polish and Czech holdings by approx. 48% as well as in Slovak and Hungarian holdings by 54 and 69%. In all the groups of holdings, the productivity of land in holdings of Type 16 was higher than in holdings of Type 15. It reached EUR 2.11 thousand/ha on average in German holdings and was higher than in Polish and other holdings by 52% and approx. 70%, respectively.

Also the productivity of assets increased as the economic size of holdings grew. Considering both types, the highest productivity of assets was found in Slovak holdings, i.e. 0.60 on average (Type 15) which was higher than in Polish and German holdings by approx. 186 and 150%, respectively. With respect to Hungarian and Czech holdings, the difference was smaller, i.e. 82 and 71%, respectively. This was due to a lower value of assets per 1 ha of UAA. Holdings of Type 16 followed similar trends, but their productivity of assets was higher than that of holdings of Type 15.

The productivity of current assets followed a volatile upward trend. In Polish holdings of both types in Classes I-IV, it increased, while in subsequent classes – decreased. The highest productivity of current assets in both types was found in German and Czech holdings, i.e. respectively 1.73 and 1.55 in holdings of Type 15 and respectively 1.66 and 1.71 in those of Type 16.

Table 6. Productivity of factors of production in the crop holdings under analysis (averages)

Countries	Economic size classes of holdings (EUR '000 of SO)											
	I (<8)		II (8 – 25)		III (25 – 50)		IV (50 – 100)		V (100 – 500)		VI (>=500)	
	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16
Productivity of land (EUR '000/ha of utilised agricultural area)												
Poland	**0.77**	**0.78**	**0.81**	**1.24**	**0.87**	**139**	**0.93**	**1.27**	**1.02**	**1.40**	**1.18**	**1.54**
Hungary	0.76	-	0.70	0.73	0.77	0.99	0.80	1.21	0.90	1.36	0.96	1.43
Czech	-	-	0.88	-	0.87	-	0.90	1.39	0.93	1.40	1.04	1.61
Slovak Rep.	-	-	-	-	0.95	-	0.80	-	0.89	0.93	0.94	1.46
Germany	-	-	-	-	1.33	1.62	1.39	1.77	1.38	2.37	1.40	2.70
Productivity of assets (-fold)												
Poland	**0.10**	**0.10**	**0.12**	**0.15**	**0.15**	**0.17**	**0.17**	**0.17**	**0.25**	**0.22**	**0.52**	**0.44**
Hungary	0.19	-	0.23	0.22	0.29	0.34	0.33	0.40	0.40	0.46	0.56	0.71
Czech	-	-	0.23	-	0.28	-	0.33	0.37	0.49	0.51	0.41	0.45
Slovak Rep.	-	-	-	-	0.54	-	0.53	-	0.72	0.53	0.62	0.80
Germany	-	-	-	-	0.12	0.11	0.14	0.14	0.28	0.22	0.41	0.42
Productivity of current assets (-fold)												
Poland	**1.27**	**1.26**	**1.30**	**1.44**	**1.39**	**1.49**	**1.52**	**1.59**	**1.27**	**1.48**	**1.10**	**0.99**
Hungary	0.48	-	0.61	0.61	0.78	1.02	0.97	0.94	1.13	1.33	1.02	1.58
Czech	-	-	1.55	-	1.53	-	1.52	2.01	1.89	1.52	1.28	1.52
Slovak Rep.	-	-	-	-	1.13	-	1.17	-	1.62	1.61	1.40	1.61
Germany		-	-	-	1.70	1.70	1.79	1.52	2.15	1.72	1.27	1.72
Productivity of labour (EUR '000/AWU)												
Poland	**8.69**	**6.06**	**14.91**	**10.99**	**32.05**	**20.02**	**52.64**	**34.58**	**67.56**	**48.17**	**67.22**	**53.13**
Hungary	21.49	-	38.36	23.31	52.31	22.47	61.85	38.31	53.94	60.41	66.48	52.68
Czech	-	-	23.53	-	35.90	-	54.33	52.99	69.84	58.73	70.31	57.32
Slovak Rep.	-	-	-	-	23.13	-	42.99	-	63.11	39.85	55.18	37.59
Germany	-	-	-	-	56.87	60.14	87.20	89.34	152.64	126.06	174.83	128.75

Source: European FADN.

The productivity of labour increased as the economic size of holdings grew. In all the classes, German holdings achieved the highest productivity which ranged between 56.9 and EUR 174.8/AWU in Type 15 as well as 60.1 and EUR 128.7 thousand/ha of UAA in Type 16. Polish holdings had the productivity of labour more than twice lower than German holdings and similar to other holdings.

The profitability of land in Polish holdings of both types followed an upward trend in Classes I-IV. It ranged between 0.36 (Class I) and EUR 0.61 thousand/ha of UAA (Class IV). It was lower in other classes. The profitability of land in Polish holdings was the highest in all the classes except for Class VI in Type 16, where it reached EUR 0.14 thousand/ha of UAA. However, it stood at EUR 0.50 thousand/ha of UAA in German holdings in that class.

The profitability of assets followed similar trends. The Polish holdings of Type 15 had it between 4.92% (Class I) and 13.55% (Class VI). It was similar in the holdings of Type 16. The profitability of assets in Hungarian and Czech holdings was higher.

The profitability of own labour in all the groups increased as the economic size grew. Polish holdings of Type 15 had it between EUR 4.23 (Class I) and EUR 107 thousand/FWU (Class V), while those of Type 16 – between EUR 3.41 (Class I) and EUR 53.1 thousand/FWU (Class V). The productivity of own labour in these classes was higher in Hungarian holdings. In Class VI, in both types, the profitability of labour was the highest in Hungarian holdings as well. The lowest profitability of labour was found in Slovak and then Czech holdings.

Subsidies of any kind were an important factor that determined the level of agricultural holding income. In Classes I-V, their share in income followed a downward trend. Polish holdings had it between 88.3% in Class I (Type 16) and 45.6% in Class V (Type 16) and was the lowest with respect to the holdings under analysis. It was the highest in German and Slovak holdings, Class VI, excluding Polish holdings of Type 15 and German holdings of Type 16. Other holdings would not be able to operate without these subsidies. Their share in income exceeded 100%.

Table 7. Profitability of factors of production in the crop holdings under analysis (averages)

Countries	Economic size classes of holdings (EUR '000 of SO)											
	I (<8)		II (8 – 25)		III (25 – 50)		IV (50 – 100)		V (100 – 500)		VI (>=500)	
	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16
Profitability of land (EUR '000/ha of utilised agricultural area)												
Poland	**0.36**	**0.43**	**0.43**	**0.61**	**0.49**	**0.69**	**0.52**	**0.61**	**0.43**	**0.61**	**0.31**	**0.14**
Hungary	0.30	-	0.34	0.43	0.38	0.48	0.38	0.58	0.31	0.45	0.18	0.14
Czech	-	-	0.26	-	0.30	-	0.26	0.48	0.23	0.48	0.13	0.18
Slovak Rep.	-	-	-	-	0.06	-	0.10	-	0.12	-	0.03	0.12
Germany	-	-	-	-	0.22	0.43	0.36	0.53	0.38	0.53	0.28	0.50
Profitability of assets (%)												
Poland	**4.92**	**5.73**	**6.25**	**7.38**	**8.62**	**8.83**	**9.27**	**8.27**	**10.64**	**9.71**	**13.55**	**3.99**
Hungary	7.65	-	11.17	12.96	14.36	16.53	15.56	19.21	13.84	15.02	10.23	6.73
Czech	-	-	6.86	-	9.53	-	9.60	12.77	12.12	14.38	5.05	5.08
Slovak Rep.	-	-	-	-	3.36	-	6.95	-	9.88	1.30	1.71	6.46
Germany	-	-	-	-	1.98	3.04	3.60	4.30	7.61	6.67	8.17	7.82
Profitability of own labour (EUR '000/FWU)												
Poland	**4.23**	**3.41**	**7.98**	**6.03**	**19.61**	**13.27**	**34.83**	**22.97**	**107.05**	**53.08**	**-**	**955.10**
Hungary	10.57	-	21.76	18.70	34.05	25.52	50.61	44.05	111.33	97.07	1 525.95	714.94
Czech	-	-	7.06	-	13.28	-	19.81	20.68	47.64	39.64	485.15	427.35
Slovak Rep.	-	-	-	-	2.35	-	7.90	-	31.38	4.34	152.61	302.61
Germany	-	-	-	-	1.98	17.04	24.38	30.84	62.87	62.87	310.49	149.16
Share of subsidies in holding income (%)												
Poland	**78.59**	**88.32**	**68.24**	**60.48**	**57.20**	**47.78**	**54.63**	**50.03**	**62.61**	**45.64**	**82.36**	**332.67**
Hungary	61.48	-	60.20	68.06	55.88	78.95	58.00	47.14	73.94	64.93	123.71	232.44
Czech	-	-	76.28	-	66.60	-	77.97	52.42	93.37	69.97	159.80	141.52
Slovak Rep.	-	-	-	-	2 623.33	-	167.82	-	114.13	764.57	242.34	782.69
Germany	-	-	-	-	182.64	94.71	106.00	74.39	99.15	54.71	145.09	77.96

Source: European FADN.

Indicators of productivity and profitability of factors of production of the holdings under analysis are not sufficient to evaluate their competitiveness, construed as their development capacity. Table 8 presents figures that characterise the competitive potential of the holdings under analysis. It was determined based on the following indicators: income parity A2, the net investment rate, management income and the competitiveness index. Income parity A2 was determined as the ratio of holding income per own labour unit (FWU) to the average level of remuneration in the national economy and is expressed in %.

The index below 100% means that farmers achieve lower income than the average in the national economy. The figures presented in Table 8 reveal that the index above 100% was achieved by Polish and Czech holdings with the economic size of Classes III-VI. Hungarian holdings achieved parity income in all the classes, Slovak ones – in Class V, Type 15 and in Class VI, Type 16 only, while German holdings – in Classes V and VI.

Polish holdings of both types in Classes III-VI enjoyed a positive net investment rate. Hungarian holdings had it positive in Classes II, V and VI, while Czech ones – in Classes V and VI. The hardest situation was that of Slovak holdings which had a positive net investment rate in Class III and Class VI (Type 15) only. German holdings achieved a positive net investment rate in all the classes (III-VI).

Management income, which is the final measure of farming efficiency, was calculated as the difference between holding income and costs of own factors of production. Its positive value is an important element of the competitive potential of holdings. Management income was positive in Polish, Hungarian and Czech holdings of both types in Classes III-VI and German holdings in Classes V and VI. Slovak holdings of Types 15 and 16 had it positive only in Classes V and VI, respectively.

Table 8. Competitive potential of the crop holdings under analysis (averages)

Countries	Economic size classes of holdings (EUR '000 of SO)											
	I (<8)		II (8 – 25)		III (25 – 50)		IV (50 – 100)		V (100 – 500)		VI (>=500)	
	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16	Type 15	Type 16
Income parity A2 (%)												
Poland	**42.45**	**34.22**	**80.09**	**60.52**	**196.88**	**133.18**	**349.70**	**230.53**	**1 074.37**	**532.72**	**-**	**9 585.51**
Hungary	111.30	-	226.12	196.90	358.53	268.72	528.17	463.83	1 172.26	1 022.11	16 067.70	7 528.06
Czech	-	-	61.55	-	115.79	-	172.33	180.31	415.38	345.63	4 230.10	3 726.13
Slovak Rep.	-	-	-	-	23.29	-	78.29	-	325.23	43.01	1 512.34	2 998.81
Germany	-	-	-	-	24.78	42.91	61.40	77.68	158.33	158.33	781.95	357.64
Net investment rate (%)												
Poland	**-151.82**	**-64.46**	**-9.57**	**-25.19**	**57.72**	**50.16**	**126.33**	**101.63**	**145.25**	**80.81**	**107.51**	**94.12**
Hungary	-155.81	-	23.04	62.59	18.38	-11.22	-0.53	-10.69	16.91	67.44	15.91	15.32
Czech	-	-	-54.07	-	-18.33	-	15.18	-15.31	14.67	9.39	62.57	31.07
Slovak Rep.	-	-	-	-	34.64	-	-26.28	-	-3.03	-6.07	16.73	-31.00
Germany	-	-	-	-	4.49	10.28	24.08	191.23	38.86	47.97	115.52	59.24
Management income (EUR '000/holdings)												
Poland	**-2.39**	**-2.68**	**-0.69**	**-0.62**	**13.60**	**9.17**	**33.97**	**20.67**	**92.00**	**57.80**	**298.31**	**26.31**
Hungary	0.31	-	-23.04	4.85	11.65	11.87	25.39	27.21	54.26	58.22	109.88	37.91
Czech	-	-	-54.27	-	2.73	-	8.51	13.18	40.89	37.99	78.35	93.91
Slovak Rep.	-	-	-	-	-11.14	-	-6.47	-	15.18	-17.46	-51.11	77.49
Germany	-	-	-	-	-9.16	-4.87	-4.54	6.31	38.47	43.78	178.99	126.56
Competitiveness index (-fold)												
Poland	**0.66**	**0.62**	**0.94**	**0.94**	**1.87**	**1.63**	**2.51**	**2.02**	**2.89**	**2.60**	**3.94**	**1.23**
Hungary	1.09	-	1.43	1.60	1.80	1.96	2.09	2.48	1.57	2.30	1.78	1.28
Czech	-	-	0.61	-	1.21	-	1.41	1.67	1.34	2.20	1.98	1.85
Slovak Rep.	-	-	-	-	0.23	-	0.65	-	0.70	0.24	0.45	2.00
Germany	-	-	-	-	0.49	0.76	0.86	1.23	1.44	2.17	2.58	2.80

Source: European FADN.

Holdings capable of development can be regarded as those which achieve holding income at the parity level, a positive net investment rate and positive net management income. Given these criteria, it can be concluded that Polish holdings of both types, Hungarian holdings of Type 15 in Classes III-VI and Type 16 in Classes II, V and VI, Czech holdings of Type 15 in Classes IV-VI and German ones of both types in Classes V and VI are capable of development.

Taking account of the value of the competitiveness index, holdings are found to be capable of development if their Wk4>=2. This condition is met by Polish holdings of Type 15 in Classes IV-VI and Type 16 in Classes IV and V, Hungarian holdings of Types 15 and 16 in Class IV as well as Classes IV and V, respectively. As regards Czech holdings, only those of Type 16 in Class V were capable of development. Slovak holdings of Type 16 in Class VI only enjoyed development capacity, so did German holdings of Types 15 (Class VI) and 16 (Classes V and VI).

3. Characteristics of crop holdings capable of development by value of the competitiveness index

Table 9 presents selected characteristics of crop holdings capable of development by value of the competitiveness index. Holdings were found to be fully capable of development if their *W*k>=2. As regards holdings of Type 15, Polish and Hungarian holdings in Class IV and German holdings in Class VI met that condition. The minimum UAA of Polish and Hungarian holdings was respectively 110 and 128 ha, while that of German holdings – 1004 ha. The share of cereals in UAA ranged between 63.5% (Hungary) and 68% (Poland). Polish and Hungarian holdings had a similar level of production intensity which was approx. EUR 0.66 thousand/ha. German holdings had it higher by 118%. The level of direct costs in Polish holdings amounted to EUR 0.34 thousand/ha and was higher than in Hungarian holdings by 42%. The costs were the highest in German holdings, i.e. EUR 0.46 thousand/ha. Their level was higher than in Polish and Hungarian holdings by 35% and 92%, respectively. The ratio of direct costs to total costs in Polish holdings reached 51% and was much more favourable than in Hungarian and German holdings, i.e. 36 and 31%, respectively. Costs of own factors of production in the holdings under analysis were similar and ranged between 0.18 and EUR 0.21 thousand/ha. Costs of external factors of production differed significantly and reached EUR 0.443 thousand/ha in

German holdings, i.e. 4.6- and 7.4-fold higher than in Hungarian and Polish holdings, respectively.

As regards the group of mixed crop holdings (Type 16), Polish and Hungarian holdings with the economic size of Classes IV and V, Czech and German holdings in Class V and Slovak holdings with the economic size of Class VI were found to be capable of development. The minimum UAA of Polish and Hungarian holdings was respectively 67 and 78 ha, that of Czech and German holdings – respectively 176 and 111 ha, while that of Slovak holdings 1318 ha.

The share of cereals in the UAA structure was relatively low and ranged between 44% (Slovakia) and 56% (Poland). The level of production intensity varied. It was the lowest in Polish and Hungarian holdings, i.e. approx. EUR 0.93 thousand/ha, while the highest in German holdings, i.e. EUR 2.03 thousand/ha, being higher than in Polish holdings by 118% as well as Czech and Slovak holdings by 53 and 26%, respectively. The level of direct costs in Hungarian holdings was the lowest and reached EUR 0.34 thousand/ha. In the Polish, Czech and Slovak holdings, it was similar, i.e. approximately EUR 0.47 thousand/ha. The costs were the highest in German holdings, i.e. EUR 0.67 thousand/ha. Their level was higher than in the Polish, Czech and Slovak holdings by approx. 43%.

