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SPECIALIZATION AND SUSTAINABLE DEVELOPMENT OF AGRICULTURAL HOLDINGS

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Abstract. In the present article, an attempt was made to assess the sustainability of agricultural holdings with different directions of production. Agricultural holdings in the Podlaskie voivodeship registered in the FADN system in 2011–2012 were investigated. Assessment accounted for agroecological indicators (share of permanent grasslands, share of cereals in crops, soil coverage with vegetation, stock density) and economic indicators (profitableness of land and labor). Analysis was conducted according to a classification into agricultural holding types: fieldcrops, dairy cattle, and granivores. Fieldcrop and granivore holdings achieved more favourable environmental sustainability indicators. Holdings specializing in dairy cattle breeding posed a threat to the natural environment, mainly due to their excessive stock density. Economic sustainability assessment showed that granivore holdings were assessed most favorably. In these holdings, holding income per full-time worker was 37% greater than in fieldcrop holdings and 57% greater than in dairy cattle holdings.

Key words: agricultural holdings, specialization, sustainable development

INTRODUCTION

The high degree of mechanization of production processes and growing competition on the domestic and international market force agricultural holdings to become specialized. From an economic perspective, specialization is linked to benefits of scale resulting from growth of production that is more rapid than consumption of

production factors, which makes it possible to reduce unit production costs (Ziółkowska, 2009). In effect, productivity and income increase (Cieślik and Żmija, 2010; Sas, 2010; Kołoszko-Chomentowska, 2013). In reality, the exposure to risk of specialized holdings is significantly greater than in multi-directional holdings, however their superior production and economic effects recompense this risk (Józwiak and Juźwiak, 2007).

Agricultural holdings in Poland are regionally diverse in terms of their direction of production (Matyka and Harasim, 2010). This is the consequence of adaptation of these entities to local environmental, climate, economic, and organizational conditions (Heller, 2006). Among other things, modelling of production processes in agricultural holdings according to the principles of sustainable development, which stipulate harmonization of environmental, economic and social objectives, is among the most important problems of agricultural economics. In studies of the degree of sustainability, holdings with different directions of production are most frequently taken into consideration (Krasowicz et al., 2007; Harasim, 2009, 2010; Castoldi and Bechini, 2010; Escribano et al., 2014). They successfully achieve the economic objective, however environmental limitations may be linked to their development. Sustainability conditions are different for agricultural holdings than for the entire agricultural sector, and thus it is necessary to conduct assessment at different levels. The specific habitat, economic and organizational conditions of agriculture also have an impact on sustainability assessment,

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and equilibrium states change under the influence of many factors. This variability of conditions justifies the need for systematic research in this scope.

The objective of this article is to assess environmental and economic equilibrium of agricultural holdings with different direction of production in the Podlaskie voivodeship. These entities have been diversified in recent years. Goods holdings applying modern technologies developed alongside with small holdings using traditional farming methods. The natural conditions of this region were mainly utilized for the development of holdings specializing in livestock production, and the specialization process is intensifying (Kołoszko-Chomentowska, 2013). On the other hand, this voivodeship is characterized by specific qualities resulting from the dominance of light soils, in which ecological hazards are manifested particularly strongly. In this situation, pro-ecological, environment-friendly management methods are preferred (Kuś and Jończyk, 2010). For this reason, the selection of specialized agricultural holdings in the Podlaskie voivodeship for assessment of sustainable developed was deemed justified.

MATERIAL AND METHODOLOGY

The research problem was undertaken based on data from agricultural holdings in the Podlaskie voivodeship that participated in the Polish Farm Accountancy Data Network (FADN) in the years 2011–2012. Different agro-ecological indices are applicable to assessment of environmental sustainability (Belanger et al., 2012; Harasim, 2013; Lebacqz et al., 2013). The selection of indicators should consider the comparison of indicators based on various criteria, mainly data availability (Lebacqz et al., 2013). Selected agro-ecological indicators were applied for environmental sustainability assessment of agricultural holdings, and they included: share of grasslands in useful agricultural area (%), share of cereals in crops (%), soil coverage with vegetation during the year (%) and stock density ($\text{LU} \cdot \text{ha}^{-1}$) (Harasim, 2013). Assessment was supplemented with indicators characterizing the burden on the environment caused by production factors, which indicate the intensity of management, called “material pressure indicators” by some authors (Piekut and Machnacki, 2011). These are: indirect consumption, value of mineral fertilizers and plant protection products, value of purchased feed, and energy consumption. The index of costs sustained

for purchasing mineral fertilizers and plant protection products is of limited value in the assessment of holding sustainability, however, it can be of diagnostic value and serve as a criterion in trend assessment (Sobczyński, 2008). The effectiveness of management (farming) was determined based on profitability of land and labour. Values of material pressure indicators are given in PLN and EUR. Conversion to EUR was carried out according to the exchange rate used during charging of subsidies by the Agency for Restructuring and Modernization of Agriculture.

