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ENVIRONMENTAL AND CLIMATIC PRESSURES AS A FUNCTION OF FARM SIZE

Key words: environmental and climatic pressures, agricultural farm, agricultural production systems, sowing structure, land use

ABSTRACT. The paper presents an assessment of the degree of implementation of environmental and climate protection functions by Polish farms and agricultural enterprises of different size and production scale. There are differences in views on this topic in the literature, with opinions dominating on the more positive role of small farms in climate and biodiversity protection. Farm analysis was made on the basis of Statistics Poland data on farm size classes established by agricultural land area in 2016. The results of the study did not confirm the view that the production systems implemented in small farms are more environmentally friendly and have a more positive impact on the climate than those on farms of a larger production scale. This is evidenced by the sowing structure: cereal dominated in small farms, exceeding the agronomically recommended 66%, while the share of structure-forming plants – legumes, industrial oilseed and catch crops – was low. Also, the implemented organisation of animal production (not carried out at all in more than half of the small farms) consequently leads to soil degradation due to a jeopardised balance of organic matter.

INTRODUCTION

In the post-war period up to the 1970s, the primary function of agriculture in the EEC was food production. In subsequent periods, environmental and climate protection began to play a much greater role [Wilkin 2010, Zegar 2011]. Changes in the function of agriculture were clearly defined in the 1992 MacSharry reforms and Agenda 2000 [Wąs et al. 2018, Wrzaszcz, Prandecki 2020]. These processes will be continued more intensively in the Common Agricultural Policy (CAP) of the European Union (EU) in the 2021-2027 period, placing emphasis on measures related to climate change mitigation and biodiversity protection [MRiRW 2019]. Agricultural production is carried out in farms

and agricultural enterprises[1] of different area and production scale[2]. In this situation, the question arises: to what extent do farms and agricultural enterprises of different sizes perform their protective functions in relation to the natural environment and climate. There are differences in views on this subject in the literature, with opinions dominating on the positive role of small farms in climate and biodiversity protection [Żmija, Czekaj 2012, Czudec 2013, Żmija, Szafrańska 2015, Czekaj et al. 2020].

RESEARCH MATERIAL AND METHODS

The aim of the research is to assess the degree of implementation of environmental and climate protection functions by farms and agricultural enterprises of a different area and scale of production. Analysis covered all farms in Poland (1410.7 thousand) and was performed with reference to the farm size classes established by area of agricultural land (AL) in 2016. The following classes were distinguished: small farms (up to 20 ha of AL, including up to 5 ha), medium-sized farms (20-50 ha of AL), large farms (50-100 ha of AL) and very large farms (100 of AL and above). The adopted division criteria included farm profitability and development capacity [Józwiak et al. 2018]. Small farms hold a dominant position in terms of number. Their share in the total number of farms was 90.5% in 2013, followed by 90.2% in 2016. In these years, they have occupied 48.4 and 47.5% of the AL area, respectively. Small farms are characterised by poor development capacity. The share of medium-sized farms in these years amounted to and maintained at a level of 7.3%, while their share of AL was 20.9 and 20.8%, respectively. In contrast, the share of large farms accounted for 1.5 and 1.6%, respectively, while their share in AL was 9.6 and 10.55%. The lowest share was recorded for very large farms and amounted to 0.8 and 0.9%, respectively, while their share in AL was: 21.2 and 21.1% [GUS 2017]. The direction of changes should be assessed positively, even though they were insignificant. The presented processes taking place in agriculture cause problems that need to be addressed.

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[1] The literature distinguishes between the concepts of a farm and an agricultural enterprise. A farm is a technical and organisational unit covering basic production factors: land, labour and capital, focused on agricultural production, whereas an agricultural enterprise is the same unit focused on the production of agricultural products in order to sell them. Moreover, a farm is an organisationally separated unit, whereas an enterprise is financially and legally separated. Individual farms producing for the market are, from a technical perspective, enterprises having the legal form of a „natural person" [Manteuffel 1984, Ziętara 2015].

[2] The size of farms is determined by the number of hectares of agricultural land, while the scale of production by the volume or value of production [Skarżyńska 2011].

The key issues of concern include:
- the conflict between the need for specialisation and the level of production intensity in agricultural farms and environmental and climatic threats,
- the need to concentrate livestock production for economic reasons versus environmental and climate risks,
- the conflict between the objectives of agricultural policy, providing for the support and maintenance of small farms being not the main source of income for farming families, and the economic objectives of farmers running high-capacity agricultural farms.