Table 9. Minimum economic size of holdings oriented towards crop production and capable of development

Countries	Characteristics of competitive holdings – capable of development						
	Economic size class/Wk	UAA (ha)	Share of cereals in UAA (%)	Total costs (EUR '000/ha)	Direct costs (EUR '000/ha)	Costs of own factors (EUR '000/ha)	Costs of external factors (EUR '000/ha)
Cereal holdings (Type 15)							
Poland	IV/2.51	109.6	68.0	0.67	0.34	0.21	0.06
Hungary	IV2.09	127.8	63.5	0.66	0.24	0.18	0.097
Czech	-	-	-	-	-	-	-
Slovakia	-	-	-	-	-	-	-
Germany	VI/2.58	1 004.2	64.4	1.45	0.46	0.18	0.443
Mixed crop holdings (Type 16)							
Poland	IV/202	67.41	55.62	0.93	0.45	0.30	0.10
Hungary	IV/2.48	78.56	44.88	0.92	0.34	0.23	0.17
Czech	V/2.20	176.45	49.64	1.33	0.46	0.18	0.24
Slovakia	VI/2.0	1 317.75	44.41	1.61	0.49	0.06	0.43
Germany	V/2.17	110.75	48.33	2.03	0.67	0.34	0.37

Source: European FADN.

Costs of own factors of production differed significantly. They were the lowest in Slovak holdings, i.e. EUR 0.06 thousand/ha, while the highest in German holdings, i.e. EUR 0.34 thousand/ha. Costs of external factors of production differed not that much. They were the highest in Slovak holdings, i.e. EUR 0.43 thousand/ha, while the lowest in Polish holdings, i.e. EUR 0.10 thousand/ha

4. Technical efficiency of holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds and those specialising in the field cultivation of different crop species in 2010-2012

Nowadays, an agricultural holding must implement new production techniques and technologies to efficiently manage its inputs, what also makes it possible to achieve favourable economic effects. The measurement of economic efficiency of holdings referred to in the previous subchapters is therefore a necessary condition only. It is not enough to evaluate their operational efficiency closer. That is why, their technical efficiency is evaluated in this subchapter.

To achieve this objective, 1007 holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds (Type 15) and 604 holdings specialising in the field cultivation of different crop species (Type 16), which kept accounts for the Polish FADN in 2010-2012 on an ongoing basis, were analysed. The Stochastic Frontier Analysis[22] was applied to determine their technical efficiency. In accordance with T.J. Coelli [Coelli et al. 2005], this analysis defines the relationship between the empirical effect and the frontier effect achievable at a given level of inputs. However, S.C. Kumbhakar and C.A. Lovell [Kumbhakar, Lovell 2004] believe that this method allows to *maximise effects which can be achieved by an individual at a given level of inputs*.

The technical efficiency of the holdings under analysis was determined by using the technical efficiency index (TE). It is effect-oriented and determined as the quotient of the actual effect (empirical effect) and the achievable desired effect (frontier effect) which an agricultural holding could achieve if the inputs

[22] In accordance with S.C. Kumbhakar and C.A. Lovell [Kumbhakar, Lovell 2003], the SFA's important advantage is *taking account of random shocks to determine technical efficiency*. The DEA, which has been commonly applied so far, provides that any deviation from the frontier curve is, however, due to technical inefficiency. Nevertheless, T. Coelli et al. [Coelli et al. 2005] point out that deviations from the frontier curve may in practice also result from random causes, i.e. outliers and unusual observations, and the impact of variables not included in the model, i.e. e.g. weather conditions. The SFA model uses an additional random variable to describe them and calls them *noise*.

incurred remained unchanged (Equation 3). In this method, the coefficient of technical efficiency ranges between 0.0% and 100.0%.

$$TE_i = \frac{y_{empirical(i)}}{y_{frontier(i)}} = \frac{\exp(\beta_o + \beta_1 \ln x_{1i} + ... + \beta_4 \ln x_{4i} + v_i - u_i)}{\exp(\beta_o + \beta_1 \ln x_{1i} + ... + \beta_4 \ln x_{4i} + v_i)} = \exp(-u_i), \qquad (3)$$

where:

TE – coefficient of technical efficiency of i-th holding,
y_i – size of the effect of i-th holding,
X_i – vector of inputs for i-th holding,
β_i – vector of estimated regression parameters,
v_i – random component relating to the so-called information noise,
u_i – positive random component relating to technical inefficiency.

It is important in parametric modelling to determine whether the difference between the empirical effect and the expected effect in the estimated model is due to the inefficient use of inputs or only results from the impact of production conditions and a measurement error. To examine this phenomenon, the hypothesis of H_0: $\gamma=0$, where γ (gamma) is a parameter determined as the quotient of the variance of the random component causing technical inefficiency and the total variability of the random component variable [Coelli et al 2005], needs to be verified. In this case, the phenomenon of technical inefficiency was examined by carrying out the likelihood ratio test (LR)[23] and comparing the results obtained with the critical value of the test $\chi^2_{1-2\alpha}(1)$. If the value of the LR statistics was higher than the critical value of the test χ^2, it would be stated that the variance of the random component is different from zero. Otherwise, all deviations from the frontier curve were considered as resulting from information noise only [Czekaj 2008].

When applying the SFA, including factors, which may affect the inefficiency of agricultural holdings in the model, is also an important element of research on their technical efficiency. For this purpose, the following linear equation of inefficiency was constructed: $u_i = z_{it}\delta$, where z_{it} is a vector of the variable which, as the author believes, has an impact on inefficiency, while δ (delta) is an equation parameter vector. To take into account factors that may affect the oper-

[23] T.J. Coelli et al. [Coelli et al. 2005] recommend that, in order to determine technical inefficiency in the model, the LR statistics be compared with the critical value of the test $\chi^2_{1-2\alpha}(1)$, $\alpha=0.05$.

ational inefficiency of agricultural holdings, the following variable was adopted: *location of a holding in LFAs*. This variable was treated as a binary variable. It equalled one if a holding was located in LFA and zero if it was not situated in LFA.

The value of total production plus operating subsidies (PLN) was adopted as an effect category for the construction of models using the SFA, while in input categories: own and foreign labour inputs expressed in AWU, value of UAA (PLN), inputs of fixed assets expressed as depreciation (PLN) and total costs minus depreciation and remuneration (PLN). A form of the Cobb-Douglas production function was used. Its all equation parameters were found to be significant and models were positively verified by carrying out the LR test.

Table 10. Estimation results of deterministic, stochastic and inefficiency models for holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds (Type 15) in 2010-2012

Deterministic model:					Stochastic model:			
variable[24]	parameter	parameter estimate	standard deviation	t-Student test	parameter	parameter estimate	standard deviation	t-Student test
continuous variable	$beta_0$	3.797	0.107	35.423	$beta_0$	4.183	0.105	39.821
X_1	$beta_1$	0.022	0.005	4.064	$beta_1$	0.055	0.005	4.906
X_2	$beta_2$	0.405	0.014	27.731	$beta_2$	0.450	0.014	30.908
X_3	$beta_3$	0.033	0.005	5.766	$beta_3$	0.032	0.005	5.963
X_4	$beta_4$	0.567	0.013	43.056	$beta_4$	0.527	0.013	40.200
					Inefficiency model:			
z_0	$delta_0$	-	-	-	$delta_0$	-4.965	1.510	-3.287
z_1	$delta_1$	-	-	-	$delta_1$	2.389[25]	0.774	3.087
	$sigma^2$	0.068	-	-	sigma	0.400	0.096	4.179
	gamma	0.540	-	-	gamma	0.913	0.022	41.288
					LR test			69.588

Source: own study based on Polish FADN data.

The frontier model's characteristics for holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds are presented in Table 10, while those for holdings specialising in the field cultivation of different crop

[24] X_1 – Own and hired labour inputs (AWU), X_2 – Value of utilised agricultural area (PLN), X_3 – Inputs of fixed assets expressed as depreciation (PLN), X_4 – Total costs minus depreciation and remuneration (PLN), Z_1 – Location of a holding in LFAs.

[25] In the inefficiency model, the plus sign before the estimate of the parameter of the variable, which has an impact on inefficiency, means that its impact on efficiency is negative, while the minus sign – that its impact is positive.

species – in Table 11. Variables of both the deterministic and stochastic model were statistically significant, as evidenced by the t-Student statistics ($t>t_{critical}$). The same applied to the variable estimated in the inefficiency model, i.e. *location of a holding in LFAs (z_1)* (Tables 10 and 11).

The value of the LR statistics in both models was higher than the critical value of the test $\chi^2_{1-2\alpha}$ (1). Thus, the LR test indicated the presence of technical inefficiency in the models. Hence, the value of gamma (γ) for holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds and those specialising in the cultivation of different crop species indicates that the share of the variability of the component representing technical inefficiency in the variability of the complex random component reached 0.913 and 0.800, respectively. This means that respectively 91.4 and 80.0% of the variability of the random component is due to technical inefficiency in place and the remaining 8.6 and 20.0%, respectively, due to noise, i.e. random reasons not taken into account in the model (Tables 10 and 11).

Table 11. Estimation results of deterministic, stochastic and inefficiency models for holdings specialising in the field cultivation of different crop species (Type 16) in 2010-2012

Deterministic model:					Stochastic model:			
variable[26]	parameter	parameter estimate	standard deviation	t-Student test	parameter	parameter estimate	standard deviation	t-Student test
continuous variable	$beta_0$	1.555	0.166	9.365	$beta_0$	16.939	0.167	10.112
X_1	$beta_1$	0.198	0.017	11.286	$beta_1$	0.210	0.015	14.167
X_2	$beta_2$	0.405	0.028	14.267	$beta_2$	0.435	0.023	17.765
X_3	$beta_3$	0.071	0.011	6.129	$beta_3$	0.072	0.011	6.291
X_4	$beta_4$	0.626	0.018	34.466	$beta_4$	0.604	0.015	38.724
					Inefficiency model:			
z_0	$delta_0$	-	-	-	$delta_0$	-4.489	1.761	-2.548
z_1	$delta_1$	-	-	-	$delta_1$	1.892	0.804	2.351
	$sigma^2$	0.085	-	-	sigma	0.377	0.092	4.070
	gamma	0.050	-	-	gamma	0.800	0.052	15.301
					LR test			76.310

Source: cf. Table 10.

[26] X_1 – Own and hired labour inputs (AWU), X_2 – Value of utilised agricultural area (PLN), X_3 – Inputs of fixed assets expressed as depreciation (PLN), X_4 – Total costs minus depreciation and remuneration (PLN), Z_1 – Location of a holding in LFAs.

It is often recognised that production specialisation in agricultural holdings allows them to rationally exploit their machinery, efficiently use their production infrastructure and efficiently manage, but the fact is that only some of them achieve a high level of technical efficiency. This opinion was confirmed in holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds and those specialising in the cultivation of different crop species.

The former used their inputs to produce expected production value not in a fully technically efficient manner (Table 12). The inputs incurred were wasted to the largest extent in very small and small holdings whose actual revenues reached 86.4 and 87.9% of achievable revenues. The greatest variability in results, i.e. 7.7%, was found in the first group. Among very small holdings, the highest technical efficiency was 94.8%, while the lowest – 65.3%, compared to 96.9 and 56.5% in small holdings. Thus, both groups included holdings whose production techniques resulted in wasting a significant part of the inputs.

The situation in this regard was more favourable in medium-small and medium-large holdings whose production value was lower than expected value by 8.4 and 8.1%, respectively. However, there were also holdings among them whose technical efficiency was far from the expected level achievable at a given level of inputs.

The most wasteful holding was among medium-large holdings. Its production value was lower than achievable value by 65.9%. It cannot be ruled out that the holding wasted so much incurred inputs due to gross management errors, thus making the processing of inputs into results inefficient.

As for holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds, those with large or very large economic size could manage more efficiently. As a matter of fact, the highest average production value was achieved by holdings whose economic size was at least EUR 100 thousand of SO, i.e. 6.6% less than that achievable at a given level of inputs. The most efficient holding among them achieved production value that was lower than potential value by 0.8%, while the most wasteful one had it smaller than achievable value by 13.7%. Given the above, it is clear that also large and very large holdings are not fully efficient. Hence, they also should invest in new production technologies which, given their favourable economic situation, seems extremely possible.

Table 12. Characteristics of the coefficient of technical efficiency in holdings specialising in the cultivation of cereals, oilseeds and high-protein crops by economic size (PLN '000 of SO) in 2010-2012 (%)

Holdings	Size			
	arithmetic mean	minimum	maximum	coefficient of variation
in total	91.1	34.1	99.2	5.4
very small (<EUR 8 thousand of SO)	86.4	65.3	94.2	7.7
small (EUR 8-25 thousand of SO)	87.9	56.5	96.9	6.0
medium-small (EUR 25-50 thousand of SO)	91.6	46.9	96.8	5.2
medium-large (EUR 50-100 thousand of SO)	91.9	34.1	96.5	5.3
large and very large (at least EUR 100 thousand of SO)	93.4	86.3	99.2	2.8

Source: cf. Table 10.

The figures in Table 13 show that, from among holdings specialising in the cultivation of different crop species, the smallest technical efficiency was achieved by very small and small holdings whose average production value was respectively 85.1 and 90.1% of potential value. Moreover, the greatest variability in results was found in both groups of holdings, i.e. 12.8 and 8.2%, respectively. Among them, the highest technical efficiency was 96.0%, while the lowest – 34.5%, thus meaning that the average production value of very small and small holdings was lower than achievable value by 4.0-65.5%.

Production techniques applied in medium-small, medium-large as well as large and very large holdings, rather than in other holdings, made more rational use of inputs incurred to achieve expected production value. Moreover, their higher technical efficiency ensured them a favourable economic situation. From among them, the best situation was that of large and very large holdings. Their average production value was 93.6% of expected value, while that of medium-small and medium-large holdings – 93.0 and 93.1%, respectively. Furthermore, the lowest variability in results, i.e. 1.4%, was found in large and very large holdings. Among them, the highest technical efficiency was 95.7%, while the lowest – 90.0%.

Given the foregoing, it should be noted that the economic size of holdings specialising in the cultivation of cereals, oilseeds and high-protein crops for seeds and those specialising in the cultivation of different crop species determines opportunities for their efficient management. However, this cannot be taken for granted, as holdings enjoyed relatively high technical efficiency, re-

gardless of their economic size. This means that much here depends on holding managers themselves, more specifically on their knowledge of tillage technology and techniques and their ability to use tillage machinery and equipment adapted to them.

Table 13. Characteristics of the coefficient of technical efficiency in holdings specialising in the cultivation of different crop species by economic size (PLN '000 of SO) in 2010-2012 (%)

Holdings	Size			
	arithmetic mean	minimum	maximum	coefficient of variation
in total	91.8	34.5	96.7	5.9
very small (<EUR 8 thousand of SO)	85.1	34.5	94.4	12.8
small (EUR 8-25 thousand of SO)	90.1	43.7	96.0	8.2
medium-small (EUR 25-50 thousand of SO)	93.0	64.7	96.7	2.8
medium-large (EUR 50-100 thousand of SO)	93.1	82.2	96.6	2.1
large and very large (at least EUR 100 thousand of SO)	93.6	90.0	95.7	1.4

Source: cf. Table 10.

Summary

After market economy principles were introduced, there were far-reaching changes in the crop structure. Cereals have been dominating for the last dozen years or more. In 2013, their share was 73%, while together with oilseeds and legumes – 83.5%. The crop structure of this type is unfavourable in environmental terms, as it does not enable rational crop rotation. The changes in the crop structure led to a higher share of holdings oriented towards crop production, usually without livestock or with a low stocking density.

In 2002-2013, the share of crop holdings increased from 47 to 53%. They were dominated by holdings oriented towards the cultivation of cereals, oilseeds and legumes. Their share in that period grew from 78.3 to 93.5%. In that group, the share of holdings with an area exceeding 1 ha increased from 63% in 2002 to 96.5% in 2013. A characteristic of these holdings is that they have no mechanical draft force. In 2013, 45% of these holdings did not have tractors.

