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In search of factors determining the participation of farmers in agri-environmental schemes – Does only money matter in Poland?

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ABSTRACT

The growing awareness of the negative impact of agriculture on the natural environment creates social expectation towards the reduction of this impact through the pro-environmental activities of farmers. Agri-environmental programmes are one of the key instruments of EU agricultural policy aimed at encouraging farmers to do so. Due to their voluntary nature and involvement of farmers in these activities, there has been a scientific discussion for a long time on the factors determining the participation of farmers in these programmes. Numerous analyses carried out mainly for agriculture of Western European countries, do not give unequivocal answers on the factors which influence the involvement of farmers in agri-environmental measures, which additionally might be different for Central-Eastern Europe. This is a significant problem for policymakers deciding on the distribution of financial support. Our analysis of 594 commercial farms, a subsample of the Polish FADN (Farm Accountancy Data Network), uses both FADN data and the outcomes of interviews with farmers. Results show that farmers who see a clear economic interest for their farm, most often participate in AES (Agri-environmental Schemes). Risk aversion turned out also to be an important determinant but is rarely analysed in the literature. On the other hand, factors related to the attitudes of farmers towards the environment have a small impact (if any) on participation. This is important information for policymakers, as it indicates the educational needs in terms of farmers' understanding of the relationship between farming and the environment, and also indicates that moving away from the model of incentives based on financial incentives would probably involve a reduction in the scale of agri-environmental measures by farmers.

1. Introduction

One of the key challenges facing modern agriculture is a stronger involvement of this sector in efforts to reduce climate change and reduce the negative impact of agricultural production on the natural environment, with a simultaneously growing demand for food (FAO, 2019, 2009; European Communities, 2008). The negative impact of agriculture on the environment is revealed in many processes including impacts on climate change through greenhouse gas emissions, water pollution, air pollution, soil degradation as well as reducing biodiversity (Tanentzap et al., 2015; Pingali, 2017; OECD, 2004; Maia et al., 2018). Limiting these processes requires strengthening farmers' motivation to implement environmental practices (van Herzele et al., 2013; Beedell and Rehman, 1999; Menozzi et al., 2015; Tanentzap et al., 2015). Agricultural policy plays a key role in shaping the pro-environmental behaviour of farmers, which includes such basic mechanisms as regulations (e.g. limits on pesticide use), and economic instruments which pay farmers directly for adopting environmentally friendly practices (Tanentzap et al., 2015).

The basic group of instruments (in addition to the obligation to comply with specific environmental regulations) which is used in the European Union (EU) under the Common Agricultural Policy (CAP) are economic incentive measures in the form of voluntary commitments of farmers referred to as Agri-environmental Schemes (AES[1]) or its current

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[1] Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) (article 39)

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successor Agri-Environment Climate Scheme AECS[2] (which emphasizes their role in activities for climate protection). Agri-environment schemes (AES) were introduced by the European Community in 1985 (European Communities, 1985), as an optional instrument for Member States (European Commission, 2005), but since 1992 AES were introduced as obligatory for all EU countries, as a part of CAP (Council Regulation (EEC), 1992). It is worth emphasizing that the European approach to the issue of nature protection in rural areas assumed that agriculture, properly targeted and managed, may be beneficial for the environment, which translates into a desire to implement within the framework of the AES, actions motivating farmers to generate environmental public goods (Baylis et al., 2008; Claassen et al., 2014; Kucharska, 2010; Batáry et al., 2015; Cullen et al., 2018). Participation in CAP agri-environmental schemes is therefore voluntary for farmers, but each Member State must develop and implement a national agri-environmental programme. To support the long-term sustainability of both nature and farming, the European Commission developed and published in 2020, the new Biodiversity Strategy for 2030 (European Commission, 2020a), which will work with the new EU Farm to Fork Strategy (European Commission, 2020b) and the new Common Agricultural Policy (CAP). The strategy promotes implementation of agri-environemtal and result-based payment schemes, and plans to monitor their operation and absorption by farmers.