The main sources of research materials contained statistical data and body literature. The hypothesis adopted for the purposes of delivering the research objective was: «the organisation of production implemented in small farms is environmentally friendly and has a positive impact on the climate, in contrast to farms of a larger scale of production». The descriptive-comparative method was used to assess the impact of farms and agricultural enterprises of different sizes on the natural environment and climate.

FARM SIZE AND ENVIRONMENTAL AND CLIMATIC PRESSURES

Among the authors dealing with the impact of organisation of production in agricultural holdings of different area on the environment, the dominant view is that smaller area farms develop lower environmental pressure [Żmija, Czekaj 2012, Czudec 2013, Żmija, Szafrańska 2015, Czekaj et al. 2020], despite their low productivity and profitability. Their sustainability and non-economic functions, manifested in the provision of public goods [Zegar 2012a,b, Czekaj et al. 2020] and in protecting national heritage [Drygas, Musiał 2013, Siekierski 2019], are emphasised. On the other hand, it is noted that they insufficiently fulfil tasks related to the maintenance of the productive capacity of soils, participate in the implementation of various agri-environmental programmes to a low extent [Wrzaszcz 2012, Dzun 2013], do not invest in fixed assets, abandon livestock production and the use of land of low agricultural suitability, thus contributing to the deagrarianisation of rural areas [Baer-Nawrocka, Poczta 2020]. There are fewer publications pointing to the impact of larger farms on the environment and climate. More often, their negative impact, related to land concentration, narrow specialisation, level of production intensity, and above all the implemented industrial model of agriculture, is emphasised [Czudec 2013, Zegar 2011].

The CAP implemented thus far has aimed at supporting small and medium-sized farms perceived as more environmentally friendly, as well as for social reasons. This policy favoured the preservation of the current state rather than contributed to addressing the issue of small farms [Wilkin 2013]. The assumptions of CAP 2021-2027 indicate the continuation of the existing policy towards small and medium-sized farms [Siekierski 2020].

In addition, the draft Strategic Plan of the CAP of the Ministry of Agriculture and Rural Development (version as of December 2020) provide for no measures to support transformations in the structure of farms. The climate protection assumptions adopted in the European Green Deal [Wrzaszcz, Prandecki 2020] will be implemented more effectively in farms of a larger area. This is indicated by previous experience in the implementation of Agri-Environmental Programmes [Gotkiewicz, Klimecki 2016].

ORGANISATION OF CROP PRODUCTION IN FARMS OF DIFFERENT AREA AND ITS RELATION TO THE ENVIRONMENT AND CLIMATE

The groups of farms[3] classified by the area of AL differ in the structure of land use. Appropriate figures are given in Table 1. These figures indicate the relationship of the following elements of land use structure with an increase in area and farms:

- the share of AL in good agricultural and environmental condition (GAEC) of the established classes of farms was high, and fell within the range from 98.3% (farms up to 5 ha) to 99.6% (large farms),
- the share of sown area in AL increased with the increase of the area of farms, from 60% (in farms up to 5 ha) to 83.2% in very large farms. The share of permanent grassland decreased accordingly,
- the share of fallow land in farms decreased with an increase in the area of farms, from 3.3% (farms up to 5 ha) to 0.5% (transitional agricultural farms),
- the share of permanent plantations decreased with the increase of the area of farms from 4.4% (small farms) to 0.4% (large farms),
- also the share of fallow land decreased from 1.7% (farms up to 5 ha) to 0.4% (large farms).

Taking the share of fallowed and set-aside lands in the AL as the evaluation criterion, it should be stated that it amounted to 5% in farms up to 5 ha, while in large farms it accounted for 1.9%. In this respect, the land use structure in large agricultural enterprises should be assessed as more favourable.

Table 2 provides the figures specifying the structure of sowings in farms differing in size. They indicate the relationship between the sowing structure elements and the size of farms. Along with an increase in the size of farms:

[3] Taking into account the nature of the established classes of farms and their development capacity, it was considered that: small farms up to 20 ha of AL have an „auxiliary" nature with limited development capacity, farms of an area of 20-50 ha have a „transitional" nature with opportunities for development, farms of an area of 50-100 ha and 100 ha and larger are defined as large and very large – capable of development [Józwiak et al. 2018].