The production potential of crop holdings oriented towards the cultivation of cereals, oilseeds and legumes (Type 15) was similar in specific economic size classes. They differed more in their UAA. Polish, Hungarian, Czech and Slovak holdings had this area similar in specific economic size classes. German hold-

ings were the smallest. Their area was smaller than that of Polish holdings by approx. 30%. The production potential of mixed crop holdings (Type 16) expressed as their UAA was much lower than that of holdings of Type 15. Polish, Hungarian, Czech, Slovak and German holdings of this type in Classes I-V had their UAA smaller by 46, 15, 68, 30 and 37%, respectively. Differences in Class VI were not that significant, excluding German holdings whose area was 391 ha of UAA, i.e. smaller than that of holdings of Type 15 by approx. 62%.

The cereal holdings under analysis used also rented land whose share increased as the size of holdings grew. The lowest share of such land was found in Polish holdings which had it between 13.8% (Class I) and 64% (Class VI). Other holdings in Class VI had it higher than 90%. The share of rented land in holdings of Type 16 was similar.

Labour inputs expressed as the number of labour units (AWU) per 100 ha of UAA decreased as the economic size of holdings increased. The highest sizes in specific classes of holdings of Type 15 had Polish and Slovak holdings in which they ranged between 8.9 AWU (Class I) and 1.75 AWU/100 ha of UAA (Class VI). The lowest labour inputs were found in German holdings, i.e. AWU/100 ha of UAA (Class VI).

Labour inputs were higher in holdings of Type 16 in all the groups. In Hungarian and Slovak holdings, they were two times higher, Polish and Czech holdings had them higher by respectively 85 and 71%, while German holdings by 54%. In Classes I-IV, total labour inputs were dominated by own labour, whose largest share was found in Polish and German holdings, i.e. 83 and 98%, respectively (Class IV). The share of own labour in all holdings, excluding German ones, did not exceed 2%. In the latter, it reached 11.3%. The share of own labour in holdings of Type 16 was similar to the one in the case of Type 15.

In both types, the value of assets per 1 ha of UAA declined as the size of holdings grew. Polish holdings of Type 15 had it between EUR 7.4 (Class I) and EUR 2.3 thousand/ha of UAA (Class VI), i.e. higher than in other holdings, excluding German ones which had it between EUR 11.3 (Class III) and EUR 3.4 thousand/ha of UAA. Holdings of Type 16 followed similar trends, but their value of assets was higher. German holdings had it higher by 47%, Polish holdings – by 28%, Czech and Slovak – by respectively 19 and 18%, while Hungarian holdings – by 7%. In holdings of both types, assets were dominated by fixed assets, while liabilities – by equity.

Both the share of fixed assets in assets and the share of equity in liabilities decreased as the size of holdings increased. In Type 15, borrowed capital was

used the least by Polish and German holdings whose share of equity in liabilities amounted to 68 and 67%, respectively, while in Type 16 – to 61 and 70%, respectively.

Production organisation in the holdings under analysis was dominated by the cultivation of cereals. Their share in UAA declined as the size of holdings grew. It was the highest in Polish holdings which had it between 77.5% (Class I) and 67% (Class VI), while the lowest in German holdings, i.e. between 66% (Class III) and 61% (Class VI). Holdings of Type 16 had a smaller share of cereals. It did not exceed 50% in German, Slovak and certain Hungarian holdings (Classes II-IV). Cereals were supplemented by other crops, mostly by oilseeds. Stocking density was very low, i.e. approx. 3 LU/100 ha of UAA on average in holdings of Type 15. This was not enough to ensure the minimum level of organic fertilisation[27]. Stocking density in holdings of Type 16 was slightly higher, i.e. between 4 and 16 LU/100 ha of UAA. In both types, the production structure was dominated by crop production whose share in most holdings exceeded 90%. It was slightly lower in Slovak holdings, i.e. between 61% (Class III) and 82% (Class VI). Production organisation in larger holdings (Classes V and VI) was more sustainable and thus more friendly to the environment.

The level of production intensity determined by the amount of total costs in EUR '000/ha of UAA increased as the size of holdings grew. The costs in holdings of Type 15 ranged between EUR 0.67 (Class I) and EUR 1.4 thousand/ha of UAA (Class VI), while in those of Type 16 – were higher, i.e. between EUR 0.7 and EUR 2.6 thousand/ha. In specific economic size classes, the level of production intensity was similar in all the holdings, excluding German ones in which it was higher. Direct costs in holdings of both types followed similar trends. The ratio of direct costs to total costs in Polish holdings ranged between 40-50%, while in other groups – between 30-35%.

The higher share of direct costs in total costs should be perceived as favourable. Costs of external factors (hired labour, rent and interest) per 1 ha of UAA increased as the economic size of holdings grew. Costs of own factors of production followed similar trends. The costs were the highest in German holdings of both types.

The efficiency of Polish crop holdings was evaluated against other holdings by using indicators of productivity and profitability of factors of production and the competitiveness index. The productivity of land, which was determined

[27] The minimum level of organic fertilisation ensuring the sustainable balance of organic matter in the soil is approx. 50 LU/100 ha of UAA.

by the yields of winter wheat per 1 ha of UAA, in Polish holdings of both types was higher than in other ones, the only exception being German holdings. The productivity of assets in Polish holdings was lower than in other holdings. The productivity of current assets in Polish holdings was higher than in Hungarian and Slovak holdings in Classes III and IV, but lower than in German holdings. The productivity of labour in Polish holdings in Classes I-IV was lower than in Hungarian holdings, comparable with that in Czech and Slovak holdings, but significantly lower than in German holdings. The difference was approx. 66%.

Polish holdings of Type 15 achieved the highest profitability of land and assets, while German holdings of Type 16 in Classes V and VI were the most profitable. The highest profitability of assets in both types was achieved by Hungarian holdings. The profitability of own labour in Polish holdings of both types was lower than in Hungarian holdings, but higher than in other holdings. Polish holdings were also the least dependent on subsidies, as evidenced by the lowest share of subsidies in holding income in Classes I-V in both types of holdings. The highest share of subsidies in income in Type 15 was found in Czech and Slovak holdings, i.e. respectively 160 and 242% (Class VI), while in Type 16 – in Polish, Hungarian and Slovak holdings, i.e. respectively 223, 232 and 783%.

Polish holdings of Type 15 in Classes IV-VI demonstrated competitive capacity, so did Hungarian holdings in Class IV and German holdings in Class VI. In Type 16, however, competitive capacity was demonstrated by Polish and Hungarian holdings in Classes IV and V, Czech holdings in Class V, Slovak holdings in Class VI and German holdings in Classes V and VI .

The minimum area of Polish and Hungarian cereal holdings (Type 15) was respectively 107 and 128 ha of UAA, while that of German holdings – as much as 1000 ha of UAA. However, the minimum area of mixed crop holdings (Type 16) was 68 and 79 ha of UAA in Polish and Hungarian holdings, respectively, 176 ha of UAA in Czech holdings, 111 ha of UAA in German holdings and as much as 1318 ha of UAA in Slovak holdings.

Having examined technical efficiency by using the Stochastic Frontier Analysis, it can be concluded that the average technical efficiency in both types of holdings was higher in holdings with a higher scale of production, mostly medium-sized ones (Class IV) as well as large and very large ones (Classes V and VI). They demonstrated the highest use of production potential (over 90%) and the lowest values of the coefficient of variation. Among holdings with a lower scale of production (Classes I-III), there were also highly efficient holdings, but their share was smaller.

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GROSS MARGIN FROM SELECTED AGRICULTURAL PRODUCTS IN 2014 – REGIONAL APPROACH[28]

Introduction

Poland is characterised by highly diversified natural conditions, including their suitability for agricultural production. This suitability is determined mostly by topographic and climatic conditions as well as related water regime which, however, varies significantly in time. Therefore, the quality and agricultural value of land together with relief demonstrate spatial variability. Climatic conditions for agricultural production in Poland are relatively good. However, having analysed them more thoroughly, it can be found that – like in other EU Member States – the length of vegetation, which determines crop yield and thus crop species selection[29], varies significantly.

An important differentiating characteristic of Polish agriculture is the agrarian structure as well. Voivodeships of south-eastern Poland (Małopolska and Pogórze region) are dominated by small-sized holdings (up to 5 ha). Consequently, the application of new technologies is very limited which affects the economic aspect of production. Farmers in that region are more characterized by production and economic scattering compared to regions where the agrarian structure is better. Different historical experiences – regardless of other conditions – are one reason for the diversity of agriculture and rural areas in Poland.

When assessing the regional diversity of results of the agricultural products under analysis, the division of the Polish territory into regional units, which was developed as part of adapting Polish statistics to EU standards, was used. The Polish territory was divided into four agricultural regions which correspond to FADN regions. The most important criteria for their selection were characteristics that define the size of agricultural production and factors that determine production results achieved by holdings. An important assumption, which was

[28] The study was prepared under the implementation of the "Analysis of changes in the profitability of production of selected agricultural products" task, within the "Enterprise and agricultural holding in the light of climate change and agricultural policy" topic; as part of the "Agriculture of Poland and the EU 2020+. Challenges, opportunities, threats, suggestions" Multiannual Programme of IAFE-NRI established by virtue of Resolution of the Council of Ministers No. 21/2015 for 2015-2019.

[29] W. Musiał, *Regional diversity of family farming in Poland (selected aspects)*. A paper prepared for the *Economic and legal mechanisms for the promotion and protection of family farming in Poland and other EU Member States* conference held at the Warsaw University of Life Sciences on 23-24 October 2014.

taken into consideration, was also preserving the integrity of the region, that is why the regions selected form bordering voivodeships – Figure 1. The analysis aims at identifying the main factors that determine the regional diversity of the gross margin resulting from agricultural production activities. The chapter devoted much attention to direct costs of production, i.e. the factor that determines the level of production intensity, and also is highly dependent on farmers.

Map 1. Division of Poland into agricultural regions

Source: A. Skarżyńska, L. Goraj, I. Ziętek, *Methodology of SGM "2002" for typology of agricultural holdings in Poland*, Multi-Annual Programme 2005-2009, No. 5, IAFE-NRI, Warsaw 2005.

Material and research method

Empirical data for agricultural production activities, which were covered by research in 2014, i.e. for sugar beets, fattening cattle and dairy cows kept in conventional and organic holdings, were collected in individual holdings located throughout Poland. The holdings were selected for research from a representative sample of holdings, which was in the field of observation of the Polish FADN, in a purposeful manner. Research was carried out in accordance with the methodology of the AGROKOSZTY system, under which data on the level of production as well as incurred inputs and direct costs of agricultural production activities are collected and processed[30].

As referred to in the literature, the amount of inputs of current assets per unit of production (e.g. 1 ha, 1 cow, 100 kg of live weight) indicates the production intensity in agriculture[31]. Taking inputs for basic current assets[32], whose value in research is expressed as the level of direct costs, as a measure of intensity, the diversity of production intensity of the activities under analysis was evaluated by region.

Intensity is demonstrated by the inputs incurred, regardless of whether their consequences proved to be rational or irrational. Therefore, production intensity is closely connected with productivity. Productivity is production per

[30] Direct costs of crop production include: costs of seed material, purchased fertilisers, plant protection products and plant growth regulators, insurance of the activity concerned and specialist costs, i.e. concerning directly a given activity as well as improving the quality and value of the final product (e.g. cost of water for irrigation, soil analysis). However, direct costs of animal production include: costs of animals entering the herd for replacement purposes, costs of fodder, rents for using fodder area for up to 1 year, treatment and insurance of animals and specialist costs (e.g. animal classification, costs of feed preservatives and feed storage); their role is the same as in the case of crop production. – cf. A. Skarżyńska, *Unit costs and income from selected products in 2013 – research results in the AGROKOSZTY system*, Problems of Agricultural Economics No. 2, IAFE-NRI, Warsaw 2015, pp. 112-132.

[31] Manteuffel R., *Economics and organisation of an agricultural holding*. Polish Agriculture and Forest Science Publishing House, Warsaw 1984, pp. 163-171.

[32] Current assets in agriculture are divided into primary and secondary assets. The former are part of newly manufactured products, e.g. seeds, fertilisers, young animals for fattening. The latter, however, are not part of that new product, but are necessary in the production process, e.g. electricity, fuel, lubricants, heating fuel, materials for ongoing renovations and maintenance of fixed assets. – cf. *Economic and Agricultural Encyclopaedia*, Polish Agriculture and Forest Science Publishing House, Warsaw 1984, p. 770.

unit of the factor of production expressed in value terms (in cash)[33]. This indicator reflects both a technical and economic aspect of the activity pursued[34].

The results are presented in tabular form. A horizontal analysis was performed by comparing parameters characterising the activities under analysis in selected holdings from four agricultural regions, i.e. Pomorze and Mazury, Wielkopolska and Śląsk, Mazowsze and Podlasie, Małopolska and Pogórze. The results of the activities were also presented as the research sample average. Revenues (i.e. value of potentially commercial production from 1 ha of crops per 1 dairy cow and 100 kg of gross live weight of slaughter cattle), costs and economic effects were evaluated. A basic measure of evaluation of the effects achieved was the level of the gross margin without and with subsidies. The method for calculating these categories is presented below:

gross margin without subsidies = production value – direct costs,

gross margin = gross margin without subsidies + subsidies.

Furthermore, a set of measures was used to analyse the results of the evaluated production activities, i.e.:

1. direct unit cost – direct costs incurred per unit of production,
2. direct profitability index – ratio of total production value to direct costs expressed as a percentage,
3. competitiveness index of the gross margin without subsidies – share of direct costs in the gross margin without subsidies,
4. technical labour productivity index – volume of production per 1 hour of total labour inputs i.e. own and hired labour,
5. economic labour productivity index (also referred to as labour productivity) – total production value per 1 hour of total labour inputs.

As data are processed electronically, there may be certain cases where sums of components differ from the provided "totals".

[33] R. Manteuffel, *Economics and organisation of an agricultural holding*, Polish Agriculture and Forest Science Publishing House, Warsaw 1984, pp. 57-59.
[34] T.J. Coelli, Rao D.S. Prasada, Ch.J. O'Donnell, G.E. Battese, *An introduction to efficiency and productivity analysi*s, Springer 2005, pp. 88-90.

Research findings

Sugar beets have been cultivated in the Polish territory for over two hundred years. Beets are very demanding as to soil conditions, thus they should be cultivated mostly on fertile soils[35]. Kołodziejczak states that the soil humus index is a general measure of soil fertility. Its average value in Poland is 46.1 points, while the highest value, i.e. over 135 points, was found, among others, in some areas of the Wielkopolska and Śląsk region[36].

Good soil quality and good agricultural production space[37], which can be found in the Wielkopolska and Śląsk region, encourage farmers to grow sugar beets[38]. Surveys of the Central Statistical Office (CSO) reveal that the Wielkopolska and Śląsk region was ranked first in terms of sugar beet cultivation area in 2010-2014. The region was followed by: Mazowsze and Podlasie, Pomorze and Mazury as well as Małopolska and Pogórze regions.

While analysing data on sugar beet cultivation area, it should be noted that sugar beet cultivation in Poland has been losing its importance for the last dozen years or more. As a result, the area in 2014 – compared to 2000 – decreased by 40.7% and reached 197 638 ha, as opposed to 333 131 ha in 2000. Nevertheless, average beet yield in individual holdings increased by 313 dt (from 387 dt/ha in 2000 to 700 dt/ha in 2014). It should be noted, however, that 2014 brought exceptionally favourable agro-meteorological conditions for sugar beet cultivation.

In 2000-2014, the level of average annual buying-in prices of sugar beet roots varied in different directions. The CSO states that, after a period of relative sugar beet buying-in price stability in 2000-2003 (PLN 10-12/dt), the price of sugar beets in 2004, i.e. when Poland became a EU Member State, rose to PLN

[35] *200 year history of sugar beet cultivation*, http://www.kws.pl/aw/KWS/poland/Firma/O_nas/Historia/~ort/200_letnia_historia_uprawy_burak_w_cukro/ [accessed on: 6 July 2015].
[36] A. Kołodziejczak, *Agricultural models and spatial differences in the farming systems in Poland*, Series: Geography, No. 90, Publisher: Adam Mickiewicz University in Poznań, Poznań 2010, pp. 104-106.
[37] The quality of agricultural production space is determined based on natural factors (such as: soil, agroclimate, relief, water conditions) and anthropogenic factors (e.g. ownership structure, agricultural culture level, State policy) – cf. M. Dudzińska, *Factors evaluating agricultural production area*, Infrastructure and ecology of rural areas, No. 1, Polish Academy of Sciences, Kraków 2011, pp. 173-175.
[38] *Plants cultivation*, https://www.igipz.pan.pl/tl_files/igipz/ZGWiRL/ARP/08.Uprawy%20roslinne.pdf [accessed on: 6 July 2015].

18.70/dt (higher than in 2000 by 83.5%). However, it gradually decreased in 2005-2008 (to reach PLN 10.37/dt in 2008). The buying-in price of beets alternately increased and decreased in the next six years (2009-2014) to stay at PLN 12.59/dt in 2014.