A systematic approach to this issue, therefore, requires recognition of the motives and factors encouraging farmers to participate in AES, which is particularly important in the context of voluntary participation in most of these programmes (Batáry et al., 2015; Dessart et al., 2019). The willingness of farmers to participate in such programmes is a necessary condition, although of course, it does not guarantee success in achieving the assumed environmental goals. Attempts to identify such factors have already been made in many countries, as evidenced by the large number of publications analysing the determinants of participation in AES which have appeared in recent years (Lastra-Bravo et al., 2015; Mozzato et al., 2018; Defrancesco et al., 2008; Uthes and Matzdorf 2013; Brown et al., 2019; Mills et al., 2013; Zimmermann and Britz, 2016; Raggi et al., 2015). However, research results from various countries remain ambiguous, which indicates that many conditions are local and require more detailed recognition in different geographical contexts (Mozzato et al., 2018; Krom, 2017; Dessart et al., 2019), in particular if context-specific measures are considered (Brown et al., 2019). As emphasized by Lastra-Bravo et al. (2015) studies on the determinants of farmers' participation in AES are still needed to provide support for policymakers in designing agricultural and rural policy. As Lastra-Bravo et al. (2015) also underline, it is important to realise that other policies with an impact on the farm, household and rural community can also influence farmers' participation in AES. That shouldn't be ignored when future agricultural and rural development policy is discussed – particularly in the context of climate policy.

A systematic review of the literature on the subject indicates that most of the analyses concerning the motives and factors determining the participation of farmers in AES were carried out mainly for Western European countries (Uthes and Matzdorf, 2013; Mozzato et al., 2018, Brown et al., 2019) . The review conducted by Uthes and Matzdorf (2013) shows that from over 400 papers on AES, more than half were for the UK, Ireland and Germany, while only a dozen or so papers focused on analysing various aspects of AES in Central and Eastern European countries. Also in the Polish national literature, only a few short studies have dealt with some aspects of farmers' participation in AES (Sawicka et al., 2016; Syp and Gebka, 2018). Due to the fragmented agrarian structure, the characteristics of Polish agriculture differ significantly from those of agriculture in many Western European countries, and this also means that the conditions for farmers' pro-environmental decisions might be different. This is even more likely if one takes into account the diversity of the research carried out to date in other countries (Mozzato et al., 2018; Lastra-Bravo et al., 2015; Uthes and Matzdorf, 2013; Dessart et al., 2019). Therefore, to fill this gap in the literature concerning factors in CEE countries, we have made the first such extensive attempt to determine the factors determining the participation of Polish farmers in AES. The second contribution of our paper is that we innovatively performed the research using the Farm Accountancy Data Network (FADN) database (the approach based on FADN data was used by some authors, e.g. Zimmermann and Britz, 2016) enriched with additional variables obtained during in-depth interviews with a representative sample of farmers (a subsample of the FADN database). This allowed us to include in the research both production and economic characteristics of farms derived from FADN, as well as behavioural aspects and environmental perceptions of farmers which are rarely analysed in the literature. Thirdly, to the set of variables most frequently used by various authors we have added measures characterizing the risk level and risk aversion of farmers, determined using the Arrow-Pratt ratio. We assumed the hypothesis that the attitude to risk is one of the determinants of farmers' propensity to participate in AES. This aspect has so far been rarely included in research on participation in AES, although the few studies available indicate that AES may be treated by farmers as a risk management tool (Vollenweider et al., 2011), as the AES payment is an almost risk-free revenue.

The theoretical starting point of our analysis was the fundamental assumption of the utility theory (Fishburn, 1968) according to which, by making a decision, the farmer maximizes personal utility taking into account existing possibilities and limitations. Therefore, the main goal of our research was to identify factors that differentiate farmers participating and not participating in AES, taking into account production and economic characteristics derived from the FADN database and adding behavioural aspects including, among others, risk level and risk aversion of farmers, obtained through the in-depth survey. To the best of our knowledge, this is the first such approach in the literature. Having in mind the limited number of AES studies in Central and Eastern European countries, we also tried to contribute to the existing literature by adding an explanation of farmers' pro-environmental decisions in Poland, the largest Eastern-European country in the EU.

The remainder of the paper is organized as follows. In Section 2, we provide the characteristics of agriculture and AES in Poland. Section 3 presents the theoretical framework and literature review on the main factors of farmers' participation in AES. Section 4 explains our methods and empirical strategy. In Section 5, we discuss the results and finally, Section 6 provides conclusions.

2. Agriculture and agri-environmental schemes in Poland

It seems realistic to accept the view that differences in participation in AES may result from geographical factors and regional differentiation (matching) of individual programmes (Mozzato et al., 2018; Pavlis et al., 2016; Brown et al., 2019). Analyses made by Pavlis et al. (2016) showed that geographical location differentiates not only the determinants of participation but also the degree of motivation to participate in AES. For example, their presented studies showed that respondents from peri-urban Northern European areas were more motivated to participate in AES than respondents from Central and Southern European areas with marginal potential for agriculture. Poland has one of the largest agricultural areas in the entire EU, accounting for 7.2 % of the land. Polish farmers constitute 18.9 % of all farmers in the EU. This makes the importance of positive and negative environmental activities taken by farmers important from both a regional and pan-European point of view.