Table 1. Structure of land use in farms by area of agricultural land in 2016

Specification	Average	Area classes of farms [ha of AL]			
		1-20	20-50	50-100	≥ 100
Share of AL in GAEC [%], including: farms up to 5 ha	99.1 -	98.9 98.3	99.4 -	99.6 -	98.9 -
Share of sown area [%], including: farms up to 5 ha	73.2 -	65.6 60.0	74.7 -	78.9 -	83.2 -
Share of permanent grasslands [%], including: farms up to 5 ha	21.8 -	25.6 8.5	22.7 -	18.9 -	14.0 -
Share of fallowed land [%], including: farms up to 5 ha	1.1 -	1.7 3.3	0.5 -	0.6 -	0.8 -
Share of permanent crops [%], including: farms up to 5 ha	2.7 -	4.4 4.4	0.5 -	0.4 -	1.1 -
Share of other crops and set-aside land [%], including: farms up to 5 ha	0.9 -	1.1 1.7	0.5 -	0.4 -	1.1 -

Source: [GUS 2017]

– the share of cereal in the sowing area decreased from 77.3% (farms up to 5 ha) to 62.3% in very large farms,
– the share of leguminous plants increased from 0.7% (farms up to 5 ha) to 1.3% in very large farms,
– the share of rape and turnip rape also increased from 1.5% (farms up to 5 ha) to 16.4% in very large farms,
– the share of industrial crops increased from 4.1% (farms up to 5 ha) to 19.8% in very large farms,
– the share of sugar beet also increased from 0.3% (farms up to 5 ha) to 2.7% in very large farms,
– the share of field vegetables decreased from 2.4% (farms up to 5 ha) to 1.5% in large farms,
– the differences in the share of catch crops were smaller. In farms up to 5 ha, the share of catch crops amounted to 9.7%, and in the farms of 20-50 ha it accounted for 14%.

The presented figures aid in the establishment that - from an environmental point of view (biodiversity) - the structure of crops in large and very large farms is more favourable. It is confirmed by the share of structure-forming plants (legumes, oilseeds, industrial plants, sugar beets, vegetables and catch crops) in the sowing structure. The share of these elements in farms up to 5 ha accounted for 18.7%, while in very large farms it reached 52.1%.

Table 2. Structure of sowings by farm size in 2016

Specification	Average	Area classes of farms [ha of AL]			
		1-20	20-50	50-100	≥ 100
Share of cereal in the sown area [%], including: up to 5 ha	69.6	76.0 77.3	67.0 -	64.4 -	62.3 -
Share of legumes [%], including: up to 5 ha	0.9	0.7 0.7	0.9 -	1.2 -	1.3 -
Share of rape and turnip rape [%], including:	7.7	3.1 1.5	5.6 -	9.6 -	16.4 -
Share of industrial crops [%], including: up to 5 ha	10.2	4.9 4.1	8.5 -	12.8 -	19.8 -
Share of sugar beet [%], including: up to 5 ha	1.9	0.9 0.3	2.5 -	2.7 -	2.7 -
Share of field vegetables [%], including: up to 5 ha	1.8	1.9 2.4	1.7 -	1.5 -	1.8 -
Share of catch crops [winter and spring] [%], including: up to 5 ha	11.4	7.7 9.7	14.0 -	13.7 -	10.1 -

Source: [GUS 2017]

An important element is the share of cereal in the sowing area. In farms up to 5 ha it was 77.3%, while in large and very large farms it accounted for 64.4 and 62.3%, respectively. From an agronomic perspective, the acceptable share of cereal should not exceed 66% [MRiRW 2004].

Farm size is associated with their other specific features. The corresponding figures are presented in Table 3. They indicate their relationship with an increase in farm size:

– there were no significant differences in the share of farms applying mineral fertilisers. Such fertilizers were used by more than 80% of farms, including 82% in farms up to 5 ha, while 89.6% in farms of 20-50 ha,
– the share of farms applying lime increased, from 6.6% in farms up to 5 ha to 28.9% in very large farms,
– the share of holdings applying natural fertilisers was diversified. It was lowest in farms up to 5 ha and very large farms, where it accounted for 44.7% and 42%, respectively, while it was highest in farms with 20-50 ha, where it amounted to 72.4%,
– the level of mineral fertilisation increased with an increase in farm size: in farms up to 5 ha it was 78.3 kg NPK/ha, and in very large agricultural holdings – 161.5 kg NPK/ha,