It should be clarified that, since the 2006/2007 season, i.e. the introduction of a EU sugar market regulation reform, the level of buying-in prices of sugar beets in Poland has depended on the level of the minimum buying-in price of roots specified for a particular season and the quality of the raw material delivered to sugar factories. In the 2014/2015 season, the minimum price of 1 tonne of beet roots with a standard sugar content of 16% stood at EUR 26.29 in the EU, i.e. at the same level as in the previous five seasons. Therefore, given that the euro exchange rate on 1 October 2014, which was published by the European Central Bank, was EUR 1 = PLN 4.1899, the minimum buying-in price of sugar beet roots was set for that season for Poland at PLN 11.02/dt.

In accordance with official statistics, the average buying-in price of 1 dt of sugar beet roots in Poland in 2014 was PLN 12.59, but it varied by voivodeship. Farmers in the Lubuskie Voivodeship achieved the lowest price of 1 dt of sugar beet roots (PLN 10.59 on average), while those in the Pomorskie Voivodeship – the highest (PLN 13.69 on average). Both voivodeships are located in the same region (Pomorze and Mazury), thus different beet prices could be due to the quality of the raw material delivered to sugar factories. The level of prices could also be influenced to a certain extent by the choice of a sugar factory to which beets were delivered. In 2014, buying-in prices of sugar beet roots differed the least in voivodeships of the Małopolska and Pogórze region. The price was the highest (PLN 12.27/dt on average) in the Świętokrzyskie Voivodeship, while the lowest in the Śląskie Voivodeship (PLN 11.72/dt on average).

In 2014, sugar beets were covered by research under the AGROKOSZTY system, as part of which data on the level of production, incurred inputs and direct costs are collected. These data were collected in 149 individual agricultural holdings located throughout the country and engaged in sugar beet cultivation. Production and economic results for sugar beets were presented as averages for all the holdings and groups of holdings classified by regional location.

The aim was to identify factors that determine the amount of the gross margin from sugar beet cultivation and to evaluate the degree of its diversity in selected holdings located in the four agricultural regions – Table 1.

Table 1. Production, inputs, costs and the gross margin from sugar beet cultivation presented as an average of the research sample of holdings and of selected holdings in specified agricultural regions (actual data)

Specification	On average in sugar beet holdings	On average in selected holdings in			
		Pomorze and Mazury	Wielkopolska and Śląsk	Mazowsze and Podlasie	Małopolska and Pogórze
Number of surveyed holdings	149	27	63	37	22
Utilised agricultural area [ha]	70.69	91.32	79.97	48.11	56.82
Sugar beet cultivation area [ha]	9.31	12.20	9.30	7.37	9.08
Root yield [dt/ha]	701	707	695	684	729
Root sales price [PLN/dt]	12.26	11.86	12.10	13.56	11.73
Leaf sales price (leaves as a by-product) [PLN/dt]	2.57	-	2.52	2.78	-
	Per 1 ha of crops				
Total production value [PLN]	8 613	8 385	8 444	9 294	8 556
including: roots	8 592	8 385	8 405	9 270	8 556
Total direct costs [PLN]	2 702	2 516	2 773	2 784	2684
of which: seed material	653	639	635	722	633
mineral fertilisers in total	1 203	1 081	1 280	1 218	1 155
off-farm organic fertilisers	4	-	-	-	26
plant protection products	792	721	820	789	829
growth regulators	13	6	6	25	27
other	38	69	33	30	14
Gross margin without subsidies [PLN]	5 911	5 869	5 670	6 510	5 872
Subsidies [PLN]	3 272	3 367	3 704	2 916	2 333
of which: sugar payment	2 361	2 456	2 793	2 005	1 422
single area payment	911	911	911	911	911
Gross margin [PLN]	9 183	9 236	9 374	9 426	8 205
Total labour inputs [h]	17.1	14.0	16.6	18.7	21.2
including: own labour inputs	13.7	11.9	12.6	15.1	17.6
Economic efficiency measures					
Share of costs of mineral fertilisers and plant protection products in direct costs [%]	73.8	71.6	75.8	72.1	73.9
Direct costs/1 dt of beets [PLN]	3.86	3.56	3.99	4.07	3.68
Gross margin without subsidies/ 1 dt of sugar beets [PLN]	8.44	8.30	8.16	9.52	8.05
Share of direct costs in the gross margin without subsidies [%]	45.7	42.9	48.9	42.8	45.7
Direct profitability index [%]	318.8	333.3	304.5	333.9	318.7
Volume of production /1 hour of total labour inputs [dt]	41.1	50.6	41.8	36.6	34.5
Production value/1 hour of total labour inputs [PLN]	505.03	599.67	507.78	497.99	404.18
Share of subsidies in the gross margin [PLN]	35.6	36.5	39.5	30.9	28.4

[-] – means that a specific phenomenon did not occur.

Source: study based on own research.

The CSO reports that yield from 1 ha of sugar beet cultivation area in individual holdings in 2014 amounted to 700 dt. The research sample average was almost the same (701 dt). However, it differed much by agricultural region – beet yield ranged from 684 dt in Mazowsze and Podlasie to 729 dt in the Małopolska and Pogórze region (difference was 45 dt).

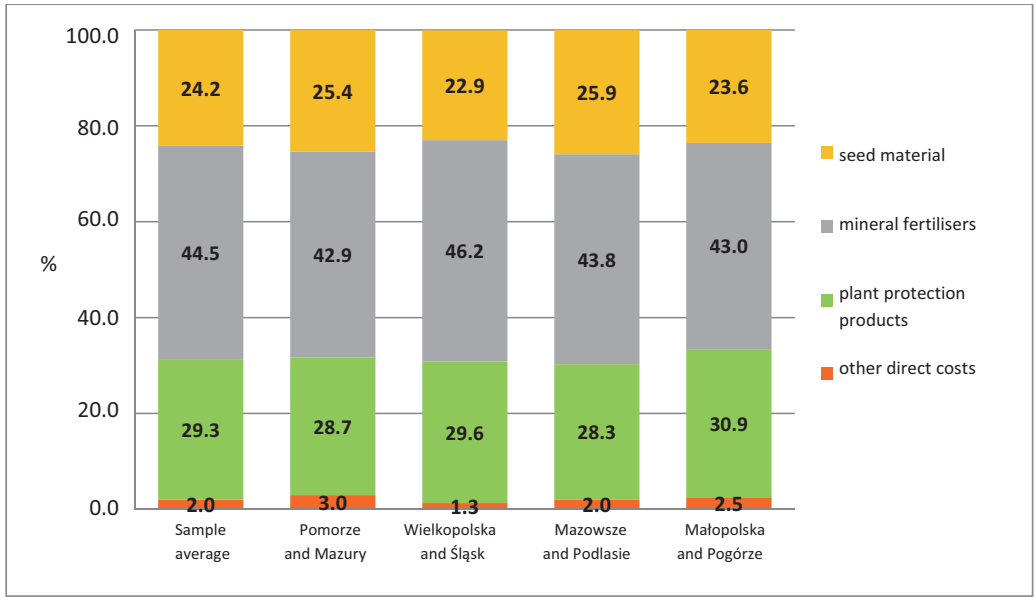
The buying-in price of sugar beets was PLN 12.59/dt on average in the country, while that provided to farmers, being the research sample average, was lower by 2.6% and reached PLN 12.26/dt. Its level varied by region. The highest price was provided to sugar beet growers in Mazowsze and Podlasie, i.e. PLN 13.56/dt, while the lowest – to those in the Małopolska and Pogórze region, i.e. PLN 11.73/dt.

The research shows that the regional location of holdings, to a greater extent, differentiated the level of revenues from sugar beet cultivation than the amount of direct costs. Having compared extremes, the difference in the first case was PLN 909 per 1 ha, while in the second – PLN 268 per 1 ha. As for production values, i.e. the productivity of the land involved, the highest (PLN 9294) was achieved in the Mazowsze and Podlasie region, while the lowest (PLN 8385) in Pomorze and Mazury. In terms of costs, the situation was similar. Farmers in Mazowsze and Podlasie bore the highest direct costs (PLN 2784/ha), while those in Pomorze and Mazury – the lowest (PLN 2516/ha) – Table 1.

The structure of direct costs of sugar beet cultivation reveals which components had the strongest influence on their level.

The research shows that the cost of mineral fertilisers had the strongest influence in all the regions. The cost of plant protection products was the next one. Their total share in the structure of direct costs ranged between 71.6% and 75.7% – Figure 1.

Figure 1. Structure of direct costs of sugar beet cultivation in 2014 presented as the sample average and the agricultural region average (per 1 ha of crops)



Source: study based on own research.

In 2014, economic results of sugar beet cultivation at the level of the gross margin were favourable. Its average level without subsidies, being the research sample average, was PLN 5911/ha, while in regional terms – it ranged between PLN 5670/ha in the Wielkopolska and Śląsk region and PLN 6510/ha in Mazowsze and Podlasie.

Producers were additionally supported by subsidies, i.e. sugar payment and single area payment. The research indicates that subsidies were considered the greatest support for beet growers in the Wielkopolska and Śląsk region. Results of beet cultivation in those holdings, being a consequence of production and price conditions, were the weakest, so the role of subsidies was the greatest, as evidenced by their high share of the gross margin – 39.5%. This means that farmers received PLN 0.65 of support per PLN 1 of the gross margin without subsidies. However, that support in other regions was: PLN 0.57 in the Pomorze and Mazury region, PLN 0.45 in Mazowsze and Podlasie as well as PLN 0.40 in Małopolska and Pogórze.

Subsidies made the gross margin from 1 ha of sugar beet cultivation area more regionally diversified. Its level without subsidies resulting from the comparison of extremes differed by PLN 840 and, including subsidies, by PLN 1221. Having considered subsidies, the order of the regions in terms of the gross margin (i.e. gross margin plus subsidies) from sugar beet cultivation changed, as a result of sugar payment which varied by region. It was the highest (PLN 2793/ha) in the Wielkopolska and Śląsk region, while the lowest (PLN 1422/ha) in the Małopolska and Pogórze region.

In both cases, however, i.e. whether the gross margin was considered without or with subsidies, holdings from the Mazowsze and Podlasie region were ranked first. The list below presents the order of the regions in terms of the gross margin achieved in the holdings under analysis from 1 ha of sugar beet cultivation area (Table 1):

without subsidies	**with subsidies**
1. Mazowsze and Podlasie	1. Mazowsze and Podlasie
2. Małopolska and Pogórze	2. Wielkopolska and Śląsk
3. Pomorze and Mazury	3. Pomorze and Mazury
4. Wielkopolska and Śląsk	4. Małopolska and Pogórze

Sugar beet cultivation was economically efficient also in 2014. The direct profitability index was 318.8% on average in the sample, thus meaning that production value was 3.2-fold higher than the direct costs incurred. The average value of the direct profitability index for sugar beet cultivation was the highest in Mazowsze and Podlasie (333.9%) as well as Pomorze and Mazury (333.3%). The lowest profitability (304.5%), however, was recorded in the Wielkopolska and Śląsk region, i.e. in holdings with the lowest gross margin without subsidies.

Compared to other regions, Mazowsze and Podlasie had the highest direct costs incurred per 1 ha of sugar beet cultivation area (PLN 2 784). Nevertheless, the gross margin without subsidies was the highest (PLN 6 510) and the ratio of direct costs to the margin generated was the most favourable. The costs accounted for 42.8% of its level, thus meaning that the highest competitiveness was that in relation to this category of income, while the largest share of direct costs in the margin achieved was recorded in the Wielkopolska and Śląsk region (48.9%). This means that sugar beet cultivation had the lowest cost competitiveness.

Sugar beet cultivation was the least labour intensive in Pomorze and Mazury (14.0 h/ha), while the most labour intensive in the Małopolska and Pogórze region (21.2 h/ha). The difference in favour of Pomorze and Mazury was 34.0%. This factor affected the technical and economic productivity of labour which was the highest in holdings from the Pomorze and Mazury region (50.6 dt, PLN 599.67, respectively), while the lowest in those from Małopolska and Pogórze (34.5 dt, PLN 404.18, respectively).

In conclusion, the factor that had the greatest impact on the amount of the gross margin from sugar beet cultivation was production value which is derived from production and price results. Direct costs had less impact. The research shows that the highest gross margin without subsidies was that of growers in Mazowsze and Podlasie (PLN 6510/ha). In this region, the economic efficiency of production, the measure of which was the direct profitability index (333.9%), was also the highest. However, the most disadvantaged beet producers were those from Wielkopolska and Śląsk, as evidenced by both the level of the gross margin without subsidies (PLN 5670/ha) and the direct profitability index (304.5%).

Furthermore, beet cultivation in Mazowsze and Podlasie stands out with its high cost competitiveness and the lowest share of direct costs in the margin generated (42.8%), which was the highest in the Wielkopolska and Śląsk region (48.9%). Nevertheless, labour inputs were used the most efficiently in holdings in Pomorze and Mazury. The reason for this was a relatively low labour intensity of sugar beet cultivation (14.0 h/ha).

Dairy cattle breeding and **milk production** in Poland play an important role in generating income of both dairy cow holdings and agriculture as a whole. Over the past dozen years or more, the dairy sector in Poland has undergone numerous changes as a result of Poland's accession to the EU. The accession involved the adoption of the Common Agricultural Policy, under which milk producers were required to adjust to EU legal requirements. From 1st of April 2004 to 31st of March 2015, farmers were provided with milk quotas which, together with increased milk quality requirements, led to a decrease in the cow population. As a result, the number of cows in the country in 2014 decreased by 28.6%, as opposed to 2000. In a regional breakdown, however, the largest decline in the number of dairy cows was recorded in the Małopolska and Pogórze region (by 64.7%), while the smallest – in the Mazowsze and Podlasie region (by 15.4%) – Table 2.

Table 2. Total cow population during the years of research in the country and in the agricultural regions

Specification	Years of research						
	2000	2005	2010	2011	2012	2013	2014
	Dairy cow population (in heads)						
Poland	**3 146 853**	**2 754 810**	**2 529 428**	**2 446 136**	**2 346 097**	**2 299 083**	**2 247 800**
Pomorze and Mazury	371 221	321 567	295 920	322 206	295 721	293 365	281 536
Wielkopolska and Śląsk	627 404	549 721	545 989	517 900	483 549	491 263	482 980
Mazowsze and Podlasie	1 470 685	1 434 114	1 374 128	1 333 471	1 296 619	1 263 420	1 244 156
Małopolska and Pogórze	677 543	449 408	313 391	272 559	270 208	251 035	239 128

Source: own study based on CSO data.

Nevertheless, the decline in the dairy cow population did not cause a decrease in the country's volume of milk production. Its level in 2014 was higher than in 2000 by 9.2% (i.e. by 1.1 million litres). This was due to milk yield of cows which grew year by year to become higher in the country in 2014 than in 2000 by 40.8% on average.

While analysing the situation of dairy holdings by region, it can be noted that cow breeding and milk production are the most concentrated in the Mazowsze and Podlasie region, while the least concentrated in the Małopolska and Pogórze region. In 2014, the difference in the number of cows between both regions was more than 5-fold. Additionally, higher milk production in holdings from the former region (by 23.2% in 2014) affected the level of milk production which was 6.4-fold higher in 2014 than in latter region. It is worth mentioning that the highest milk yield of cows in recent years has been recorded in the Wielkopolska and Śląsk region, i.e. 5758 litres in 2014.

In accordance with CSO data, recent years have also brought changes in the buying-in price of milk which followed a clear upward trend, declining slightly in 2001-2003, i.e. just before Poland's accession to the EU, and in 2008--2009. Fluctuations in prices of milk in 2008-2009 were caused largely by the global economic crisis. Buying-in prices of milk in the domestic market began to remain stable as late as in the first half of 2010. The second half of 2010, however, brought a continuous increase in the price of milk.

The booming dairy market made prices of milk remain relatively high in 2014. In accordance with CSO data, the average buying-in price of milk was PLN 1.37/litre. However, large disparities occurred in specific voivodeships, as the level of prices ranged between PLN 1.27/litre in the Małopolska Voivodeship and PLN 1.47/litre in the Opolskie Voivodeship.

Based on research performed under the AGROKOSZTY system, the study presents a comparative analysis of the level of production, incurred inputs and costs as well as income in the form of the gross margin per 1 dairy cow. Empirical data from 169 holdings, which kept dairy cows in 2014, were a starting point for research. Research findings were presented as the research sample average and the regional average.