[2] Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005 [2013] (article 28).

2.1. Short description of Polish agriculture

Rural areas in Poland cover 93 % of the country's territory. The total area of agricultural land in 2018 was about 14.7 mln hectares (GUS, 2020), which placed Poland in 5th place in the European Union for agricultural land area. The share of people employed in agriculture is rather high compared with the western EU and in 2018, was estimated to be 10.2 % (GUS, 2020). The share of the agricultural sector in Gross Value Added amounted to 2.6 % in 2018. The vast majority of Polish farms are family farms and unlike many other post-socialist countries, they did not undergo strong collectivization processes. The effect of the historical past is a fragmented agrarian structure. Polish agriculture is characterized by a large number of farms but slowly, over time, the farm structure is improving. According to national statistics in 2018, there were 1.4 million farms, of which 52.2 % were below 5 ha. The majority of the smallest farms (below 5 ha), as well as some farms from the 5−10 ha cluster, can be characterized as subsistence or semi-subsistence farms. Their contribution to the market of agricultural produce is insignificant and non-agricultural sources provide the greatest part of the personal incomes of their owners. At the other end of the spectrum, the number of larger farms is growing. Agricultural land is moving mainly to the cluster of largest farms (50 ha and more), while the area occupied by smaller farms is decreasing.

2.2. AES in Poland

Agri-environmental programmes were introduced in Poland with its accession to the EU. So far, three further programmes covering the periods 2004–2006, 2007−2013 and 2014−2020, have been implemented in Poland. Although the detailed solutions were slightly different and modified in all three programmes, their overall objectives and overarching packages of activities were similar. They included supporting environmentally-friendly agricultural production systems (organic and sustainable agriculture), protecting endangered bird species and habitats; increasing the share of buffer land in the agricultural landscape (soil and water protection, buffer zones), preserving endangered plant and animal genetic resources in agriculture. In the latest programme, for 2014−2020, the territorial orientation of measures was strengthened, including the special needs of Natura 2000 areas (including special bird protection areas), national parks, areas exposed to nitrates from agricultural sources (nitrate vulnerable zones), areas exposed to erosion and low humus soil areas. The requirements have been modified to focus activities more closely on identified needs and environmental pressures.

As pointed out by some authors (Raggi et al., 2015), the criteria for access to agri-environment schemes, which is different in different countries, might be an important factor influencing farmers' access to AES, and sometimes even strongly limiting the possibility of farms' participation in the programme. In Poland, the criteria for access to agri-environmental programmes were very broad and didn't limit farmers' access to these programmes. Agri-environmental packages were implemented throughout the country. A farmer received support if at least during the commitment period (usually 5 years), the farmer used to be the owner of agricultural land with an area of at least 1 ha (3 ha in the case of the sustainable agriculture package). However, what could be important from the perspective of factors influencing the participation of farmers in AES is the fact that part of the measures within the AES packages concerns activities on permanent grasslands (meadows and pastures), or the obligation to maintain them. For example, packages "Protecting endangered bird species and habitats" and "extensive grasslands" involved together almost 70 % of farms participating in AES and covered 45.4 % of AES areas (compare Table 1). This could obviously reduce the access of farms that did not have grassland area in the land structure, and therefore were not eligible for this group of payments, *per se*.

AES in Poland (as in the whole EU) are mainly input (activity) based. It means that farmers receive subsidies not for the achievement of environmental goals, but only for input (effort) in the form of implementation of activities beneficial for the environment. The largest funds (56 %) in 2007−2020 were allocated to several activities implemented as part of the "Protecting endangered bird species and habitats" package (Table 1). These actions covered a total of 42 % supported areas. Significant funds were also allocated to implementation of the "sustainable agriculture" package, which concerned 56 % of the area covered by the programmes.

