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Predispositions and challenges of agriculture from areas particularly facing natural or other specific constraints in Poland in the context of providing environmental public goods under EU policy

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Abstract: The study's main objective is to determine the predisposition and challenges of agriculture to provide environmental public goods to society in areas particularly facing natural or other specific constraints (ANCs) established within their current delimitation in Poland. Its organisational features, economic situation, and the degree of interest in measures specifically serving the protection of the natural environment under the Common Agriculture Policy (CAP) EU were indicated. Statistically significant factors determined farmers' willingness to participate in these measures. It turned out that farms from ANCs communes with particularly difficult conditions significantly contribute to the total production potential of agriculture in Poland. However, compared to farms with better natural conditions, they are characterised by a lower income per 1 ha of utilised agriculture area (UAA) and a higher share of subsidies, including those for participation in environmental measures, which were implemented to a greater extent. Based on the logistic regression model, it was found that in ANCs communes with particularly difficult conditions, the most important factor of farmers' greater willingness to implement environmental measures was their higher level of education. On the other hand, this inclination was negatively affected by the higher income adjusted for operating subsidies per 1 ha of UAA.

Keywords: agri-environment-climate measure (AECM); environmental public goods; logistic regression model; New Institutional Economics (NIE); organic farming measure

It is widely believed that humanity has never been so close to causing a global crisis resulting from the current scale of violation of key boundaries defining the safe functioning of the natural environment (IPBES 2019; Dasgupta 2021). Despite its efforts to stop this process, the degradation of many of its ecosystems continues, including those of exceptionally high natural value and used for agriculture (Stoate et al. 2009; Chu and Karr 2017; Pe'er et al. 2020). The state of affairs, therefore, prompts an urgent strength-

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ening of the existing institutional actions taken to protect it even more strongly (Bradley 2021). First, they should be concerned with improving the condition of soils used for agriculture. They are one of the basic resources of the natural environment, necessary for the survival of humanity because the good condition is of fundamental importance for the effective fight against climate change, the production of healthy food and human health, the preservation of biodiversity and ensuring food security (Orgiazzi et al. 2016, Brevik et al. 2020). It should be emphasised that agriculture, by properly caring for the quality of soils, can provide society with a wide range of public goods, as is increasingly expected from it (Nilsson et al. 2017).

In the European Union (EU), there is a great readiness and will of the European Commission (EC) to take action to protect agricultural soils. They are demonstrated in the currently most important EU strategic document, the European Green Deal (EGD) strategy of 2019, and in its thematic strategies for 2020–2022. As a priority, areas where agriculture operates under disadvantaged conditions, with low-quality soils and low natural organic matter content, require urgent remedial action. We are talking about areas facing natural or other specific constraints (ANCs), whose new delimitation – according to the same criteria – was recommended by the EC to all EU Member States under the Common Agriculture Policy (CAP) 2014–2020 (European Comission 2016). In addition, this delimitation also applies under CAP 2023–2027. In the EU, these areas currently account for 57.9%, and in Poland for 58.7% of the utilised agricultural area (UAA) (European Comission 2019). In Poland, some are ANCs with particularly difficult conditions for farming (Zielinski et al. 2022).

The presence and durability of appropriate rules (institutions) that can foster the formation of desired behaviours are a prerequisite for agriculture operating in ANCs with particularly difficult conditions to provide environmental public goods at the level society expects continuously. In this context, a significant achievement is brought by the New Institutional Economics (NIE) trend, where the fundamental role is played by formal institutions treated as forms of public order and informal institutions, which are socially acceptable standards of conduct and values nurtured by the human individual, influencing routine in the way it thinks and behaves in economic reality (North 1990; Williamson 2000; Menard and Shirley 2008; Richter 2015). In this trend, both institutions identify and direct several of their internal motivations, which, apart from the desire to achieve personal economic well-being, also strengthen a sense of honesty, justice and social responsibility when making decisions, including those regarding protecting the natural environment.

The study is designed to contribute to filling the research gap regarding assessing the predisposition and challenges of agriculture from ANCs with particularly difficult conditions in the context of providing society with environmental public goods in Poland. In the international literature, there is still a need for results of this type of analysis conducted about these areas currently of particular concern by the EC as part of the EGD strategy.

The study's main objective is to determine the predisposition and challenges of agriculture from ANCs with particularly difficult conditions in the context of providing society with environmental public goods in terms of communes in Poland. The aim is also to indicate its condition and direction of development, including assessing its economic situation against the background of agriculture with better farming conditions. In addition, it is also important to determine the factors that have a statistically significant impact on farms from these communes on their willingness to better adapt to the existing restrictions by participating in the agri-environment-climate (AECM) and/or organic farming measure under the EU CAP.