On average, there were 26.8 cows in the holdings under analysis, while their number in the selected regions ranged between 23.3 cows in the Małopolska and Pogórze region and 31.2 cows in Pomorze and Mazury. However, stocking density per 100 ha of utilised agricultural area in the sample of holdings located in: Pomorze and Mazury was 57.8 cows, Wielkopolska and Śląsk – 62.0 cows, Mazowsze and Podlasie – 66.1 cows, and Małopolska and Pogórze – 57.8 cows. This means that breeding dairy cows was the most concentrated in the Mazowsze and Podlasie region, while the least – in Pomorze and Mazury as well as Małopolska and Pogórze.

In all the regions, milk yield of cows in the holdings under analysis was, on a national average basis, higher than in individual holdings which, according to CSO data, amounted to 5047 litres[39]. The highest milk yield of cows was achieved in holdings from the Wielkopolska and Śląsk regions (7008 litres), while the lowest – in Pomorze and Mazury (5448 litres). The difference between the former and the latter was 22.3% – Table 3.

Research findings indicate that farmers from Wielkopolska and Śląsk were provided with the most favourable price of milk, i.e. PLN 1.46/litre which was higher than the average buying-in price of milk in the country by 6.6% (according to GUS – PLN 1.37/litre[40]). In contrast, the lowest price of milk, i.e. PLN 1.34/litre, was recorded in the Małopolska and Pogórze region. It was lower than the national average buying-in price of milk by 2.2%.

Milk production and price conditions in specific regions determined the level of production value per 1 dairy cow. The most favourable situation in this respect was that of milk producers from Wielkopolska and Śląsk. Their total production value per 1 cow was PLN 11 322. In contrast, it was the lowest in Pomorze and Mazury, i.e. PLN 8120/1 cow.

[39] *Physical volumes of animal production in 2014*, CSO, Warsaw 2015.
[40] *Buying-in and prices of agricultural products in 2014*, CSO, Warsaw 2015.

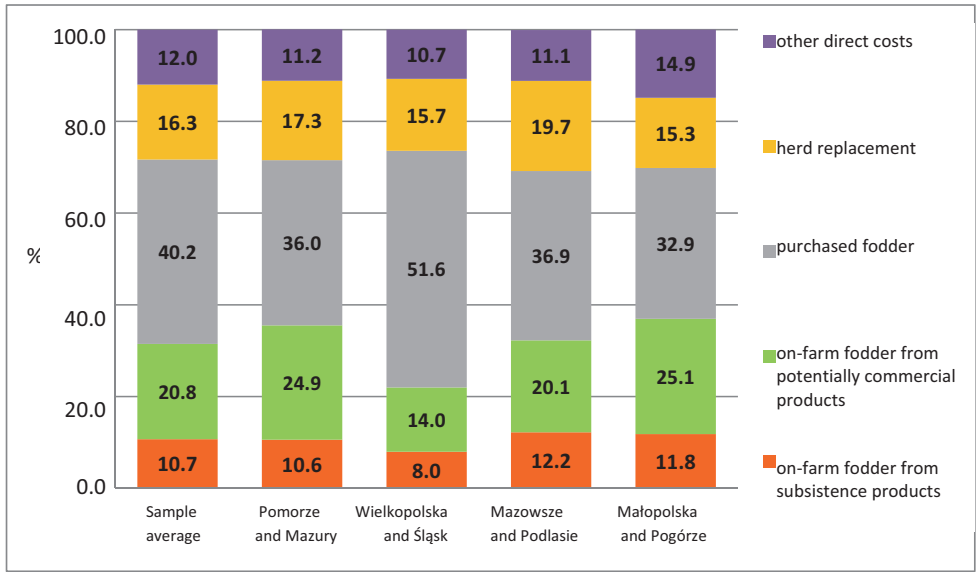
Table 3. Production, inputs, costs and the gross margin from milk production presented as an average of the research sample of holdings and of selected holdings in specified agricultural regions (actual data)

Specification	On average in dairy cow holdings	On average in selected holdings in			
		Pomorze and Mazury	Wielkopolska and Śląsk	Mazowsze and Podlasie	Małopolska and Pogórze
Number of surveyed holdings	169	41	32	54	42
Utilised agricultural area [ha]	43.96	53.92	47.74	37.09	40.22
Permanent grassland area [ha]	13.27	16.13	12.50	11.09	13.86
Share of permanent grassland in UAA [%]	29.9	29.9	26.2	29.9	34.5
Fodder area[a] [ha]	0.56	0.62	0.49	0.52	0.60
Average annual number of dairy cows [head]	26.8	31.2	29.6	24.5	23.3
Milk yield of cows [litre]	6 016	5 448	7 008	5 964	5 866
Sales price of milk [PLN/litre]	1.41	1.34	1.46	1.42	1.44
Sales price of calves weaned from cows [PLN/kg]	10.57	10.11	11.89	9.72	11.62
Sales price of culled cows [PLN/kg]	3.87	3.94	4.01	3.85	3.72
	Per 1 dairy cow				
Total production value [PLN]	9 371	8 120	11 322	9 249	9 314
of which: milk	8499	7 269	10 257	8 462	8 456
calf weaned from a dairy cow	544	547	633	459	568
culled dairy cows	328	305	432	328	291
Total direct costs [PLN]	3 311	2 556	4 437	3 154	3 553
of which: herd replacement	540	441	697	620	543
off-farm fodder	1 331	921	2 290	1 163	1 169
on-farm fodder from commercial products	688	637	622	633	893
on-farm fodder from subsistence products	354	271	353	387	420
other direct costs	397	286	476	352	528
Gross margin without subsidies [PLN]	6 060	5 564	6 884	6 095	5 761
Subsidies[b] [PLN]	509	564	449	472	548
Gross margin [PLN]	6 569	6 128	7 333	6 567	6 309
Total labour inputs [h]	101.8	75.7	86.7	110.9	138.4
including: own labour inputs	94.2	72.8	79.8	104.8	122.1
Economic efficiency measures					
Direct costs/1 litre of milk [PLN]	0.55	0.47	0.63	0.53	0.61
Gross margin without subsidies/1 litre of milk [PLN]	1.01	1.02	0.98	1.02	0.98
Share of direct costs in the gross margin without subsidies [%]	54.6	45.9	64.5	51.8	61.7
Share of the cost of purchased fodder in total costs of fodder [%]	56.1	50.4	70.1	53.3	47.1
Consumption of concentrated fodder per 1000 litres of milk [dt]	2.9	2.6	3.3	2.6	3.1
Direct profitability index [%]	283.0	317.7	255.2	293.2	262.2
Volume of production/1 hour of total labour inputs [litre]	59.1	72.0	80.8	53.8	42.4
Production value/1 hour of total labour inputs [PLN]	92.04	107.30	130.59	83.42	67.29
Share of subsidies in the gross margin [%]	7.8	9.2	6.1	7.2	8.7

[a] The area dedicated to the production of on-farm subsistence fodder. [b] The subsidies cover the single area payment (SAP) per fodder area. *Source: study based on own research.*

When analysing direct costs, it was found that both their level and structure differed. The highest costs – per 1 cow – were borne by farmers from the Wielkopolska and Śląsk region (PLN 4437). They were higher than those in holdings located in: Małopolska and Pogórze by 24.9%, Mazowsze and Podlasie by 40.7% and Pomorze and Mazury by 73.6%. The largest share in the structure of direct costs (from 69.2 to 73.6%) was that of the total cost of fodder. The cost of herd replacement accounted for 15.3-19.7%, depending on the region, while other direct costs – for 10.7-14.9% of total direct costs – Figure 2.

Figure 2. Structure of direct costs of keeping dairy cows in 2014 presented as the sample average and the agricultural region average (per 1 cow)



Source: study based on own research.

Direct costs of keeping dairy cows were determined by the cost of fodder. Its level varied by region which was due to a different method of feeding animals. The highest cost of fodder was recorded in holdings in the Wielkopolska and Śląsk region (PLN 3 265), while the lowest – in Pomorze and Mazury (PLN 1829).

The research showed that economic results of milk production at the level of the gross margin without subsidies in 2014 were favourable. On average, farmers in the research sample achieved PLN 6060/1 cow. In regional terms,

however, the gross margin without subsidies in holdings under analysis ranged from PLN 5564/1 cow in Pomorze and Mazury to PLN 6884/1 cow in the Wielkopolska and Śląsk region. The difference was due to significant differences in milk yield of cows and the price of milk. The highest milk yield of cows and the highest sales price of milk in the Wielkopolska and Śląsk region made it possible to achieve revenues higher than in the Pomorze and Mazury region by 39.4%. In value terms, the difference in favour of Wielkopolska and Śląsk amounted to PLN 3202, which, despite the higher costs (by PLN 1881, i.e. 73.6%), made the gross margin without subsidies higher by 23.7%.

Subsidies are an instrument to support farmers' income. As regards dairy cow holdings, fodder area payments were taken account of. Analysis findings reveal that this support had no significant impact on improving the profitability of milk production, as evidenced by their small share in the gross margin, i.e. from 6.1 to 9.2%.

There are close links between production value, incurred costs and achieved economic results. The profitability index, being the ratio of production value to direct costs (%), was taken as a measure for the evaluation of efficiency of milk production in holdings located in different parts of the country. In 2014, the average direct profitability index in the entire research sample amounted to 283.0%, thus meaning that production value was 2.8-fold higher than the direct costs incurred. Considering the regional distribution of holdings, the average direct profitability index for milk production was the highest in Pomorze and Mazury (317.7%), while the lowest in holdings in the Wielkopolska and Śląsk region (255.2%).

Having analysed data per 1 litre of milk, it is clear that direct costs of its production, with the highest milk yield of cows, i.e. in the Wielkopolska and Śląsk region, were the highest, i.e. PLN 0.63. The Małopolska and Pogórze region was ranked second, achieving PLN 0.61. The gross margin without subsidies in these regions was PLN 0.98/litre, while in the other two, in which the unit direct cost of milk production was lower – PLN 1.02/litre.

The research shows that labour inputs incurred for keeping 1 dairy cow were used the most efficiently in holdings in the Wielkopolska and Śląsk region as well as Pomorze and Mazury, as evidenced by both the volume and value of production per 1 hour of total labour.

In conclusion, economic results of milk production were determined by production value generated by 1 dairy cow. The level of production value was

more affected by milk yield of cows than by the sales price of milk. Both variables were the highest in holdings in Wielkopolska and Śląsk, while the lowest in those in Pomorze and Mazury.

Higher milk yield of cows was accompanied by production intensity growth measured by the level of direct costs of keeping 1 cow. The most favourable ratio of direct costs to the generated margin was recorded in the Pomorze and Mazury region. The costs accounted for 45.9% of its level, thus meaning that the highest competitiveness was that in relation to this category of income, while the largest share of direct costs in the margin achieved was recorded in the Wielkopolska and Śląsk region (64.5%). This means that milk production had the lowest cost competitiveness.

The difference in direct costs between the regions was determined by the cost of fodder. Compared to holdings with the smallest milk yield of cows (in the Pomorze and Mazury region), the cost of fodder in holdings with the highest milk yield of cows (in the Wielkopolska and Śląsk region) differed by 78.5%. Nonetheless, the gross margin per 1 cow was the highest in holdings from the Wielkopolska and Śląsk region, while the lowest in those from Pomorze and Mazury. This was mostly due to milk yield of cows. It can, therefore, be concluded that milk yield of cows is vital in the entire process of milk production. If higher, it stimulates income growth, despite higher costs of keeping animals.

The volume of **live cattle** (slaughter cattle) production in Poland varied significantly. This is particularly evident when evaluating a longer period of time. In accordance with the Central Statistical Office (CSO), live cattle production in 2000 was 635.0 thousand tonnes, but decreased in 2005 to 598.6 thousand tonnes (down by 5.7%). In the first years after Poland's accession to the EU, the volume of live cattle production in the country increased to 751.2 thousand tonnes in 2011, but fell in 2012-2013. In 2014, however, live cattle production rose once again and reached 804.4 thousand tonnes.

In 2000-2014, the highest live cattle production was found in voivodeships of the Mazowsze and Podlasie and the Wielkopolska and Śląsk regions. In 2014, it was 361.9 and 258.5 thousand tonnes, respectively. Since 2000, its level in these regions increased by respectively 57.1 and 36.9%, while in the other two agricultural regions, i.e. Małopolska and Pogórze as well as Pomorze and Mazury, decreased by 12.1 and 17.5%, respectively. The lowest production was recorded in the Pomorze and Mazury region, i.e. 84.9 thousand tonnes in 2014.

Considering the price situation of live cattle and comparing 2000 with 2014, the buying-in price of livestock in 2014 was higher by 105.5%, i.e. PLN 3.06 (according to the CSO). During this period, there were two periods of more rapid growth in prices, i.e. 2004-2005 and 2011-2012. However, the next two years (2013-2014) brought a slight decrease in the buying-in price of slaughter cattle. In 2014, the national average was PLN 5.96/kg, but it differed by voivodeship. The highest price was provided to farmers in the Świętokrzyskie Voivodeship (PLN 6.48/kg), while the lowest – in the Lubuskie Voivodeship (PLN 5.49/kg). Having compared both levels, it can be concluded that the former one was higher by 18.0%.

Smaller differences in price levels were observed in specific agricultural regions. The difference between the highest and the lowest buying-in price of live cattle in the Pomorze and Mazury and the Małopolska and Pogórze region, in which livestock production was the lowest, was respectively 13.1% and 12.9%, while in the regions with large slaughter cattle production, i.e. Mazowsze and Podlasie as well as Wielkopolska and Śląsk – 11.3% and 6.8%, respectively. Therefore, it cannot be explicitly stated that the high level of production in any region made buying-in prices of live cattle less diversified – Table 4.

Table 4. Production, inputs, costs and the gross margin from live cattle production presented as the average of the research sample of holdings and of selected holdings in the specified 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	86	27	18	26	15
Utilised agricultural area [ha]	51.61	62.17	58.81	41.08	42.206
Permanent grassland area [ha]	13.18	14.06	14.98	10.58	13.93
Share of permanent grassland in UAA [%]	25.5	22.6	25.5	25.8	33.0
Fodder area[a] [ha]	0.04	0.05	0.03	0.03	0.04
Net livestock production (gain)[b] [kg]	44.93	39.52	80.04	37.19	25.98
Gross livestock production[c] [kg]	82.68	67.26	147.66	72.15	50.71
Average weight of fattened animals [kg/head]	590	553	631	585	607
Average annual sales price of livestock [PLN/kg]	6.20	5.89	6.43	6.19	6.46
	Per 100 kg of gross live weight				
Total production value [PLN]	620	589	643	619	646
Total direct costs [PLN]	470	462	470	461	509
of which: herd replacement	313	262	334	317	349
off-farm fodder	38	55	30	43	13
on-farm fodder from commercial products	89	108	83	70	110
on-farm fodder from subsistence products	23	27	17	25	32
other direct costs	7	10	7	5	5
Gross margin without subsidies [PLN]	150	127	174	158	137
Subsidies[d] [PLN]	34	49	25	29	40
Gross margin [PLN]	184	177	199	187	177
Total labour inputs [h]	10.6	12.4	8.9	10.6	12.0
including: own labour inputs	10.1	11.5	8.9	10.5	10.1
Economic efficiency measures					
Share of the cost of purchased fodder in total costs of fodder [%]	25.3	29.1	22.9	31.2	8.2
Cost of achieving PLN 1 of the gross margin without subsidies [PLN]	3.12	3.63	2.70	2.91	3.72
Direct profitability index [%]	132.0	127.5	137.0	134.4	126.9
Gross volume of production/ 1 hour of total labour inputs [kg]	9.5	8.1	11.3	9.4	8.3
Production value/1 hour of total labour inputs [PLN]	58.73	47.71	72.63	58.22	53.73
Share of subsidies in the gross margin [%]	18.4	28.0	12.7	15.4	22.7

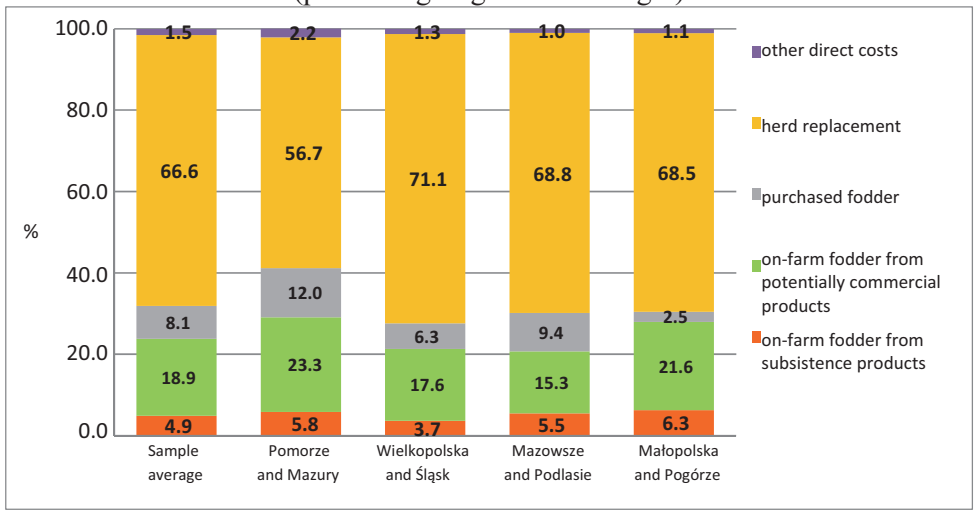
[a] The area dedicated to the production of on-farm subsistence fodder. [b] Net livestock production is annual weight gain in a herd of fattened animals aged 1+. [c] Gain + weight of purchased animals. [d] The subsidies cover the single area payment. *Source: study based on own research.*

Regional differences in the gross margin from beef production were due to interdependencies between its sales price and production costs. The average price of livestock obtained in the holdings under analysis was PLN 6.20/kg. Its level, however, varied by region. The highest price was provided to beef producers in the Małopolska and Pogórze region, i.e. PLN 6.46/kg, while the lowest – in Pomorze and Mazury, i.e. PLN 5.89/kg.