It is worth adding that according to Eurostat (2017) data, the share of area under agri-environmental commitments in Poland in 2013 was around 19 %, while in the EU it was around 26 %. Given that Poland is one of the largest countries in terms of UAA (utilized agricultural area[3]) in the EU, its impact on the quality of the agricultural environment should be considered significant. According to the estimates presented in the study by Zimmermann and Britz (2016), Poland also belongs to countries with a relatively low average level of payments per 1 ha (below EUR 100 while in some countries the average level of this payment exceeds EUR 300), which may mean that economic incentives are an important reason for farmers to participate in AES. If we consider that the assumed goal of agricultural policy is to further promote participation in the AECS (European Commission, 2020a), this situation indicates the need to look for better ways to encourage farmers. In the current literature, only a few short studies have dealt with some aspects of farmers' participation in AES. The factors which are mentioned i.e farm andfarmer characteristics and job satisfaction (Syp and Gebka, 2018), bureaucracy burden, economic incentives (Sawicka et al., 2016), do not explain this complex phenomenon. Therefore, improving the recognition of characteristics of farmers participating and not participating in AES is crucial for targeting these programmes.

3. Theoretical background and literature review

3.1. Utility theory approach

Searching for variables explaining farmers' participation decisions requires recognizing the various spheres of farmers' activity that may have an impact on the decisions made. Decision-making mechanisms have long been considered by economists and psychologists. Typically, the theoretical basis for considering the farmers' decision-making mechanism is random utility theory or theory of planned behaviour (TPB) (Borges et al., 2014, 2019). TPB (Ajzen, 1991) is a socio-psychological theory appropriate to analyse farmers' intentions which are determined by a psychological constructs consisting of attitude, subjective norm and perceived behavioural control. Since we focused on explaining how observable socioeconomic characteristics influence farmers' real decisions (not intentions), we based our study on the random utility approach. This approach is an extension of general utility theory which "is a theory postulated in economics to explain the behaviour of individuals based on the premise that people can consistently rank order their choices depending upon their preferences" (Prakash, 2009, p. 96). Utility theory is used to explain choices made by decision-makers in a situation where two or more options can be compared. Utility theory is based on the "ordinal" approach which ranks order choices (Prakash, 2009) and is used for explaining consumer choices under certainty. Producers' choices are usually made under uncertainty, thus random utility framework seems to be a more suitable theoretical basis for analysing farmers' decisions about participation in AES. This approach aims at modelling the choices of individuals among discrete sets of alternatives and assumes that the available alternatives

[3] Utilised agricultural area, abbreviated as UAA, is the total area taken up by arable land, permanent grassland, permanent crops and kitchen gardens used by the holding, regardless of the type of tenure or whether it is used as a part of common land. (Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Utilised_agricultural_area_(UAA))

Table 1
The realisation of agri-environmental schemes in Poland 2007-2020.

	AES Commitments 2007−2013			AECS Commitments 2014−2020			Total Commitments 2007−2020		
Package	Number of benef. farms	Area under support (ha)	Value* (EUR)	Number of benef. farms	Area under support (ha)	Value* (EUR)	Number of benef. farms	Area under support (ha)	Value* (EUR)
Sustainable agriculture	19 515	551 770	101 964 679	7 324	331 652	68 056 251	24 731	883 422	170 020 930
Soil and water protection	22 354	244 541	46 688 413	9 749	118 677	25 948 738	27 724	316 537	72 647 410
Orchard preservation of traditional varieties of fruit trees	–	–	–	710	516	556 014	710	516	556 014
Protecting endangered bird species and habitats	25 021	239 436	169 761 860	42 789	469 843	228 156 144	55 749	659 144	397 918 003
Preserving endangered plant and animal genetic resources in agriculture	4 581	40 241	26 954 951	5 683	11 140	28 221 521	9 237	50 732	55 176 472
Extensive grasslands	8 551	45 436	11 537 080	–	–	–	8 551	45 436	11 537 080
Preserving buffer zones	21	13	35 298	–	–	–	21	13	35 298
Total	57 140	1 058 260	356 942 280	56 784	929 064	350 938 668	93 245	1 552 292	707 891 208

Source: data of Agency of Restructuring and Modernization of Agriculture.
* 4.3 Euro/PLN exchange rate used to recalculate the value of commitments.

can be described by a utility function (Horowitz et al., 1994). Similarly to general utility theory, the random utility framework assumes that individuals prefer the alternative with the highest utility. "The utility of an alternative depends on attributes of the alternative and individual that are observable (e.g. age of an individual) and attributes that are not observable (Horowitz et al., 1994). Observed attributes are represented in the utility function by explanatory variables, unobserved ones are represented as random variables". Thus, utility function can be expressed by the formula (Horowitz et al., 1994):

$$U_j = \beta' X_j + \varepsilon_j,$$

where Xj is a vector of observed attributes of alternative j, β is a conformable vector of constant parameters and ε is a random variable that accounts for the effects on preferences of unobserved attributes of the alternative. In the context of the research problem undertaken, it can be assumed that farmers participate in AES if the utility from participation exceeds the utility from not participating (Borges et al., 2019).