Theoretical background

Role of agriculture in providing society with environmental public goods. Society expects agriculture to fulfil its objectives related to providing it not only with market goods but also, to an increasing extent, with a wide range of public goods associated with protecting the natural environment (FAO 2017; Leduc et al. 2021; EEA 2022). Therefore, the question of how to better motivate farmers to manage the natural environment institutionally becomes crucial. To remedy the situation, society is currently introducing many environmental regulations in agriculture, offering additional payments, and expanding the range of forms of information transfer that promote better protection. This process is carried out in the EU mainly under the CAP, where measures to deliver environmental public goods are gaining increasing attention (Louhichi et al. 2018). The agri-environment-climate (AECM) and organic farming measures represent this state of affairs.

In the international literature, there is scientific evidence that agriculture is more likely to carry out these measures in areas with poorer farming conditions resulting from lower-quality soils (Wynn et al. 2001; Harvey

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2003; Defrancesco et al. 2008; Hynes and Garvey 2009; Uthes and Matzdorf 2013; Batary et al. 2015; Defrancesco et al. 2018; Velten et al. 2018; Lakner et al. 2020; Wąs et al. 2021; Coyne et al. 2022; Kujala et al. 2022). It should be noted that one of the strengths of these areas is the frequent presence of diverse and valuable natural landscapes, with a large share of permanent grasslands, forests, watercourses and other areas not subjected to strong anthropopressure, including often belonging to the Natura 2000 network, which can effectively support the provision of a wide range of public goods related to the protection of the natural environment to the society (Schmidtner et al. 2012; Früh-Müller et al. 2019, Zieliński et al. 2022). It is also worth emphasising that farms with extensive organisation of agricultural production operate in these areas much more often than in other areas (Zimmermann and Britz 2016). Therefore, the additional payments received by these farms for the implementation of AECM and/or organic farming measures may be economically satisfactory enough to make them a permanent alternative to conventional agricultural practices used so far (Keenleyside et al. 2011, Früh-Müller et al. 2018; Wittstock et al. 2022).

MATERIAL AND METHODS

In the first part of the resulting study, agriculture from ANCs with particularly difficult conditions was characterised by other areas' backgrounds regarding Poland's communes. The analyses used the currently applicable delimitation of ANCs, which was carried out in Poland in 2019 at the request of the Ministry of Agriculture and Rural Development (MARD) and the EC by the Institute of Soil Science and Plant Cultivation State Research Institute (ISSPC SRI), as part of biophysical criteria, and Institute of Agricultural and Food Economics National Research Institute (IAFE NRI) – as part of the fine-tuning procedure [Regulation (EU) No. 1305/2013 of the European Parliament and of the Council of December 17, 2013 on Support for Rural Development by the European Agricultural Fund for Rural Development (EAFRD) and Repealing Council Regulation (EC) No. 1698/2005; European Comission (2016)]. In Poland, ANCs communes with particularly difficult conditions are characterised by a low agricultural production area valorisation index (APAV) set by the ISSPC SRI. It should be emphasised that the Ministry of Agriculture and Rural Development (MARD) and the EC have accepted the index to determine the current ANCs zones in Poland. The average value of the APAV index for a community in Poland is currently 66.6 points out of 120 points achievable.

Three groups of communes were selected for this analysis. From now on, the first had an average APAV index lower than 52 points out of 120 points possible to be achieved, referred to as communes with particularly difficult conditions under ANCs. The second group consisted of communes remaining with ANCs. The third one is without ANCs (Figures 1 and 2).

In the selected groups of communes, attention was first paid to the natural value of their landscape. It was assessed by the share of Natura 2000 areas in their total area. They also indicate the state of agriculture characterised by extensive organisation of agricultural production carried out in the vicinity of valuable components of the natural environment and meeting the requirements of the EC under the concept of agriculture from High Nature Value farmlands (HNVf) areas (European Comission 2017). The 2018 delimitation of these areas, established on behalf of MARD by the ISSPC SRI and the Institute of Agricultural and Food Economics – National Research Institute (IAFE NRI), was used to achieve this goal. As part, three variants of UAA HNVf of moderate, high, and exceptionally high natural value were designated in Poland (Prandecki et al. 2021; Zieliński and Jadczyszyn 2022).

After determining the management conditions and the value of the landscape, and the condition of agriculture meeting the HNVf criteria in selected groups of communes, an analysis of its organisational features was carried out based on data from the Agency for Restructuring and Modernization of Agriculture (ARMA), which acts in Poland as a public institution implementing payments under the EU CAP.