Table 3. Specific features of farms by area of AL in 2016

Specification	Average	Area classes of farms [ha of AL]			
		1-20	20-50	50-100	≥ 100
Share of farms applying mineral fertilisers [%], including up to 5 ha	76.0 -	83.0 82.1	89.6 -	87.3 -	84.0 -
Share of farms applying lime, including: up to 5 ha	10.5 -	10.0 6.6	22.9 -	25.8 -	28.9 -
Share of farms applying natural fertilisers, including up to 5 ha	48.2 -	51.2 44.7	72.4 -	60.0 -	42.0 -
NPK [kg/ha], including: up to 5 ha	131.6 -	97.0 78.3	144.4 -	158.1 -	161.5 -
Share of farms with tractors [%], including: up to 5 ha	68.1 -	72.6 63.0	94.4 -	95.0 -	92.6 -
Share of organic farms [%], including: up to 5 ha	1.4 -	0.9 0.2	5.6 -	10.2 -	14.9
AWU/100 ha of AL, including: up to 5 ha	11.3 -	18.9 65.0	6.9 -	3.9 -	2.1 -
Share of farms where the person in charge has a university degree, including: up to 5 ha	13.2 -	14.2 16.4	14.2 -	20.6 -	38.2 -

Source: [GUS 2017]

– the share of farms with tractors increased. Only 63% of farms up to 5 ha had tractors, while this share accounted for 92% and 92.6%, respectively, in large and very large farms,
– the share of organic farms also increased. In the class of the smallest farms it amounted to 0.2%, while in the very large farms it reached 14.9%,
– the labour force resources, defined as labour units (AWU – 2,120 hours of work per year) per 100 ha of AL, decreased.

In farms up to 5 ha the resources amounted to 65 AWU, while in large and very large farms to 3.9 and 2.1 AWU per 100 ha, respectively. In farms up to 5 ha labour resources are too high comparing to the area of farms, which hinders their sustainable use;

– there was also an increase in the share of holdings where the managing person has higher education. In farms up to 5 ha this share was 16.4%, while in very large farms it accounted for 38.2%.

To sum up, it should be stated that in terms of the analysed features, the image of farms of a larger area is more favourable.

ORGANISATION OF ANIMAL PRODUCTION IN FARMS OF DIFFERENT SIZES AND ITS RELATION TO THE ENVIRONMENT AND CLIMATE

The figures characterising the organisation of livestock production in farms of different sizes are presented in Table 4. They indicate its relationship with size:

Table 4. Livestock production in farms in 2016 by AL area

Specification	Average	Area classes of farms [ha of AL]			
		1-20	20-50	50-100	≥ 100
Share of farms with livestock, including: up to 5 ha	51.1 -	54.8 50.8	72.0 -	60.2 -	39.3 -
Stocking density [SD/100 ha of AL], including: up to 5 ha	61.0 -	56.9 71.9	84.0 -	61.7 -	47.2 -
Share of farms with cattle [%], including up to 5 ha	24.6 -	24.1 10.3	56.7 -	43.6 -	26.1 -
Structure of the cattle population [%], including: up to 5 ha	100.0 -	44.4 4.4	34.5 -	10.8 -	10.3
Share of farms with cows (dairy) [%], including up to 5 ha	19.3 -	18.3 5.1	47.8 -	36.7 -	22.2 -
Structure of the cow population (dairy) [%], including: up to 5 ha	100.0 -	41.8 4.4	35.8 -	11.5 -	10.9 -
Share of farms with pigs [%], including up to 5 ha	12.4 -	12.6 3.2	24.2 -	18.3 -	10.1 -
Structure of the pig population [%], including: up to 5 ha	100.0 -	35.4 3.4	25.4 -	11.0 -	28.2 -
Structure of the pig population in herds of 200 animals and above [%], including up to 5 ha	100.0 -	13.9 0.8	24.9 -	15.5 -	45.7 -
Share of farms with sows [%], including up to 5 ha	8.4	8.3 1.4	18.6 -	15.5 -	6.6 -
Structure of the sows population [%], including: up to 5 ha	100.0 -	41.2 3.9	23.9 -	10.2 -	24.7 -
Structure of the sows population in herds of 50 animals and above [%], including: up to 5 ha	100.0 -	5.7 -	14.7 -	15.7 -	63.9 -
Structure of chicken livestock, including: up to 5 ha	100.0 -	59.9 21.0	18.0 -	8.2 -	13.9