The following types of holdings were accounted for in the analysis: field crops (116 holdings), dairy cattle (270 holdings) and granivores (128 holdings).

RESULTS

The holdings subject to study are diverse in terms of the production factors they are equipped with, which results from their respective directions of production (Table 1). Crop holdings (field crops) are distinguished in terms of the land's resources. They are characterized by the largest area of agricultural land, and the share of leased land is the largest in them (40.6%). All of the studied holding groups were mainly based on family labour, and hired labour was only a small supplement but crop holdings made greater use of hired labour than other types of holdings. The value of fixed assets indicates the technical level of a holding's equipment. From this perspective, granivores holdings were the best equipped, which is expressed by greater labour and land infrastructure provided by fixed assets.

The economic size of holdings, determined based on standard production, is the consequence of the diversity of production factors. In the Community Typology for Agricultural Holdings, field crop holdings are classified as small, the dairy cattle type as medium-small, and the granivores type as medium-large.

The structure of agricultural land is characteristic of the chosen directions of production, and the most permanent grasslands are present in the dairy cattle holding type (42%) as the feed base for livestock (Table 2). Permanent grasslands perform various ecological functions, and their greater share in the farmland structure means that the holding's pressure on the environment is low. From this perspective, dairy cow holdings seem to have better results. Crop structure is the basic determinant of the organization of plant production.

Table 1. Selected characteristics of surveyed agricultural holdings (2011–2012)
Tabela 1. Wybrane charakterystyki badanych gospodarstw rolnych (2011–2012)

Specification Wyszczególnienie	Type of farming – Typ rolniczy		
	field crops uprawy polowe	dairy cattle bydło mleczne	granivores zwierzęta ziarnożerne
Economic size (EUR) Wielkość ekonomiczna (euro)	21 748	34 847	91 410
Utilised Agricultural Area (ha) Powierzchnia UR (ha)	40.85	29.28	35.98
including rented UAA ¹ (ha) w tym powierzchnia dzierżawionych UR ¹ (ha)	16.58	9.29	14.12
Total labour input (AWU ²) Zatrudnienie ogółem (AWU ²)	1.91	1.91	2.01
Family labour input (FWU ³) Zatrudnienie własne rodziny (FWU ³)	1.59	1.88	1.87
Fixed assets (PLN/ha) Aktywa trwałe (zł/ha)	11 977	22 346	23 741
Fixed assets (PLN/AWU) Aktywa trwałe (zł/AWU)	256 171	342 561	424 863

¹ Utilised Agricultural Area – Powierzchnia użytków rolnych.

² Annual Work Unit – Jednostka przeliczeniowa pracy.

³ Family Work Unit – Jednostka przeliczeniowa pracy członków rodziny.

Source: own calculations.

Źródło: obliczenia własne.

It is decisive to the production and economic effects, besides the level of fertilization and harvested crops. In the case of cereals, a share greater than 66% is to be avoided (Duer et al., 2002). The share of cereals in the crop structure of the studied holdings was very high – nearly 80% in crop holdings and over 96% in granivores holdings. In such cases, the ecological equilibrium of agrocoenoses is violated. In dairy holdings, the share of cereals in the crop structure can be considered to be correct from the perspective of ecological equilibrium, since the upper limit of the standard accepted in the principles of good agricultural practice was only slightly exceeded.

An important aspect of the sustainability of holdings is keeping the soil surface of arable land under vegetation cover for as long as possible. According to the principles of good agricultural practice, approx. 60% of the surface of arable land in flatlands, and at least 75% of the surface of grounds threatened by erosion, should remain under vegetation cover throughout the whole

year (Duer et al., 2002). These ecological sustainability conditions were met in field crop and granivore holdings. The index of soil coverage by vegetation during the year was lower than recommended in dairy cattle holdings. This results from the large share of corn in the crop structure, as it is the primary feed for cattle.

Organization of livestock production is assessed from the perspective of use of produced manure. The number of animals on a holding and their stocking density are both important. Livestock production is also linked to environmental restrictions, which concern, above all, potential threats resulting from agricultural use of animal excrements. The average stocking density in field crop and granivore holdings did not pose a threat to the natural environment because it did not exceed the maximum level of 1.5 LU·ha⁻¹ (Duer et al., 2002). Dairy cattle holdings posed such threats, because the stocking density significantly exceeded the upper stocking limit that has been accepted in good agricultural practice.