Next, the economic situation of field and milk farms from separate groups of communes was assessed based on data from farms continuously keeping accounts for the Polish Farm Accountancy Data Network (FADN)

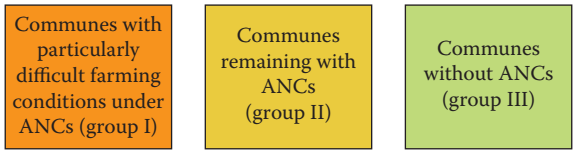

Figure 1. Schematic diagram of the analysis of agriculture within selected groups of communes due to the fact and nuisance of ANCs in Poland

ANCs – areas facing natural or other specific constraints
Source: author's own elaboration

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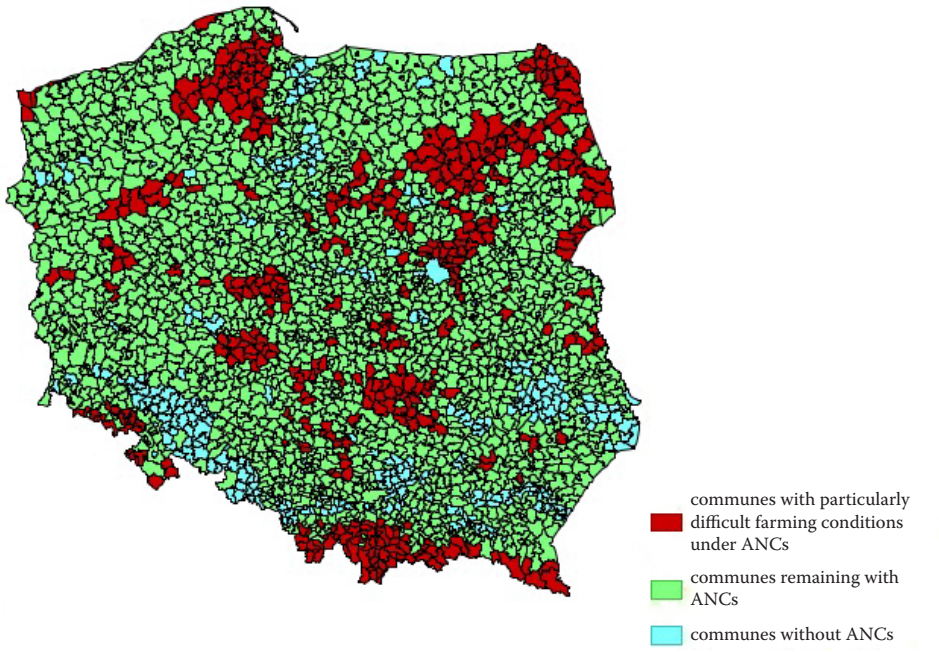

Figure 2. Distribution of communes in Poland due to the fact and nuisance of ANCs in Poland

ANCs – areas facing natural or other specific constraints

Source: Zieliński et al. (2022)

in 2016–2021. When separating farms according to their type of farming, their high importance in the structure of farms in Poland was considered.

In the final part of the study, the factors underlying the decision of farms from ANCs communes with particularly difficult conditions to implement the AECM and/or organic farming measures were identified. For this purpose, a logistic regression model was used, based on data from farms participating in these measures (158 farms) and other farms (795 farms), which continuously kept accounts for the Polish Farm Accountancy Data Network (FADN) in 2016–2021. It should be noted that in the international literature, these models are commonly used to identify factors determining the willingness of farmers to participate in the activities indicated here (Vanslembrouck et al. 2002; Lakner et al. 2020; McGurk et al. 2020; Paulus et al. 2022).

In the logistic regression model, the probability (P) of the occurrence of the expected situation (1) for the binary dependent variable is described by the function being the distribution function of the logistic distribution and finally takes the form (Christensen 1997; Fahrmeir et al. 2013) [Equation (1)]:

$$P\left(y=1|\ x_1,x_2\ldots x_k\right)=\frac{e^{\beta_0+\sum_{i=1}^{k}x_i\times\beta_i}}{1+e^{\beta_0+\sum_{i=1}^{k}x_i\times\beta_i}} \quad (1)$$

where: $P\ (y = 1|x_1, x_2 \ldots x_k)$ – probability that the variable y will take the value equal to 1 for the values of the independent variables in quantitative (continuous) or qualitative (binary) terms ($x_1, x_2 \ldots x_k$); β_i for $i = 0, \ldots, k$ – regression coefficients

The model parameters were estimated using Statistica, version 13.3. The Likelihood Ratio test and the Wald test assessed the quality of the obtained logistic regression model. In addition, Cox and Snell's pseudo-R^2 measure and its modification proposed by Nagelkerke were used.

RESULTS AND DISCUSSION

Characteristics of communes with ANCs with particularly difficult conditions, compared to other communes in Poland. A new delimitation of ANCs has been in place in Poland since 2019. As mentioned, it aimed to adapt Poland to the new criteria EC for their determination, identical for all EU-27 countries (European Comission 2013, 2016). In Poland, the share of ANCs currently accounts for 58.7% of the total UAA. This share is close to the EU-27 average of 57.9% (Figure 3).