Source: [GUS 2017]

– approximately 51% of farms up to 5 ha carried out no animal production. A smaller share was recorded in very large farms, where it amounted to 39%,
– stocking density per 100 ha of agricultural land decreased with the increase of size. In farms up to 5 ha, it was 72 SD, which can be considered an average value. In the largest farms it amounted to 47 SD, which can be considered the minimum value from the point of view of balance of organic matter in soil,
– only about 10% of farms up to 5 ha kept cattle, of which only 4.4% kept both cattle and cows. In the other classes, the share of farms keeping cattle and cows was definitely higher, and fell within the range of: cattle 56.7-26.1%, cows 47.8-22.2%,
– the share of farms up to 5 ha with pigs was very low, amounting to 3.2%, in which the total number of pigs was 3.4%. The corresponding figures for sow farms were 1.4 and 3.9%, respectively. In this class there was no sow rearing in herds of 50 animals and above, which facilitates the delivery of a satisfactory income, at a parity level,
– small farms (up to 20 ha) accounted for around 60% of the poultry stock.

To sum up, it should be stated that nearly half of very small farms (up to 5 ha of AL) and small farms (up to 20 ha of AL) carried out no animal production, which poses a threat to the maintenance of a sustainable balance of organic matter in soil. Moreover, in very small farms cattle and pigs are reared to a negligible extent (less than 5%). In terms of poultry breeding, the dominant position is held by small farms.

CONCLUSIONS

The results of the presented research allow to state that the assumed research hypothesis, according to which "the organisation of production implemented in small farms is environmentally friendly and has a positive impact on the climate, in contrast to farms of a larger scale of production", was not confirmed. This is evidenced by the sowing structure and organisation of animal production. The structure of sowings was dominated by cereal in small farms up to 20 ha of AL (76%), and in farms up to 5 ha – 77.3%, while in very large farms (50 ha and more) the share of cereal amounted to 62.3%, and was lower than the recommended 66%, according to agronomic recommendations. Moreover, the share of structure-forming plants (legumes, industrial oilseeds and catch crops) in the sowing structure in large and very large farms accounted for 64.4 and 62.3%, respectively, while in farms up to 5 ha it was only 18.7%. Soil liming was used to a lesser extent in small farms (10%), while in very large farms – approx. 30%. Over 50% of small farms carried out no animal production, which in consequence leads to soil degradation due to the jeopardised balance of organic matter in the soil.

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OBCIĄŻENIA ŚRODOWISKOWO-KLIMATYCZNE W ZALEŻNOŚCI OD POWIERZCHNI GOSPODARSTW

Słowa kluczowe: obciążenia środowiskowo-klimatyczne, gospodarstwo rolne, systemy produkcji rolniczej, struktura zasiewów, użytkowanie ziemi

ABSTRAKT

W artykule przedstawiono ocenę stopnia realizacji funkcji ochrony środowiska i klimatu przez polskie gospodarstwa i przedsiębiorstwa rolnicze o różnej powierzchni i skali produkcji. W literaturze przedmiotu można znaleźć różnice w poglądach na ten temat, przy czym dominują opinie o bardziej pozytywnej roli małych gospodarstw w ochronie klimatu i bioróżnorodności. Analizy gospodarstw dokonano na podstawie danych GUS, dotyczących wydzielonych klas wielkości gospodarstw według powierzchni użytków rolnych w 2016 roku. Wyniki przeprowadzonych badań nie potwierdziły poglądu, że występujące w małych gospodarstwach systemy produkcji są bardziej przyjazne środowisku i korzystniej wpływają na klimat niż te w gospodarstwach o większej skali produkcji. Świadczy o tym struktura zasiewów: w małych gospodarstwach dominowały zboża, przekraczając rekomendowane agrotechnicznie 66%, natomiast niski był udział roślin strukturotwórczych – strączkowych, oleistych przemysłowych i poplonów. Również stosowana organizacja produkcji zwierzęcej (w ponad połowie gospodarstw małych nie prowadzono jej wcale) w konsekwencji prowadzi do degradacji gleby z powodu zagrożonego bilansu substancji organicznej.

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