Table 2. Indicators for agro-ecological assessment characterizing the farms (2011–2012)

Tabela 2. Wskaźniki oceny agroekologicznej charakteryzujące gospodarstwa (2011–2012)

Specification Wyszczególnienie	Type of farming – Typ rolniczy		
	field crops uprawy polowe	dairy cattle bydło mleczne	granivores zwierzęta ziarnożerne
Utilised Agricultural Area (ha) Powierzchnia UR (ha)	40.85	29.28	35.98
including: permanent grasslands (%) w tym: trwałe użytki zielone (%)	15.11	42.00	8.10
Crop structure (%) Struktura zasiewów (%)			
cereals – zboża	78.0	66.7	96.4
fodder – pastewne	7.3	31.7	1.1
industrial crops – przemysłowe	13.0	0.0	1.9
potato – ziemniak	1.7	1.3	0.6
Soil coverage with vegetation (% arable land) Indeks pokrycia gleby roślinnością (% GO)	64.1	40.3	59.9
Stocking density (LU/ha) ¹ Obsada zwierząt (LU/ha) ¹	0.48	1.80	0.68

¹ Livestock unit – Jednostka przeliczeniowa zwierząt.

Source: own calculations.

Źródło: obliczenia własne.

Indirect consumption per 1 ha of farmland is a general indicator of burden (material pressure) on the environment (Piekut and Machnacki, 2011). It encompasses direct costs and general holding costs related to the operations of the agricultural holding. Granivore holdings were characterized by the highest intensity of production due to high costs of purchasing feed (Table 3). These holdings primarily

specialize in fattening pigs, and their production is based on purchase, full-portion mixtures. The average indirect consumption value in this group amounted to PLN 11,776 (EUR 2,768) per 1 ha of farmland in 2011–2012 and was nearly three times greater than in dairy cattle holdings and four times greater than in field crop holdings. These holdings also achieved the highest production value (Table 4).

Table 3. Intensity of production in the surveyed farms (2011–2012)

Tabela 3. Intensywność produkcji w badanych gospodarstwach (2011–2012)

Specification Wyszczególnienie	Type of farming – Typ rolniczy		
	field crops uprawy polowe	dairy cattle bydło mleczne	granivores zwierzęta ziarnożerne
1	2	3	4
Total intermediate consumption (PLN/ha) Zużycie pośrednie (zł/ha)	2 891	4 001	11 776
Total intermediate consumption (EUR/ha) Zużycie pośrednie (euro/ha)	679	940	2 768

Table 3. cont. – Tabela 3. cd.

1	2	3	4
Mineral fertilizers (PLN/ha) Nawozy mineralne (zł/ha)	614	481	602
Mineral fertilizers (EUR/ha) Nawozy mineralne (euro/ha)	144	113	141
Plant protection products (PLN/ha) Środki ochrony roślin (zł/ha)	181	58	128
Plant protection products (EUR/ha) Środki ochrony roślin (euro/ha)	42	14	30
Value of purchased feed (PLN/ha) Pasze z zakupu (zł/ha)	184	1 753	9 089
Value of purchased feed (EUR/ha) Pasze z zakupu (euro/ha)	43	412	2 136
Energy (PLN/ha) Energia (zł/ha)	522	595	765
Energy (EUR/ha) Energia (euro/ha)	123	140	180

Source: own calculations.

Źródło: obliczenia własne.

Table 4. Production and economic results (2011–2012)

Tabela 4. Wyniki produkcyjno-ekonomiczne (2011–2012)

Specification Wyszczególnienie	Type of farming – Typ rolniczy		
	field crops uprawy polowe	dairy cattle bydło mleczne	granivores zwierzęta ziarnożerne
1	2	3	4
Production value (PLN/ha) Wartość produkcji (zł/ha)	4 949	7 405	16 353
Production value (EUR/ha) Wartość produkcji (euro/ha)	1 163	1 740	3 844
crop production (PLN/ha) produkcja roślinna (zł/ha)	3 820	1 150	3 252
crop production (EUR/ha) produkcja roślinna (euro/ha)	898	270	764
animal production (PLN/ha) produkcja zwierzęca (zł/ha)	1 090	6 223	13 072
animal production (EUR/ha) produkcja zwierzęca (euro/ha)	256	1 463	3 072
Net value added (PLN/AWU) Wartość dodana netto (zł/AWU)	55 049	54 505	77 133
Net value added (EUR/AWU) Wartość dodana netto (euro/AWU)	12 939	12 811	18 130

Table 4. cont. – Tabela 4. cd.