In Poland, in ANCs communes with particularly difficult conditions, natural constrains are caused by poor soil quality and unfavourable climatic and topographical conditions. As a result, the average APAV index in these communes is 46.0 points, while in communes remaining with ANCs – 66.0 points, and without ANCs – 86.5 points. The frequent presence of diverse and valuable natural landscapes is one of their

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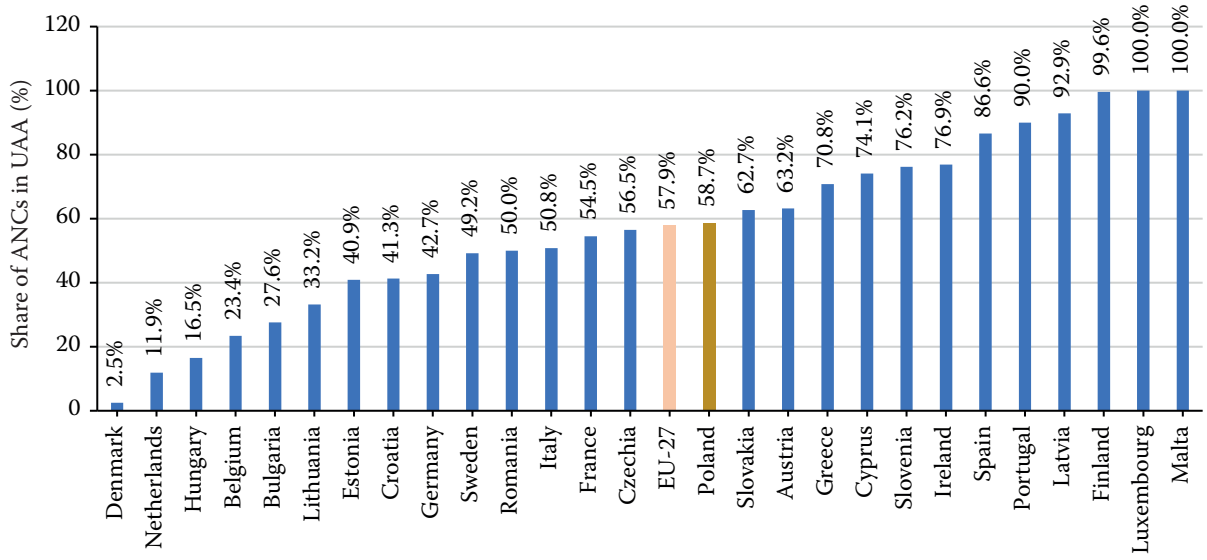

Figure 3. Share of ANCs in the total UAA in EU-27 in 2019

ANCs – areas facing natural or other specific constraints; UAA – utilised agriculture area; CAP – Common Agriculture Policy

Source: author's own elaboration based on the data of European Comission (2019), CAP Context Indicators – 2019 update

strengths compared to comparative communes. They are characterised by a much greater share of extensive UAA HNVf of moderate, high, and particularly high natural value. In addition, their very high natural values are also evidenced by a clearly greater share of Natura 2000 sites in the total area (Table 1).

Agriculture in ANCs communes with particularly difficult conditions co-decides on the total production potential of agriculture in Poland. In 2016 and 2022, there were 15.6% and 15.7% of the total number of farms in these communes. In both analysed years, they used 13.2% of the total UAA each (Table 2).

In 2022, in ANCs communes with particularly difficult conditions, the share of the total area supported under the AECM and organic farming measure in the total UAA was the highest and amounted to 16.6%. On the other hand, in the communes remaining with ANCs and without ANCs, it amounted to 11.2% and 5.3%, respectively (Table 3, Figure 4).

Economic situation of farms from ANCs communes with particularly difficult conditions, as compared to other farms in Poland. Based on the Polish FADN data from 2016–2021, it was established that farms in the type of farming field crops and dairy cows, from ANCs communes with particularly difficult conditions, as compared to farms from communes being the reference point, achieved lower ag-

Table 1. Management conditions and environmental values of communes separated due to the fact and nuisance of ANCs in Poland

Variable	Communes		
	ANCs with particularly difficult conditions	remaining with ANCs	without ANCs
APAV index (points)	46.0	66.0	86.5
Share of UAA HNVf in the total UAA with (%):			
Moderate natural value	48.9	25.9	10.4
High natural value	29.7	15.7	4.3
Particularly high natural value	24.2	12.4	3.3
Share of Natura 2000 areas in the total area	34.0	21.9	9.6

ANCs – areas facing natural or other specific constraints; APAV – agricultural production area valorisation index; UAA – utilised agriculture area; HNVf – High Nature Value farmlands

Source: author's own elaboration based on the data – Institute of Soil Science and Plant Cultivation State Research Institute and Institute of Agricultural and Food Economics National Research Institute for 2018

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Table 2. Number of farms and UAA in communes separated due to the fact and nuisance of the ANCs in Poland in 2016 and 2022