However, direct costs of production of 100 kg of gross live weight of slaughter cattle, on average in the sample of holdings under analysis, amounted to PLN 470. Their level in the Wielkopolska and Śląsk region was the same, while in Mazowsze and Podlasie as well as Pomorze and Mazury – slightly lower, i.e. PLN 461 and PLN 462, respectively. The highest costs were incurred by beef producers in the Małopolska and Pogórze region, i.e. PLN 509 per 100 kg of gross live weight.

Direct costs of live cattle production were influenced significantly by the amount and cost of used fodder. The share of the total cost of fodder in direct costs ranged between 27.6% in the Wielkopolska and Śląsk region and 41.1% in Pomorze and Mazury. However, a decisive impact on their level was that of the cost of herd replacement. Its share in total direct costs ranged from 56.7% in Pomorze and Mazury to 71.1% in the Wielkopolska and Śląsk region – Figure 3.

Figure 3. Structure of direct costs of live cattle production in 2014 presented as the sample average and the agricultural region average (per 100 kg of gross live weight)



Source: study based on own research.

The research performed showed that economic results of slaughter cattle production at the level of the gross margin without subsidies in 2014 were favourable. On average, farmers in the research sample achieved PLN 150/100 kg of gross live weight. Considering the results by regional location of holdings, the highest margin was observed in holdings from Wielkopolska and Śląsk (PLN 174/100 kg). They were followed by holdings from the Mazowsze and Podlasie region (PLN 158/100 kg) as well as Małopolska and Pogórze (PLN 137/100 kg). In contrast, the lowest margin was achieved by farmers from Pomorze and Mazury (PLN 127/100 kg). The difference between the extremes of the gross margin without subsidies was due to differences in the sales price of livestock and direct costs of its production. Compared to Pomorze and Mazury, the sales price and direct costs in the Wielkopolska and Śląsk region were higher by 9.2% and 1.7%, respectively. As a result, this was the level of revenues which determined the amount of the gross margin achieved.

Although not high, fodder area subsidies contributed to the improvement of livestock production results and also reduced the regional disparity in the gross margin without subsidies. The difference between its extremes decreased from 46 to PLN 22/100 kg after taking account of subsidies. The reason for this is that holdings from regions, where the gross margin without subsidies was lower (i.e. Pomorze and Mazury as well as Małopolska and Pogórze), used more fodder from subsistence products (i.e. green fodder, silage, hay) to feed cattle. Therefore, fodder area per 100 kg of livestock was larger and, consequently, beef producers received higher subsidies. Their share in the gross margin in Pomorze and Mazury as well as Małopolska and Pogórze was respectively 28.0 and 22.7%, while in the Wielkopolska and Śląsk region – 12.7% – Table 4.

The profitability index, being the ratio of production value to direct costs (%), was applied to evaluate the economic efficiency of live cattle production in holdings located in different parts of the country. The average direct profitability index for live cattle production in the holdings under analysis was 132.0%. Considering the regional breakdown, the average direct profitability index was the highest in the Wielkopolska and Śląsk region (137.0%), while the lowest in holdings from Pomorze and Mazury (127.5%) as well as Małopolska and Pogórze (126.9%), i.e. regions where the gross margin was the lowest.

Having analysed the results, it was found that the regions differed significantly in terms of the productivity of labour which was the highest in the Wielkopolska and Śląsk region (PLN 72.63), while the lowest in Pomorze and

Mazury (PLN 47.71). Its level was largely affected by the labour intensity of live cattle production, i.e. in the Wielkopolska and Śląsk region – 8.9 hours, while in Pomorze and Mazury – 12.4 hours per 100 kg of gross live weight. Live cattle production in the sample of holdings from Wielkopolska and Śląsk was also characterised by high competitiveness in relation to the generated gross margin without subsidies. The research shows that PLN 2.70 were needed to generate PLN 1 of the margin. However, in the region of Mazowsze and Podlasie it was PLN 2.91, in Pomorze and Mazury – PLN 3.63, while in the Małopolska and Pogórze – PLN 3.72.

In conclusion, the regional differences in the gross margin from slaughter cattle production were due to interdependencies between the sales price and production costs. The advantage of holdings from Wielkopolska and Śląsk, where the gross margin was the highest (PLN 174/100 kg), over holdings from Pomorze and Mazury, i.e. those with the lowest margin (PLN 127/100 kg), resulted mostly from the fact that their sales price of livestock was higher by 9.2%. The advantage of the Wielkopolska and Śląsk region is also evidenced by indicators of the productivity of labour which were related to its organisation. The technical and economic productivity of labour were respectively 11.3 kg of livestock and PLN 72.63 per 1 hour of total labour inputs. Compared to its lowest level in the Pomorze and Mazury region, they were higher by 39.5 and 52.2%, respectively. The economic efficiency of live cattle production was also the highest, the direct profitability index was 137.0% against 134.4% in Mazowsze and Podlasie, 127.5% in Pomorze and Mazury as well as 126.9% in the Małopolska and Pogórze region.

It is important for **organic dairy** holdings to have own fodder resources, thus the importance of permanent grassland as a source of fodder which may largely meet nutritional needs of cattle. In accordance with statistical data, organic utilised agricultural area in Poland in 2013 was 670 thousand ha, while in 2014 – it decreased to 657.9 thousand ha. Nevertheless, it is worth noting that the largest share in the structure of organic utilised agricultural area in 2013-2014 was that of crops for fodder as well as meadows and pastures. In 2013, their total area accounted for 66.0%, while in 2014 – 67.3% of total organic utilised agricultural area. The high share of crops for fodder as well as meadows and pastures could be indicative of popularity of animal production, particularly ruminant production, in organic holdings.

Regrettably, the share of organic holdings engaged in both crop and animal production, is getting smaller, i.e. in 2014, there were only 19.3% of such

units, as opposed to 2013 when the share was 44.2% of organic agricultural holdings in total[41]. When farmers give up animal production, including keeping dairy cows in a holding, organic milk production in the country decreases each year – Table 5.

Table 5. Organic cow milk production (‘000 litres) in 2009-2014 in Poland and in specified agricultural regions

Specification	Years of research					
	2009	2010	2011	2012	2013	2014
Poland	**362 270**	**376 303**	**395 427**	**338 299**	**273 244**	**252 367**
Pomorze and Mazury	81 659	115 548	102 358	101 109	49 867	85 790
Wielkopolska and Śląsk	23 442	29 574	24 584	21 421	21 077	18 983
Mazowsze and Podlasie	69 123	69 994	63 590	33 242	28 600	19 705
Małopolska ad Pogórze	188 046	161 187	204 895	182 527	173 700	127 889

Source: own study based on data from the Chief Inspectorate of Trade Quality of Agricultural and Food Products.

Animal production in organic agricultural holdings, including keeping dairy cows, is not only an important source of income for farmers, but it also has environmental significance[42]. In seeking to evaluate agricultural production in organic holdings comprehensively, it is worth not only analysing production and economic results, but also evaluating its environmental impact. For the preliminary evaluation of environmental sustainability of organic dairy holdings (i.e. eco-friendliness of agricultural production), the following indicators[43] can be used, e.g.: share of cereals in the structure of sowings on arable land, the number of groups of crops cultivated on arable land and the number of animals kept in a holding per 1 ha of utilised agricultural area.

Information on the share of cereals in sowings on arable land is a statistical indicator of the eco-friendliness of agricultural production which character-

[41] *Report on the state of organic farming in Poland in 2013-2014*, Chief Inspectorate of Trade Quality of Agricultural and Food Products, Warsaw 2015.
[42] W. Wrzaszcz, *Level of sustainability of individual agricultural holdings in Poland*, Studies and Monographs, IAFE-NRI, No. 155, Warsaw 2012, p. 65.
[43] W. Wrzaszcz, *Level of sustainability of individual agricultural holdings in Poland*, Studies and Monographs, IAFE-NRI, No. 155, Warsaw 2012, p. 67.

ises correct crop rotation and the degree of biodiversity of agrocoenoses[44]. As for cereals (wheat, rye, barley, oats, triticale, cereal blends, buckwheat, millet, maize for grain and other cereals), their share in the structure of sowings should not exceed 66%[45]. Another measure of the correctness of on-farm crop production organisation is the number of groups of crops cultivated on arable land. This measure indicates the degree of structural diversity of crops, thus making it possible to select and rotate crops and, consequently, reducing the agrophage population, weed infestation and minimising nitrogen losses. It is also stressed that at least 3 groups of crops from among the following ones must be cultivated: cereals, papilionaceous plants, root crops, oilseeds/industrial crops, grass on arable land and other crops (not included in these groups). The most important environmental restrictions applicable to animal production are those concerning stocking density in utilised agricultural area[46]. The acceptable level of stocking density on agricultural land should be derived from an equivalent of a legally permitted natural fertiliser dose, i.e. 170 kg of nitrogen per 1 hectare of utilised agricultural area[47]. For the purpose of this study, it was assumed that the acceptable stocking density of dairy cows in an organic holding is no more than 2 cows per 1 ha of utilised agricultural area[48].

In 2014, 22 individual organic agricultural holdings were examined under the AGROKOSZTY system in terms of their animal production activities – dairy cows. The study presents the preliminary evaluation of environmental sustainability of organic dairy holdings and the comparative analysis of the level of production, incurred inputs and costs as well as income in the form of the gross margin per 1 dairy cow. The findings are presented as the research sample average and the regional average (excluding the Wielkopolska and Śląsk region, as there were no holdings in the research sample).

Information on the crop structure, utilised agricultural area, arable land and the average annual number of cows was used to perform the ***preliminary***

[44] A. Faber, *Evaluation of the level of sustainability of agriculture in Poland in different spatial scales*, Studies and Reports of the Institute of Soil Science and Plant Cultivation – National Research Institute, No. 20, Puławy 2010, pp. 9-27.
[45] J. Kuś, *Role of crop rotation in the contemporary world*, Institute of Soil Science and Plant Cultivation, Puławy 1995. p. 34.
[46] E. Majewski, *Economic and organisational conditions for the development of the Integrated Agricultural Production System in Poland*, Warsaw University of Life Sciences Press, Warsaw 2002.
[47] *Act of 10 July 2007 on fertilisers and fertilisation*, Journal of Laws No. 147, item 1033.
[48] *Commission Regulation (EC) No. 889/2008,* Annex IV *Maximum number of animals per hectare referred to in Article 15(2),* OJ L 250 of 18 September 2008.

evaluation of environmental sustainability of organic dairy holdings. The first of the indicators applied indicates the share of cereals in sowings on arable land in a holding (as previously mentioned, it should not exceed 66%). This indicator in the sample of organic holdings located in Pomorze and Mazury was 38.9%, in the Małopolska and Pogórze region – 47.1%, while in Mazowsze and Podlasie – 65.3%, thus meaning that the requirement to guarantee the correctness of crop rotation and the degree of biodiversity of crops, which were cultivated in organic holdings, was met.

Another indicator is the number of groups of crops cultivated on arable land. This measure indicates the degree of structural diversity of crops in a holding (it is stressed that at least 3 groups of crops must be cultivated). Calculations made by using variables from databases revealed that these requirements were met by only 50.0% of organic holdings in Pomorze and Mazury, 61.5% – in the Małopolska and Pogórze, and 66.7% – in Mazowsze and Podlasie. The last of the indicators at issue concerns stocking density in utilised agricultural area, farming intensity and indicates the scale of environmental load of natural fertilisers. After calculating the average annual number of dairy cows per 1 ha of utilised agricultural area, stocking density was as follows: 0.44 cows in the Pomorze and Mazury region, 0.61 cows in Mazowsze and Podlasie and 0.53 cows in Małopolska and Pogórze. With such a low stocking density, the permitted natural fertiliser dose (equivalent of 170 kg of nitrogen/hectare of UAA) cannot be exceeded.

The research performed indicates that milk yield of cows and the sales price of milk differ depending on the regional location of organic holdings in the research sample. The most favourable situation in terms of milk yield was that in the Małopolska and Pogórze region, i.e. 4072 litres of milk per 1 cow. Milk yield of cows in the Pomorze and Mazury region was 4003 litres, while its lowest level was recorded in Mazowsze and Podlasie – 3019 litres, i.e. lower than the highest level in the Małopolska and Pogórze by 25.9% – Table 6.

Table 6. Production, inputs, costs and the gross margin from milk production in organic holdings presented as an average of the research sample and of selected holdings in specified agricultural regions (actual data)

Specification	On average in dairy cow holdings	On average in selected holdings in			
		Pomorze and Mazury	Wielkopolska and Śląsk	Mazowsze and Podlasie	Małopolska and Pogórze
Number of surveyed holdings	22	6	0	3	13
Utilised agricultural area [ha]	18.09	31.15	-	10.86	13.74
Total cereal area [ha]	4.93	8.64	-	4.71	3.27
Permanent grassland area [ha]	6.78	8.90	-	3.65	6.52
Share of permanent grassland in UAA [%]	37.4	28.6	-	33.6	47.4
Fodder area[a] [ha]	0.86	1.01	-	0.43	0.82
Average annual number of dairy cows [head]	8.9	13.6	-	6.6	7.3
Milk yield of cows [litre]	3 938	4 003	-	3 019	4 072
Sales price of milk [PLN/litre]	1.15	1.10	-	1.08	1.20
Sales price of calves weaned from cows [PLN/kg]	9.99	9.35	-	9.71	11.54
Sales price of culled dairy cows [PLN/kg]	4.35	4.86	-	4.19	3.70
	Per 1 dairy cow				
Total production value [PLN]	5 584	5 518	-	4 161	5 931
of which: milk	4 531	4 411	-	3 284	4 892
calf weaned from a dairy cow	746	719	-	595	801
culled dairy cows	308	387	-	282	237
Total direct costs [PLN]	1 486	1 270	-	1 129	1 778
of which: herd replacement	357	367	-	330	388
off-farm fodder	112	148	-	11	102
on-farm fodder from commercial products	668	403	-	662	897
on-farm fodder from subsistence products	88	102	-	22	89
other direct costs	261	250	-	104	302
Gross margin without subsidies [PLN]	4 099	4 248	-	3 032	4 153
Subsidies[b] [PLN]	1 239	1 534	-	583	1 122
Gross margin [PLN]	5 338	5 782	-	3615	5 275
Total labour inputs [h]	219.6	160.9	-	340.4	245.0
including: own labour inputs	217.1	159.2	-	340.4	241.4
Economic efficiency measures					
Direct costs/1 litre of milk [PLN]	0.38	0.32	-	0.37	0.44
Gross margin without subsidies/1 litre of milk [PLN]	1.04	1.06	-	1.00	1.02
Share of direct costs in the gross margin without subsidies [%]	36.3	29.9	-	37.2	42.8
Share of the cost of purchased fodder in total costs of fodder [%]	12.9	22.7	-	1.5	9.3
Consumption of concentrated fodder per 1000 litres of milk [dt]	1.8	1.1	-	3.0	2.2
Direct profitability index [%]	375.8	434.4	-	368.6	333.6
Volume of production/1 hour of total labour inputs [litre]	17.9	24.9	-	8.9	16.6
Production value/1 hour of total labour inputs [PLN]	25.43	34.28	-	12.22	24.21
Share of subsidies in the gross margin [%]	23.2	26.5	-	16.1	21.3

[a] The area dedicated to the production of on-farm subsistence fodder.[b] The subsidies cover the environmental payment and the single area payment (SAP) per fodder area.[-] – means that a specific phenomenon did not occur.
Source: study based on own research.