1	2	3	4
Family farm income (PLN/ha) Dochód z rodzinnego gospodarstwa rolnego (zł/ha)	2 472	3 497	4 283
Family farm income (EUR/ha) Dochód z rodzinnego gospodarstwa rolnego (euro/ha)	581	822	1 007
Family farm income (PLN/FWU) Dochód z rodzinnego gospodarstwa rolnego (zł/FWU)	62 030	54 230	85 392
Family farm income (EUR/FWU) Dochód z rodzinnego gospodarstwa rolnego (euro/FWU)	14 580	12 747	20 071

Source: own calculations.

Źródło: obliczenia własne.

Holdings specializing in field crops were distinguished by a greater consumption of mineral fertilizers and plant protection products than the other groups and thus exerted greater pressure on the environment.

Profitability of land, profitability of labour, and profitability of fixed assets are among the basic indexes of economic effectiveness, because they determine the degree in which basic production factors are used. The income of a holding changes depending on, above all, production value and sustained costs. Granivores type holdings sustained the highest costs, achieved production of the greatest value, and generated the highest income (Table 4). Dairy cattle holdings had the least favourable results. Holding income per fully employed family member amounted to PLN 54,230 (EUR 12,747) and was 57% lower than the income obtained by granivores holdings and 14% lower than the income obtained by field crop holdings.

CONCLUSION

The presence of goods holdings specializing in specific directions of production indicates that the natural conditions of the Podlaskie voivodeship, which are unfavourable for agriculture, do not rule out the effective functioning of agricultural holdings. This group of holdings is and will continue to be decisive to the future of agriculture in this region. They successfully achieve their economic objective and are capable of implementing technical progress. The introduction of new technologies makes it possible for production capabilities to grow. However, this

model of development encounters barriers arising from environmental limitations. Demanding requirements of consumers as to the quality of produced food, as well as protection of natural resources, encourage a perspective of an agricultural holding in terms of its relationships with the environment.

The analysis that was conducted confirms that the direction of production determined by the holding's agricultural type is the factor with the strongest impact on ecological and economic sustainability of agricultural holdings. Dairy cattle holdings exerted less pressure on the environment due to the largest share of permanent grasslands. However, this direction of production poses threats to the environment due to excessive stocking density. All holding types had unfavourable results in terms of crop structure. This is the effect of excessive simplification of the crop structure and elimination of winter crops. Granivores holdings exhibited a greater degree of agro-ecological sustainability due to soil coverage by vegetation and stocking density. However, while their use of technologies allowed for better economic effects, these technologies also posed a burden to the environment. In the case of field crop holdings, conditions of agro-ecological sustainability were met in terms of soil coverage by vegetation and stocking density.

Granivores holdings achieved the best results from the perspective of economic effects. During the years 2011–2012, the income of a family-owned agricultural holding per full-time worker in the family was 37% greater than in field crop holdings and 57% greater than in dairy cattle holdings.

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SPECJALIZACJA A ZRÓWNOWAŻONY ROZWÓJ GOSPODARSTW ROLNYCH

Streszczenie. W artykule podjęto próbę oceny zrównoważenia gospodarstw rolnych o różnych kierunkach produkcji. Badania- mi objęto gospodarstwa rolne województwa podlaskiego będące w systemie FADN w latach 2011–2012. W ocenie uwzględniono wskaźniki agroekologiczne (udział trwałych użytków zielonych, udział zbóż w zasiewach, pokrycie gleby roślinnością, obsada zwierząt) i ekonomiczne (dochodowość ziemi i pracy). Analizę prowadzono w podziale na typy rolnicze gospodarstw: uprawy polowe, krowy mleczne i zwierzęta ziarnożerne. Korzystniejsze wskaźniki zrównoważenia agroekologicznego osiągnęły gospodarstwa typu uprawy polowe i zwierzęta ziarnożerne. Gospodarstwa specjalizujące się w chowie bydła mlecznego stwarzały pewne zagrożenia dla środowiska naturalnego głównie ze względu na zbyt dużą obsadę zwierząt. W ocenie zrównoważenia ekonomicznego najlepiej wypadły gospodarstwa typu zwierzęta ziarnożerne. Dochód z gospodarstwa na osobę pełnozatrudnioną był w nich o 37% wyższy niż w gospodarstwach roślinnych i o 57% wyższy niż w gospodarstwach mlecznych.

Słowa kluczowe: gospodarstwo rolne, specjalizacja, rozwój zrównoważony

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