Variables	ANCs with particularly difficult conditions		remaining with ANCs		without ANCs	
Year	2016	2022	2016	2022	2016	2022
Number of farms (thousands)	210.1	199.1	968.7	914.3	166.4	153.7
UAA (thousands ha)	1 881.1	1 874.5	10 579.4	10 575.6	1 756.9	1 758.9

ANCs – areas facing natural or other specific constraints; UAA – utilised agriculture area; ARMA – Agency for Restructuring and Modernization of Agriculture
Source: author's own elaboration based on ARMA data

Table 3. Share of the area covered by the AECM and organic farming measure supported under the CAP 2014–2020 in the total UAA in communes with different saturation and specificity of ANCs in Poland in 2022

Variable	Communes		
	ANCs with particularly difficult conditions	remaining with ANCs	without ANCs
Area of AECM measure (thousands ha UAA)	220.4	831.9	78.7
Area of organic farming measure (thousands ha UAA)	91.4	352.2	13.7
Share of the area covered by the AECM and organic farming measure in the total UAA (%)	16.6	11.2	5.3

ANCs – areas facing natural or other specific constraints; UAA – utilised agriculture area; AECM – agri-environment-climate measure ; CAP – Common Agriculture Policy; ARMA – Agency for Restructuring and Modernization of Agriculture
Source: author's own work based on ARMA data

ricultural income. If these farms were hypothetically deprived of subsidies, including those received under the AECM and organic farming measures, their ability to generate agricultural income would be limited. This unfavourable economic situation would occur, especially in the years of exceptionally low prices on agricultural markets and the effects of climate change, including droughts, which in Polish conditions, especially in ANCs with particularly difficult conditions, are characterised by increasingly longer duration and increasing intensity of occurrence. It is worth adding that in the event of high intensity of these events, farms with field crops even recorded a loss (Tables 4 and 5).

Evaluation of factors influencing farms' willingness to participate in AECM and/or organic farming measures in ANCs communes with particularly difficult conditions in Poland. The results of the estimation of the logistic regression model are included in Table 6. where its parameter values, odds ratios, and the statistics of the Wald test, the likelihood ratio (LR) test, Cox Snell's and Nagelkerke's pseudo-R^2 are included.

The factor whose increase by one unit determined the probability of farm participation in the AECM and/or organic farming measure to the greatest extent was the farmer's transition to a higher level of education (it was a continuous variable, where 1 – primary education, 2 – basic agricultural or non-agricultural education, 3 – secondary agricultural or non-agricultural education and 4 – higher agricultural or non-agricultural education). In this situation, the chance of his participation in these measures increased by 84.6% [exp(β) = 1.845792]. The greater age of the farmer also positively impacted the increase in this chance. It was found that the occurrence of this circumstance was, in turn, able to increase the probability of participation in them by 4.2% [exp(β) = 1.041899]. Another important variable in the model was the share of ANCs in the total UAA and the total share of permanent grasslands, forests, and waters in the total area of a given community. An increase in their share by another 1% meant an increase in the probability of participation in these measures by 14.7 and 2.4%. respectively [exp = 1.146816; exp(β) = 1.024179]. The increase in the chance of farms participating in these measures was also influenced by the greater presence of the surrounding local community of farmers who had joined them earlier and the greater share of the population living in rural areas in the total population of a given community.

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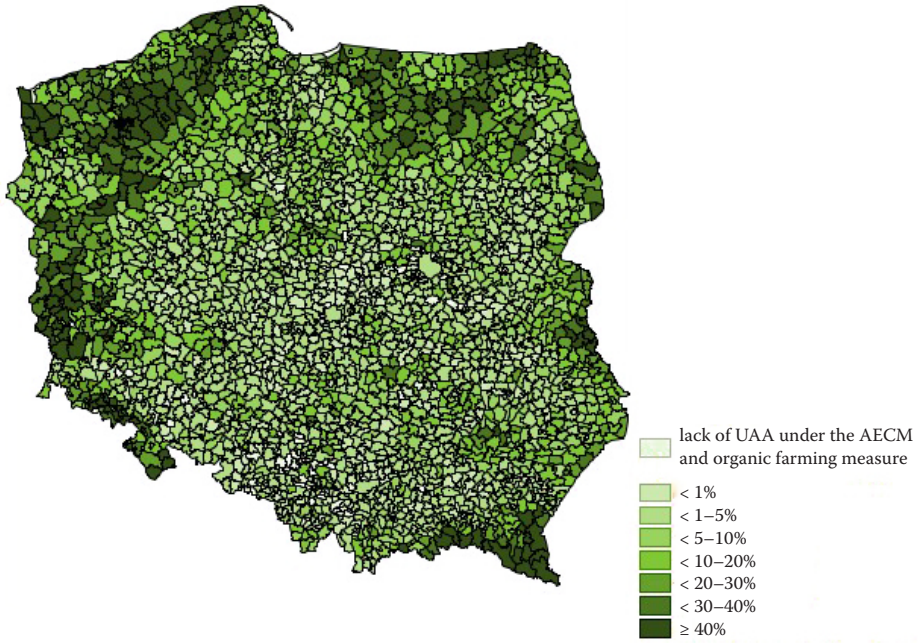