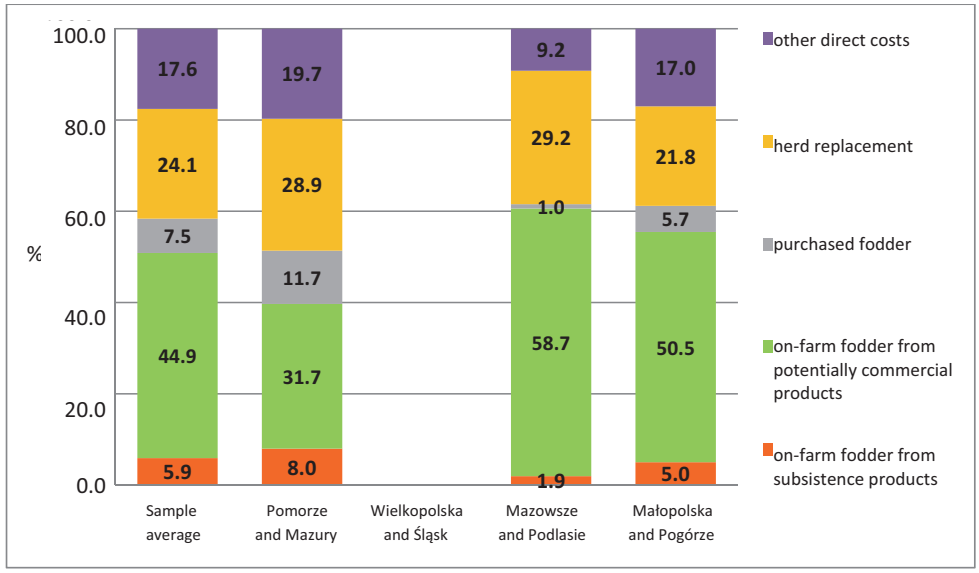
Unfortunately, farmers did not receive a higher price for milk they produced because of the quality of the raw material. The most favourable situation was that of farmers from the Małopolska and Pogórze region, where the sales price of milk was PLN 1.20/litre and was lower than the national average buying-in price (PLN 1.37/litre) by only 12.4%. However, the price of milk in the Pomorze and Mazury region as well as Mazowsze and Podlasie was similar and amounted to respectively PLN 1.10 and PLN 1.08, i.e. lower than the national average buying-in price of milk in 2014 by 19.7 and 21.2%.

The above conditions of milk production in organic holdings affected a certain level of production value per 1 cow. The highest production value, i.e. PLN 5 931/1 cow, was achieved in holdings from the Małopolska and Pogórze region. This was due to the highest milk yield of cows and the highest sales price of milk. In Mazowsze and Podlasie, however, revenues per 1 cow were the lowest, i.e. PLN 4 161. This was due to both milk yield of cows and the price of milk which were significantly lower compared to other regions – Table 6.

As far as the analysis of direct costs incurred for milk production is concerned, the research revealed that both their level and structure differed. The definitely highest costs – per 1 cow – were borne by farmers from the Małopolska and Pogórze region, i.e. PLN 1 778. They were higher than those in holdings located in Pomorze and Mazury by 40.0% as well as Mazowsze and Podlasie by 57.5%. The largest share in the structure of direct costs was that of the total cost of fodder which ranged between 51.4 and 61.6%, depending on the region selected – Figure 4.

Studies revealed significant differences in the cost of off-farm fodder and on-farm fodder from commercial products. As a result, regional differences in how dairy cows are fed become evident. Purchased fodder was used the most by farmers from the Małopolska and Pogórze region as well as Pomorze and Mazury.

Figure 4. Structure of direct costs of keeping dairy cows in 2014 in organic holdings presented as the sample average and the agricultural region average (per 1 cow)



Source: study based on own research.

When evaluating economic results, the level of the gross margin without subsidies per 1 dairy cow was taken into account. According to this measure, the most favourable situation was that of holdings from the Pomorze and Mazury region, where the gross margin without subsidies was PLN 4247/1 cow. Given the productivity of cows and the price of milk, production value per 1 cow, compared to the best result in the Małopolska and Pogórze region, differed by PLN 413. In terms of the direct costs incurred, however, there is a clear predominance of holdings from Pomorze and Mazury, where their level per 1 cow was lower than in the Małopolska and Pogórze region by PLN 508. In this situation, direct costs were a driver of the highest gross margin without subsidies in holdings situated in the Pomorze and Mazury region.

As part of agri-environmental programmes, farmers can receive subsidies as additional support for their income. As for dairy cows, both the environmental payment and the single area payment, to which they were entitled as a result of using own area to produce subsistence fodder, were taken into account. The analysis carried out revealed that such support in the form of subsidies contrib-

uted significantly to improve the income situation of milk production, as evidenced by their share in the gross margin, i.e. from 16.1 to 26.5%.

In 2014, milk production in the organic holdings under analysis was profitable. The profitability index, being the ratio of production value to direct costs (%), was applied as a measure of profitability. When comparing the results in the specified regions, the advantage of holdings from Pomorze and Mazury, where the direct profitability index was the highest, i.e. 434.4%, can be observed. In contrast, holdings from the Małopolska and Pogórze region, despite their highest production value, had the lowest direct profitability of milk production (333.6%). This was due to relatively high costs incurred for keeping dairy cows.

The calculations made confirm that the most favourable income situation of milk production was that in the Pomorze and Mazury region. Holdings located there achieved the highest gross margin without subsidies per 1 litre of milk (PLN 1.06). This is because direct costs of production of 1 litre of milk were the lowest (PLN 0.32) which could be due to the lowest consumption of concentrated fodder per 1000 litres of milk. Also labour inputs incurred for keeping 1 dairy cow in that region were used the most efficiently, as evidenced by both the volume and value of production per 1 hour of total labour – Table 6.

In conclusion, milk production in organic holdings throughout the regions made it possible to achieve the gross margin without subsidies. Its value per 1 cow was the highest (PLN 4248) in holdings from the Pomorze and Mazury region. Farmers from Małopolska and Pogórze had it slightly lower (by 2.2%), as a result of relatively high direct costs (PLN 1 778/cow), because revenues generated by 1 cow were the highest (PLN 5931). It should be added that milk yield of cows in the region was the highest. To some extent, it explains high costs and the high use of concentrated fodder per 1000 litres of milk (2.2 dt). In contrast, the lowest margin was found in holdings in Mazowsze and Podlasie. Without support in the form of subsidies, it amounted to PLN 3032/1 cow. This was due to the level of revenues (PLN 4161/cow), because direct costs were the lowest (PLN 1129/cow).

The performed preliminary evaluation of environmental sustainability of organic dairy holdings indicates that agri-environmental requirements were mostly met. Extensive milk production was not a source of significant environmental loads of natural fertilisers, because the stocking density of cows was low. The crop production organisation of the holdings under analysis had appropriate crop rotation but, to a lesser extent, the structural diversity of crops was ensured.

Summary

The gross margin calculations, as referred to in this study, for agricultural production activities examined in 2014 reflect changes in internal and external conditions for running holdings in different agricultural regions. This was due to the fact that the level of production, unit costs and production prices of agricultural products were subject to changes of various degrees. The level of the income achieved, in this case the gross margin, largely depends on the ratio between prices of agricultural products and prices of means of production.

Given the regional location of holdings, thus their dependence on agrometeorological conditions and markets, the research was aimed at demonstrating regional differences at the level of production and economic effects of agricultural products. The results were presented in relation to the level of the gross margin.

Having analysed **sugar beet** cultivation results by region, it was found that the most favourable situation in 2014 was that of farmers from Mazowsze and Podlasie. Their gross margin without subsidies per 1 ha was PLN 6510. The region was followed by: Małopolska and Pogórze – PLN 5872, Pomorze and Mazury – PLN 5869, Wielkopolska and Śląsk – PLN 5670. The amount of the margin was, to the greatest extent, influenced by production value which is derived from production and price results. Direct costs had less impact. As for production values, i.e. the productivity of the land involved, the highest (PLN 9294) was achieved in the Mazowsze and Podlasie region, while the lowest (PLN 8385) in Pomorze and Mazury. In terms of costs, the situation was similar. Farmers in Mazowsze and Podlasie bore the highest direct costs (PLN 2784/ha), while those in Pomorze and Mazury – the lowest (PLN 2516/ha). The regional location of holdings differentiated the level of production value from sugar beet cultivation more than the amount of the direct costs incurred. Having compared extremes, the difference in the first case was PLN 909 per 1 ha, while in the second – PLN 268 per 1 ha.

Subsidies were support for beet producers. The research shows that their role in the Wielkopolska and Śląsk region was the greatest, as evidenced by their share in the gross margin, i.e. 39.5%. This means that farmers received PLN 0.65 of support per PLN 1 of the gross margin without subsidies. However, that support in other regions was: PLN 0.57 in the Pomorze and Mazury region, PLN 0.45 in Mazowsze and Podlasie as well as PLN 0.40 in Małopolska and Pogórze.

As regards the research sample holdings which kept **dairy cows** in 2014, the best milk production results were achieved by farmers in the Wielkopolska and Śląsk region. Their gross margin without subsidies per 1 cow was PLN 6884. The Mazowsze and Podlasie region (PLN 6095) was ranked second. It was followed by Małopolska and Pogórze (PLN 5761) as well as Pomorze and Mazury (PLN 5564).

The main factor that differentiated the level of the margin was production value. The difference between its extremes was PLN 3202/1 cow. The level of production value was more influenced by milk yield of cows than the price of milk. Both variables were the highest in holdings from Wielkopolska and Śląsk, while the lowest in those from Pomorze and Mazury. The former had milk yield higher by 28.6%, while the price of milk – by 9.0%. What is more, farmers from Wielkopolska and Śląsk incurred the highest direct costs with respect to keeping dairy cows (PLN 4437), while those from Pomorze and Mazury (PLN 2556) – the lowest. The difference was PLN 1881/1 cow. This means that the regional location of holdings differentiated the level of production value more than the amount of direct costs. The difference in direct costs was determined by the cost of fodder. The level of this cost was related to the share of concentrated fodder in the ration of cows and its origin, i.e. either purchased or produced in a holding.

Research findings prove that milk yield of cows is very important in the process of milk production. If higher, it stimulates income growth, despite higher costs of keeping animals. Support in the form of subsidies due to the fodder area involved had little impact on improving economic results of milk production. Their share in the gross margin (with subsidies) per 1 cow ranged between 6.1 and 9.2%. This means that farmers received PLN 0.07-0.10 per PLN 1 of the gross margin without subsidies.

In 2014, **live cattle** production at the level of the gross margin was profitable. The research covered holdings whose beef production was combined with dairy cow breeding. There is no tradition of meat cattle breeding in Poland, thus beef production is, to a large extent, related to dairy cattle breeding. Therefore, the results obtained cannot match those achieved by farmers engaged in meat cattle fattening.

Regional differences in the gross margin from live cattle production were due to interdependencies between the sales price and the unit cost of production. The highest price was provided to beef producers in the Małopolska and Pogórze region, i.e. PLN 6.46/kg, while the lowest – in Pomorze and Mazury,

PLN 5.89/kg. Direct costs of production of 100 kg of gross live weight were the lowest in Mazowsze and Podlasie (PLN 461) as well as Pomorze and Mazury (PLN 462), while the highest in the Małopolska and Pogórze region (PLN 509). The level of direct costs was influenced by the amount and cost of fodder and, to the greatest extent, by the cost of herd replacement. The gross margin without subsidies achieved from 100 kg of beef ranged from PLN 127 in Pomorze and Mazury to PLN 174 in the Wielkopolska and Śląsk region. In the former, PLN 2.70 were needed to generate PLN 1 of the gross margin without subsidies, while in Mazowsze and Podlasie – PLN 2.91, in Pomorze and Mazury – PLN 3.63 and in the Małopolska and Pogórze region – PLN 3.72. The advantage of the Wielkopolska and Śląsk region is also evidenced by indicators of the technical and economic productivity of labour as well as the economic efficiency of production. It should be added that subsidies in that region played the relatively smallest role. Their share in the gross margin (with subsidies) per 100 kg of gross live weight was 12.7%, while in Pomorze and Mazury, where it was the highest – 28.0%. This means PLN 0.14-0.39 of subsidies per PLN 1 of the gross margin without subsidies.

Having analysed the results of **milk production in organic holdings** in 2014, it was found that the level of revenues per 1 cow was the highest in the Małopolska and Pogórze region (PLN 5931). This was due to the highest – compared to other regions – milk yield of cows (4072 litres) and the highest price of milk (PLN 1.20/litre). Direct costs of keeping dairy cows were the highest as well (PLN 1778/cow). Their level made the Małopolska and Pogórze region achieve the second highest gross margin without subsidies (PLN 4153/cow). The highest margin was achieved by farmers in Pomorze and Mazury (PLN 4248/cow), while the lowest – by those in Mazowsze and Podlasie (PLN 3032/cow).

The level of the margin in the former was determined by lower direct costs (PLN 1270), while in the latter – production value (PLN 4161), as a derivative of the lowest productivity of cows and the price of milk. Similarly to conventional holdings, the regional location of holdings differentiated the level of production value more than the amount of direct costs. Having compared extremes, the difference in the first case was PLN 1770 per 1 cow, while in the second case – PLN 649 per 1 cow. The labour inputs incurred for keeping cows were used the most efficiently in the region of Pomorze and Mazury, as evidenced by both the volume and value of production per 1 hour. The diversity of

labour productivity measures was mainly due to differences in labour inputs incurred for keeping cows.

Income from milk production in organic holdings was supported by subsidies due to the fodder area involved. Their share in the gross margin (with subsidies) ranged from 16.1% in the Mazowsze and Podlasie region to 26.5% in Pomorze and Mazury. This means that farmers in the former region received PLN 0.19, while those in the latter – PLN 0.36, per PLN 1 of the gross margin without subsidies.

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THE SMALLEST AND THE LARGEST DOMESTIC AGRICULTURAL ENTITIES OF NATURAL PERSONS NOT COVERED BY THE MONITORING OF THE POLISH FADN IN 2010-2013

Introduction and methodological notes

The monitoring of the Polish FADN does not cover the smallest and largest domestic agricultural holdings. The smallest ones are not covered by that monitoring because of legal regulations in force throughout the European Union, while the sample of the largest ones is not large enough and monitoring findings cannot be published due to the obligation of maintaining statistical confidentiality.

Therefore, the study presented analyses of agricultural entities of both these size groups, but only those which were owned by natural persons in 2010-2013, also referred to as individual holdings. In that period, they accounted for a total of 45.5% of all entities owned by natural persons, employed approx. 39% of full-time employees and had nearly 20% of utilised agricultural area. These figures indicate that the entities under analysis influenced supply of products of agricultural origin but, most of all, referred to social issues in rural areas.

Their size was measured by using the SO (Standard Output) measure which indicates agricultural production income calculated in a standard way. Production value thus calculated is the product of the area of crops of a particular type and the number of animals of particular species and utility groups as well as relevant coefficients. The word "standard" means that coefficients of revenues from various types of crops, species and utility groups of animals are averages for specific macro-regions of the country.

The group of the smallest agricultural entities included those with revenues of up to 2 SO (0-2 SO)[49] and 2-4 SO, corresponding in 2010 to annual agricultural production revenues, being amounts calculated in a standard way, ranging from zero to approx. PLN 8 thousand[50] and PLN 8-16 thousand, respectively. The largest ones were those of at least 1000 SO, i.e. with annual agricultural production revenues of at least PLN 3995 thousand.

[49] In 2010, 14% of agricultural holdings of up to 2 SO could not be classified into particular production types, as there were no necessary figures. Some of them probably kept their utilised agricultural area in the state of the so-called production readiness and were not engaged in agricultural production.

[50] In 2010, the average euro exchange rate was PLN 3.9946; since 1 SO was EUR 1000, it corresponded to approx. PLN 3995.

Empirical materials were derived from results of the National Agricultural Census 2010[51] and results of the Partial Census 2013[52]. Furthermore, the analysis used averages relating to agricultural holdings of natural persons in general, which were derived from the same sources, and selected information – from results of the monitoring of the Polish FADN from 2010 and 2013.

Information collected as part of the agricultural censuses was of completely different type than that collected under the monitoring of the Polish FADN. The former provided figures to calculate technical and organisational measures and indicators for agricultural entities of different size and structures of income of agricultural holdings and households of their owners. However, the latter concerns assets and sources of their financing, incurred costs as well as generated revenues and income of entities in size groups determined in the same way.

This information diversity affects the diversity of characteristics of the smallest and largest entities, which are presented in this study, compared to the already quite commonly known analysis of holdings of intermediate sizes drawn up based on the results of the monitoring of the Polish FADN. Such an analysis is, for example, presented in the second chapter of this monograph. Nevertheless, the information presented in this chapter sheds new light on two size groups of agricultural entities owned by natural persons, i.e. the smallest and the largest ones.