Figure 4. Share of the UAA covered by the AECM and organic farming measure under the CAP 2014–2020 in the total UAA of communes in Poland in 2022

ANCs – areas facing natural or other specific constraints; UAA – utilised agriculture area; AECM – agri-environment-climate measure; CAP – Common Agriculture Policy; ARMA – Agency for Restructuring and Modernization of Agriculture

Source: author's own elaboration based on ARMA data

Table 4. Economic situation of farms with field crops in 2016–2021

Farms from communes	Variable	Year					
		2016	2017	2018	2019	2020	2021
ANCs with particularly difficult conditions	income (EUR/ha)	349.1	363.4	263.6	355.8	395.3	520.4
	including the share of subsidies (%)	112.2	83.4	129.2	82.4	82.4	60.0
Remaining with ANCs	income (EUR/ha)	467.2	452.1	435.7	440.2	495.3	724.8
	including the share of subsidies (%)	77.9	62.6	49.5	67.4	57.4	36.4
Without ANCs	income (EUR/ha)	503.4	527.0	571.6	479.8	556.5	909.4
	including the share of subsidies (%)	69.1	52.0	47.2	55.4	46.4	27.5

ANCs – areas facing natural or other specific constraints; FADN – Farm Accountancy Data Network
Source: author's own elaboration based on Polish FADN data

Table 5. Economic situation of dairy farms in 2016–2021

Farms from communes	Variable	Year					
		2016	2017	2018	2019	2020	2021
ANCs with particularly difficult conditions	income (EUR/ha)	816.3	1 027.7	933.6	934.9	968.2	1 154.8
	including the share of subsidies (%)	60.0	35.2	38.5	38.0	37.9	30.3
Others with ANCs	income (EUR/ha)	855.5	1 112.4	1 035.0	1 038.4	1 093.7	1 316.0
	including the share of subsidies (%)	54.3	30.6	32.6	31.8	32.3	24.6
Without ANCs	income (EUR/ha)	813.5	1 160.6	1 039.4	1 091.6	1 090.1	1 444.3
	including the share of subsidies (%)	60.9	28.3	32.3	31.2	33.8	23.3

ANCs – areas facing natural or other specific constraints; FADN – Farm Accountancy Data Network
Source: author's own elaboration based on Polish FADN data

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Table 6. Estimated parameters of the logistic regression model; pseudo-R^2 Coxa Snella = 0.262987085; pseudo-R^2 Nagelkerke' a = 0.411092417

Variable	β	SE	Wald test	Confidence intervals (95%)		ρ	exp(β)	Confidence intervals (95%):		ρ	Likelihood ratio test		
				upper	lower			upper	lower		lnL	Chi-squared	ρ
Free expression	−23.3387	4.548265	26.33074	−32.2532	−14.4243	0.000000	–	–	–	–	−374.158	–	–
Number of farms participating in the AECM and/or organic farming measure in a given commune	0.0240	0.002512	91.06051	0.0191	0.0289	0.000000	1.024265	1.019233	1.029321	0.000000	−307.628	133.0589	0.000000
Share of population living in rural areas in the total population of a given commune (%)	0.0222	0.007369	9.09249	0.0078	0.0367	0.002567	1.022469	1.007808	1.037344	0.002567	−303.982	7.2925	0.006924
Share of UAA ANCs in the total UAA in a given commune (%)	0.1370	0.042768	10.25974	0.0532	0.2208	0.001360	1.146816	1.054604	1.247090	0.001360	−289.516	28.9315	0.000000
Share of permanent grasslands. forests and waters in the total area of a given commune (%)	0.0239	0.008120	8.65696	0.0080	0.0398	0.003258	1.024179	1.008008	1.040609	0.003258	−285.103	8.8270	0.002968
The fact that the farmer has a higher level of education	0.6129	0.162798	14.17404	0.2938	0.9320	0.000167	1.845792	1.341556	2.539548	0.000167	−278.404	13.3973	0.000252
Farmer age (years)	0.0410	0.012717	10.41789	0.0161	0.0660	0.001248	1.041899	1.016252	1.068194	0.001248	−271.155	14.4984	0.000140
UAA on the farm (ha)	0.0103	0.004204	6.03677	0.0021	0.0186	0.014011	1.010382	1.002092	1.018742	0.014011	−268.728	4.8539	0.027584
Income adjusted for operating subsidies per 1 ha of UAA (EUR,00/ha)	−0.1283	0.044268	8.39540	−0.2150	−0.0415	0.003762	0.879619	0.806517	0.959347	0.003762	−262.931	11.5950	0.000661
The fact that the farmer has a successor	0.0188	0.135111	0.01928	−0.2461	0.2836	0.889577	1.038230	0.611337	1.763220	0.889577	−262.913	0.0346	0.852359
Farmer's involvement in work on his farm	0.1622	0.147994	1.20159	−0.1278	0.4523	0.273004	1.383274	0.774396	2.470887	0.273004	−262.320	1.1857	0.276203

SE – standard error; β – regression coefficient; ρ – precise P value; lnL – maximum likelihood logarithm; ARMA – Agency for Restructuring and Modernization of Agriculture; UAA – Utilised Agriculture Area; AECM – agri-environment-climate measure; ANCs – areas facing natural or other specific constraints; FADN – Farm Accountancy Data Network

Source: author's own elaboration in Statistica version 13.3 based on Polish FADN and ARMA data for 2016–2021

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Each additional farm participating in them increased the chance for the next farm to undertake them by 2.4% [exp (β) = 1.024265]. On the other hand, a 1% increase in the share of the population living in rural areas increased this chance by 2.2% [exp = 1.022469]. To a lesser extent, this propensity was positively influenced by the fact that the farm had a larger UAA, each increase of which by 1 ha increased it by 1.0% [exp(β) = 1.010382]. The chance of participation of farms in the AECM and/or organic farming measure was negatively affected by the increase in agricultural income adjusted for operating subsidies per 1 ha of UAA [exp(β) = 0.879619] (Table 6).

Discussion of the results. In the current economic reality characterised by high turbulence and complexity of the processes, effectively operating formal and informal institutions are needed by agriculture from ANCs with particularly difficult conditions for better protection of the natural environment. In this context, the set of standards, regulations and incentives contained in the EGD strategy from 2019, in its thematic strategies from 2020–2022, as well as in the CAP, revised every few years, plays an important role in this context, in which more and more emphasis is placed on above all, the importance of the AECM and organic farming measure as those mainly serving the provision of environmental public goods. However, it should be emphasised that effective protection of the natural environment by agriculture in areas with special natural constraints is not possible without the simultaneous shaping of values and motivating farmers to apply the activities in a sustainable manner and at the level expected by society (Jones et al. 2016; Valujeva et al. 2022).