Changes in the smallest and the largest agricultural entities in 2010-2013

The change in the characteristics of the smallest and the largest entities in 2010-2013 was caused by phenomena and processes of two types. Firstly, the Central Statistical Office changed the definition of an agricultural holding of a natural person in 2013. The new definition did not cover entities not engaged in agricultural activity and increased size thresholds for areas under cultivation and the number of animals in entities without utilised agricultural area and in those with utilised agricultural area of up to 1 ha, inclusive.

[51] *Characteristics of agricultural holdings*, National Agricultural Census 2010, CSO, Warsaw 2012, pp. 384-397 and 416.
[52] *Characteristics of agricultural holdings in 2013*, Information and Statistical Papers, CSO, Warsaw 2014, pp. 358-371.

Table 1. Changes in the number of entities and characteristics of their managers, labour inputs and the provision of mechanical draft force in the smallest and largest domestic agricultural entities of natural persons engaged in agricultural activity in 2013 compared to the situation in 2010

Measures and indicators	Total or average national values	Agricultural entities		
		smallest		largest – at least 1000 SO
		0-2 SO	2-4 SO	
Change in the number of entities (difference in '000)	-461.5	-451.3	-19.0	0.0[d]
Change in the number of entities in 2013 compared to 2010 (%)	-24.5	-52.9	-6.3	5.1
Share of entities whose managers had formal vocational qualifications[a] (difference in pp)	6.7	4.4	0.5	7.1
Entity's labour inputs expressed as full-time employees[b] (difference in pp)	22.0	42.9	0.9	31.7
Full-time employees per 100 ha of utilised agricultural area in good culture[c] (difference in pp)	-7.8	-0.2	6.3	-3.1
Share of entities with at least one tractor (difference in pp)	14.1	9.8	0.0	-1.5

[a)] Those with higher, post-secondary, secondary and basic vocational agricultural education as well as those who completed an agricultural course.

[b)] Including labour inputs of permanent and casual hired employees, contract employees, labour inputs as part of neighbourly help and those of others. Full-time employment means 2120 hours of work in a holding per year.

[c)] Utilised agricultural area in good culture is arable land maintained in accordance with requirements of national law.

[d)] In the analysed period, the number of holdings of this size increased by 22.

Source: Own calculations made based on figures derived from [Characteristics of... 2012] and [Characteristics of... 2014].

To become an agricultural holding, an agricultural entity must meet at least one of the following minimum thresholds, i.e.: 0.5 ha of fruit tree plantation, fruit shrub plantation, field vegetables, field strawberries, hop; 0.3 ha of orchard and ornamental plant nurseries; 0.1 ha of vegetables, flowers and/or ornamental plants under cover, or tobacco; 25 m^2 of edible mushroom cultivation area; 10 heads of cattle; 5 cows; 50 pigs in total; 10 sows; 20 sheep and/or goats; 100 units of poultry in total; 5 horses in total; 50 female rabbits; 5 females of other fur animals; 10 wild animals (roe deer, fallow deer, bison, etc.) kept for meat production; 20 beehives.

Secondly, changes in 2010-2013 in the smallest and the largest agricultural entities were affected by processes, which had begun earlier, but it cannot be ruled out that phenomena and processes that have hitherto not occurred had no impact.

The figures given in Table 1 indicate that the number of agricultural entities owned by natural persons decreased in 2013 by 461.5 thousand, i.e. by 24.5% compared to 2010. The largest drop (mostly due to the change in the definition) was observed in relation to entities of 0-2 SO in size, i.e. by 52.9%, but in relation to those of 2-4 SO in size – the drop was only 6.3%. In contrast, an increase was recorded in relation to entities of at least 1000 SO in size.

Furthermore, the figures presented in Table 1 reveal that – in relation to national averages – the share of managers with formal vocational qualifications in both groups of the smallest entities declined in 2010-2013.

As regards the smallest entities, differences in labour inputs per unit of utilised agricultural area in good culture increased in relation to the national average. These inputs, on a national average basis, declined, but remained almost unchanged or even increased in the smallest holdings. There is no evidence of a correlation between figures that characterise this phenomenon and changes in the share of entities with at least one tractor.

However, changes in the largest entities were different. The share of those with formal vocational qualifications grew faster than the national average. Besides, there was a decline in employment, also per unit of utilised agricultural area in good culture, while the share of holdings with at least 1 tractor dropped as well. When the area of such a holding was small, it was reasonable to give up own equipment and own draft force and benefit from services instead.

In 2013, the national average total area of holdings of natural persons increased significantly, as opposed to 2010. The reason for this was mainly the change in the definition of the term "agricultural holding", as the new definition did not include a significant part of entities with up to 1 ha of utilised agricultural area, mostly those of 0-2 SO in size. In holdings of 2-4 SO in size, however, there could be other significant factors, such as the division of some holdings between children of their owners and thus the transfer of some of them to the next size group.

The figures given in Table 2 indicate that average utilised agricultural area in entities of at least 1000 SO in size in the years under analysis stopped increasing, despite an approx. 5% drop in those with up to 10 ha of utilised agricultural area. Probably, the main process was the division of holdings from that group

between family members of their owners, as referred to above, in order to mitigate negative effects of a fall in subsidy rates.

The share of utilised agricultural area in total area changed slightly on a national basis, so did in both groups of the smallest entities. However, the situation of the largest entities under analysis was different. Does the afforestation of utilised agricultural area, as referred to in relation to 2010, continue?

The share of utilised agricultural area in good culture remained basically unchanged. But a drop in the share of entities using organic fertilisers of animal origin fit in a long-term trend of animal production liquidation. This phenomenon did not proceed rapidly, the only exception being holdings of 2-4 SO in size.

The last phenomenon was probably affected by the aforementioned division of holdings between children, some of whom had already lived in urban areas. Animal production requires constant supervision and regular maintenance and thus could not be carried out in such a situation.

Table 2. Changes in land resources, their characteristics and the use of growth regulators in the smallest and the largest domestic agricultural entities of natural persons engaged in agricultural production in the year 2013 compared to the situation in 2010

Measures and indicators	Total or average national values	Agricultural entities		
		smallest		largest – at least 1 000 SO
		0-2 SO	2-4 SO	
Average total area of an agricultural entity (difference in pp)	29.5	35.1	-6.1	21.3
- including average utilised agricultural area	31.3	37.7	-6.7	0.3
Share of entities with utilised agricultural area of (difference in pp):				
up to 1 ha, inclusive	-19.1	-39.4	-2.7	-1.3
1-10 ha	13.2	39.0	3.4	-3.6
over 10 ha	5.9	0.4	-0.7	4.9
Share of utilised agricultural area in total area (difference in pp)	1.2	0.1	-0.1	-9.1
Share of utilised agricultural area in good culture[a] (difference in pp)	0.0	0.1	-0.3	0.0
Share of entities using organic fertilisers of animal origin (difference in pp)	-1.7	-0.8	-11.7	-0.4
Share of entities using mineral fertilisation and soil liming (difference in pp)	10.6	5.5	-5.3	5.2

[a] Cf. reference mark "c" in Table 1.

Source: cf. Table 1.

The average share of entities using mineral fertilisation and soil liming increased significantly in the country. However, the growth rate of that share in the entities under analysis was about half smaller, while entities of 2-4 ESU in size experienced even a drop in that share. The figures presented and Table 5 show that some of the smallest agricultural entities were still oriented towards using available labour resources and reluctant to use the purchased current means of production.

The share of entities engaged in specialist production rose significantly in the country in 2010-2013 (Table 3), as a result of the rapid pace of changes in that process observed in both groups of the smallest entities. In the latter, the share grew approximately twice faster than the national average, largely at the expense of the share of entities engaged in mixed production. Changes also took place in the group of the smallest entities engaged in specialist production. The share of entities specialised in growing field crops increased at the expense of those specialised in growing horticultural crops and breeding animals fed with concentrated fodder.

Table 3. Structural changes in production types in the smallest and the largest domestic agricultural entities engaged in agricultural production in 2013 compared to the situation in 2010

Specialisation level and production types	National average share (%)	Changes in the share (%) of entities		
		smallest		largest – at least 1 000 SO
		0-2 SO	2-4 SO	
Entities engaged in specialist production in total (difference in pp)	7.6	11.4	12.1	1.4
including: - in field crops	9.3	19.7	16.9	0.9
- in horticultural crops	-0.5	-0.8	-1.5	-0.6
- in permanent crops	0.2	-2.5	0.6	0.9
- in breeding animals fed with roughage	1.7	-0.7	-1.5	-0.5
- in breeding animals fed with concentrated fodder	-3.1	-4.3	-2.4	0.7
Entities engaged in mixed production in total (difference in pp)	-3.3	-4.8	-12.1	-1.4
including: - with different crops	-0.7	-0.9	-1.2	0.0
- with different animals	-1.3	0.0	-2.9	-0.3
- with different crops and animals	-1.3	-3.9	-8.0	-1.1
Unclassified entities[a] (difference in pp)	-4.3	-6.6	-	-

[a] In 2013, the CSO published data collected only in holdings engaged in agricultural production, rather than those engaged in the so-called agricultural activity as in previous years.
Source: cf. Table 1.

The change in the definition of an agricultural entity of a natural person as well as other phenomena and processes in the analysed period led to a significant increase in the share of the smallest entities specialised in growing field crops. Those of 0-2 SO in size probably experienced an increase in the share of holdings specialised in the production of cereals and crops with similar production technology at the expense of the share of mostly those with another field of specialisation. As a matter of fact, the share of entities growing cereals increased significantly (by 13.5 pp).

The share of entities specialised in the field cultivation of crops grew in the size group of 2-4 SO as well, though not that much as was the case in even smaller entities. This was due to the drop in the share of those with a mixed production structure and, to a lesser extent, the share of those specialised in growing horticultural crops and engaged in specialist breeding animals fed with roughage and concentrated fodder.

Given the foregoing, it should be noted that there was an increase in unit labour inputs in entities of 2-4 SO in size (Table 1) and no progress in the share of entities with their own tractors. Based on these and other data, it can be concluded that the reason could not be an increase in the share of more labour-intensive crops or animal population growth, but rather the transfer of some of holdings with larger area and those better equipped with draft force (Table 2) to a group of holdings with a higher SO measure.

Minor structural changes in production types were observed in the group of the largest entities.

The last element of the analysis addressed in this study covers structural changes in income sources (Table 4). On a national average basis, the share of households with agricultural production income, which exceeded half of total income, increased significantly in 2010-2013. Nevertheless, these changes were much smaller in holdings of 0-2 SO in size, while those of 2-4 SO in size experienced even a drop in that share. Instead, some of them began, however, direct sales of goods produced by them to consumers. The scale of sales was more than half of total sales of an agricultural holding.

The situation of the largest entities and households of their owners is different. In the period under consideration, the share of entities with agricultural production income, which exceeded half of total income, increased more than the national average. The reason for this was a drop in the share of income from non-agricultural economic activity. However, there were exceptions. In fact, agricultural production in more than one in thirty of holdings was so small that

households took over more than 50% of the value of the final agricultural production generated. According to Polish FADN data from 2013, the total value of that production could amount to at most a few PLN '000, i.e. approx. 1 per mille of the total average value of revenues of such an "agricultural entity".

Table 4. Structural changes in income sources of households with the smallest and largest agricultural entities engaged in agricultural production in 2013 compared to the situation in 2010

Indicators and measures	National average share (%)	Agricultural entities		
		smallest		largest – minimum 1000 SO
		0-2 SO	2-4 SO	
Share of households with agricultural production income exceeding 50% of total income (difference in pp)	7.3	1.8	-2.0	11.3
Share of households using more than 50% of the value of the final agricultural production of an agricultural holding (difference in pp)	-11.3	-15.1	-10.0	2.9
Share of agricultural entities whose value of direct sales of products[a] to consumers exceeded 50% of the value of total sales of an agricultural holding (difference in pp)	3.1	6.2	2.3	-6.1
Share of agricultural entities engaged in gainful economic activity other than agricultural activity associated with it[b]	-3.8	0.1	-0.5	-11.4

[a)] Direct sales to consumers include sales of agricultural products produced in an agricultural holding, either processed or unprocessed, at marketplaces, in own stores and to neighbours,except for sales to owners of stores, restaurants, etc.

[b)] This regards production activity (e.g. processing of agricultural raw materials) or service activity (e.g. agrotourism) pursued in a self-employed capacity, which uses resources of the owner's family and agricultural holding (labour, land, buildings, machinery, own raw materials for processing, etc.), except for activities using labour resources only.

Source: cf. Table 1.

Summary

The chapter compared characteristics of groups of the smallest and largest agricultural holdings (also referred to later in this chapter as agricultural entities) owned by natural persons who were not covered by the monitoring of the Polish FADN in 2010-2013 due to legal regulations or the fact that the group under monitoring was too small and thus even its averaged characteristics could not be published due to the obligation of maintaining statistical confidentiality. To this end, mostly the results of both the National Agricultural Census 2010 and the Partial Census 2013 were used. The smallest entities were those of 0-2 SO and 2-4 SO in size, while the largest – those of at least 1000 SO in size. Averages determined for all domestic holdings owned by natural persons served as a point of reference for characteristics of groups of these entities.

However, the summary evaluates the situation of the holdings under analysis in 2013. It addressed both size groups of the smallest holdings together, as the change in the definition of the term "agricultural holding" made the smallest entities from the size group of 0-2 SO lose their status of a holding.

In 2013, the smallest holdings had, compared to national averages: smaller share of holding managers with formal vocational qualifications, significantly smaller utilised agricultural area, much higher labour inputs per unit of utilised agricultural area in good culture; smaller share of utilised agricultural area and higher share of both wooded area in total area and utilised agricultural area in good culture in its total area; smaller share of holdings using organic fertilisers of animal origin, mineral fertilisers and soil liming. The share of holdings engaged in specialist crop production was higher, while that with the total share of those which specialised in animal production (with predominant non-specialist animal breeding over crop production) or mixed production (combining various crop and animal production) was smaller. All this demonstrates that: potential opportunities offered by own utilised agricultural area were not taken full advantage of in a very large part of the holdings under analysis, productivity of labour was poor, income was supplemented by funds derived from own wooded area, while income earned as a result of using effects of own crop production as part of pursued animal production was given up.

As a result, no more than approx. 15% of households of owners of the smallest holdings derived more than half of their total income in 2013 from the agricultural production pursued, but no more than 39% of them used more than half of the value of agricultural production generated by them for own needs. It

was estimated that the agricultural production of the latter was very low, thus indicating that they were, in fact, not agricultural holdings, but rather households engaged in agricultural production referred to in the first chapter. Besides, the share of the smallest holdings engaged in gainful non-agricultural economic activity was smaller than the national average. Only the share of holdings, whose direct sales of more than half of the value of total sales of manufactured agricultural products to consumers, was slightly higher than the average national share.

The situation of holdings of at least 1000 SO was different. These were holdings with characteristics of an enterprise referred to in the first chapter. Most of their managers had formal vocational qualifications. Their share was significantly higher than the national average. The average utilised agricultural area of these economic entities was approx. 27-fold larger than the national average.

The share of utilised agricultural area in total area was much lower than the national average, thus indicating unusual, as far as Polish conditions are considered, attitude of agricultural producers towards forest management and being probably related to land afforestation subsidies. Nevertheless, the share of utilised agricultural area in good culture in its total area was higher than the national average. The characterised holdings hired wage employees. It was estimated that their share in the total number of the employed was the largest.

Labour inputs per unit of utilised agricultural area in good culture were several times smaller than the national average value of the corresponding indicator. The share of holdings using organic fertilisers of animal origin, mineral fertilisers and soil liming was, however, higher than the national average.

Most of the characterised holdings used mineral fertilisers. However, there were some which gave up using them probably due to a very high number of heads of swine and poultry per unit of utilised agricultural area. The content of minerals in purchased fodder and, consequently, organic fertilisers of animal origin was large enough to meet needs of crops.

The share of holdings engaged in specialist agricultural production was much higher than the national average and as much as approx. 72% of them specialised in animal production, mostly in breeding animals fed with concentrated fodder. All this demonstrates that potential opportunities offered by own utilised agricultural area were used well or very well, the productivity of labour was high, a shorter time of capital turnover brought some benefits, while income was supplemented by funds derived from own wooded area on soils of low quality.

Consequently, approx. 90% of households of owners of the largest agricultural holdings derived more than half of their total income from the agricul-

tural production pursued and only approx. 3% of the others used more than half of the value of the agricultural production generated. As a result of estimation, it can be concluded that the latter had an agricultural holding whose agricultural production was very low and thus they derived most of their total income from non-agricultural economic activity.

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