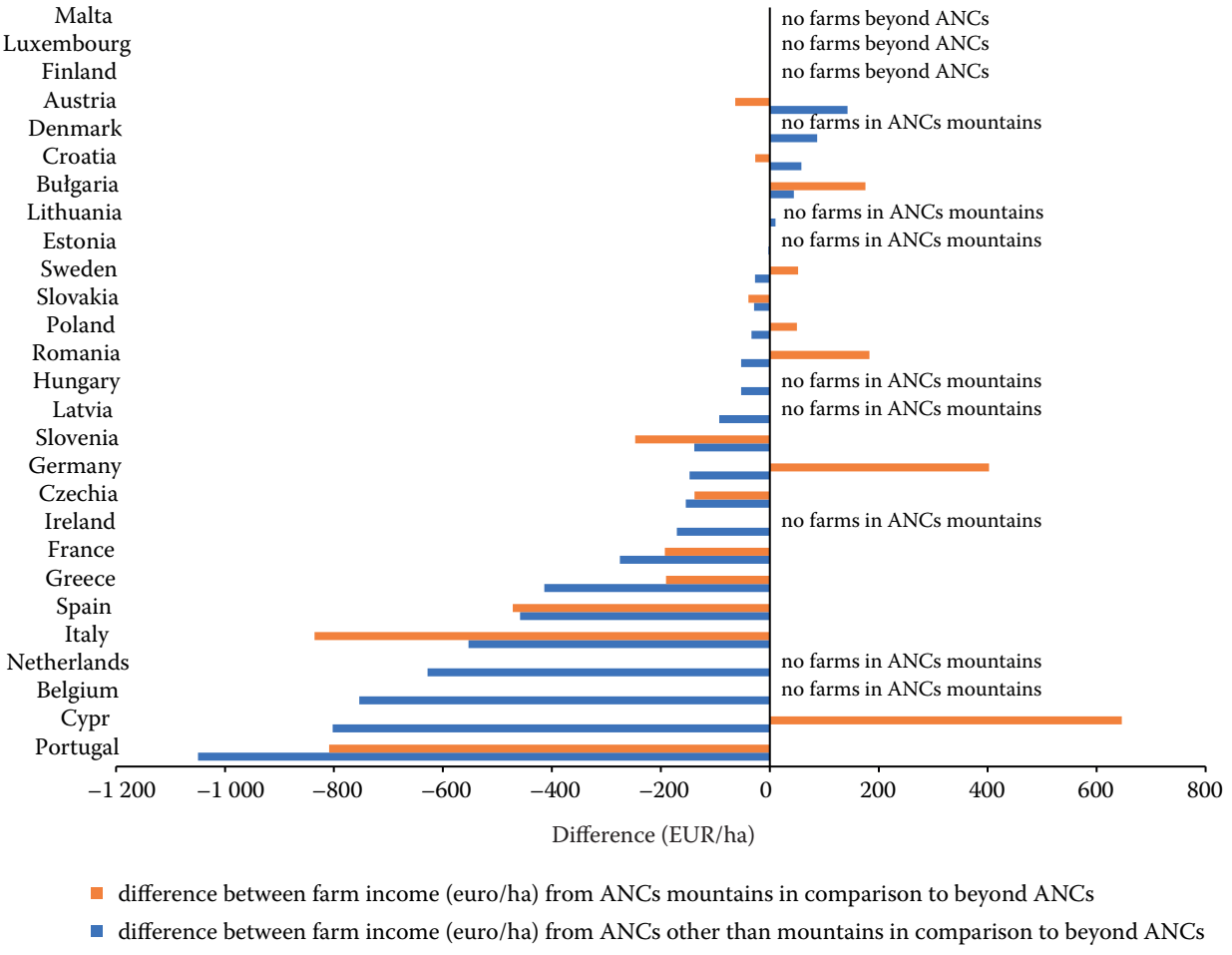

Figure 5. Decrease (–) or increase (+) of income per 1 ha of UAA (EUR/ha) in farms with ANCs compared to farms without ANCs in the EU-27 on average in 2004–2020

ANCs – areas facing natural or other specific constraints; UAA – Utilised Agriculture Area
Source: European Comission (2023)

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Formal and informal institutions should be required to constantly search for more and more new tools that will encourage agriculture from the ANCs with particularly difficult conditions to undertake environmental activities to an even greater extent in the conditions of constantly growing competitive pressure. In this context, the role of institutions is important in finding a balance between providing environmental public goods and ensuring satisfactory income from agricultural activity. It must be borne in mind that the simultaneous improvement of economic and environmental efficiency is the most cost-effective way of protecting the natural environment by agriculture, as it is accompanied by the concurrent maintenance or improvement of its competitiveness (Sidhoum et al. 2023). However, based on the European FADN data, it turned out that, on average, in 2004–2020, the income per 1 ha of UAA in farms with mountains and other than mountains ANCs compared to farms beyond ANCs was significantly lower in many EU-27 countries (Figure 5).

CONCLUSION

The study tried to justify that for effective protection of ANCs with particularly difficult conditions, the presence of sustainable and stable institutions essential that would be able to regulate and motivate agricultural activities in them and would foster the formation of behaviours expected by the society, including those related to providing it with a wide range of environmental public goods. The NIE trend has a lot to offer in this research area. It supplements neoclassicism with an additional scope and research methods. including by attributing special importance to institutions in shaping the market management framework desired by society. For agriculture from ANCs with particularly difficult conditions, well and carefully designed public actions are needed, which, through regulation and financial incentives, can play an important role in the success of environmental protection. The presence of informal institutions is also required since formal rules can only be implemented in agriculture sustainably and stable if they are trusted, promote generally desirable behaviour in farmers, and sustainably and stably enable communication and cooperation within local communities. With this synergy, both institutions can ensure that agriculture achieves personal economic benefits and benefits to society through greater concern for the state of the natural environment.

The research results indicate a significantly lower production potential of ANCs with particularly difficult conditions in areas without ANCs measured by the APAV index. At the same time, it was found that there is a much higher share of UAA HNVf and Natura 2000 areas.

Farms from communes with ANCs with particularly difficult conditions, as compared to farms from communes without ANCs, there was lower income per 1 ha of UAA also a significantly higher share of operating subsidies in income, including those received under the AECM and organic farming measure. This situation is not surprising because a real chance for these farms to continue and develop is participation in these measures, because especially in these areas, they can support uncertain agricultural income related to difficult conditions for agricultural production.

Based on the logistic regression model, it was found that in the communes with ANCs with particularly difficult conditions, older farmers and those with a higher level of education were more likely to implement the AECM and/or organic farming measure. The increase in the share of ANCs and permanent grasslands, forests, and waters in each community, the presence of other farms involved in their implementation in the immediate vicinity, and a greater share of people living in rural areas in a given community also turned out to be a contributing factor. Larger UAAs on farms were also significant. On the other hand, less willingness to implement the AECM and organic farming measures was shown by farms obtaining higher income adjusted for subsidies per 1 ha of UAA.

It should be noted that maintaining agricultural production in ANCs with particularly difficult conditions and their rational and multifunctional development remains one of Poland's priorities under the EU CAP 2023–2027.

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