Utility maximization framework leads to discrete-choice models that are used to analyse farmers' behaviours (Defrancesco et al., 2008). From the formal point of view the farmers' decision whether to join an AES or not may be expressed by the binary variable Y_i which represents the possible choices that can be expressed in the general formula (Zimmermann and Britz, 2016):

$$y_i = \left\{ \begin{matrix} 1 \\ 0 \end{matrix} \right\} \text{if} Y_i^* = x_i\beta + \varepsilon_i \left\{ \begin{matrix} > \\ < \end{matrix} \right\} 0,$$

with the parameters β to be estimated, the explanatory variables x_i and the error term εi with E(εi) = 0. Yi* represents an unobservable latent variable, and assuming that farmer *i* receives a utility U_{ij} when alternative $j(= 0 \text{ or } 1)$ is chosen and further assuming utility-maximizing behaviour, farmer *i* chooses an alternative $Y_i = 1$, if $U_{i1} > U_{i0}$.

Empirical research referring to the utility theory or random utility theory is aimed at identifying the parameters of farm and farmer characteristics that stimulate making specific decisions. An extensive literature review by Borges et al. (2019) indicates that empirical respondents referring to utility maximization usually include groups of variables such as farmer characteristics (age, off-farm work, education, experience, gender, risk-aversion); farm characteristics (diversification, labour, soil type, farm size, land tenure, farm income etc.), household (family labour, family size, off-farm income, assets etc.), farming context (region, participation in different environmental programmes, distance from farm to market, credits, erosion etc.), information/learning (attendance at training sessions, farmers' perceptions, memberships in a different group, etc.). The methodological basis for such studies is usually a probit, logit or Tobit model (Borges et al., 2019).

3.2. Main research directions on AES

Research on AES focuses on several threads. Analysis of more than 400 studies on the AES published during the period 1994–2012, carried out by Uthes and Matzdorf (2013) showed that these studies cover such thematic areas as:

- analysis of the ecological effects of AES based on field experiments, monitoring data or farm survey;
- the analysis focused on the identification of factors that influence farmer decisions to take up AES and seeks to characterize them according to different types of attitudes;
- analysis of individual schemes in different countries or evaluation of these schemes to highlight national or regional differences;
- analyses addressing various economic aspects related to AES;
- analyses of the place and role of AES in the wider context of the whole CAP.

In recent years increasingly more analyses are being published in the context of result-oriented measures (Russi et al., 2016; European Commission, 2017, 2019a, 2019b), as well as the importance of AES in the battle against climate change (Munday et al., 2018). An important issue, especially because of the huge public spending, is the question about the effectiveness of AES (Batáry et al., 2015). A review of various studies done by Kleijn and Sutherland (2003) indicated that in about half of the cases no positive impact on biodiversity was noted, hence this problem is raised in many studies. At this point, it is worth paying attention to the question posed by many researchers about the efficiency of spending of public funds (Kuhfuss et al., 2016). This is especially so if one takes into account the fact that numerous analyses indicate that the main factor encouraging farmers to participate in AES is financial incentives rather than environmental concerns (Vollenweider et al., 2011). Research on AES also appears in the context of the issue of "intensity" - the majority of research being related to areas of highly intensive agriculture, while relatively little has concerned the effectiveness of AES in areas with extensive production (Kampmann et al., 2012), although the analysis by Zimmermann and Britz (2016) shows that participation in AES is more likely for less intensive farms.

3.3. Motivations behind the search for factors determining farmers' participation in AES - how to motivate farmers?

Insufficient participation of farmers and low level of the enrolled area in AES measures have been indicated many times as disappointing outcomes of AES in Europe (Kuhfuss et al., 2016). One of the key reasons for implementing AES under CAP is to motivate farmers to introduce solutions beneficial to the environment on farms. The positive impact of a farmer's motivation to reach the environmental goals has been underlined many times (Matzdorf and Lorenz, 2010)). Although the impact of AES on farmers' motivations does not appear to be questionable, the answer to the question about the impact of AES on a better understanding of the environmental objectives remains ambiguous (Matzdorf and Lorenz, 2010). There is also no unequivocal answer as to whether the pro-environmental attitudes of farmers participating in AES are the result of this participation, or whether a greater propensity to participate in AES results from greater environmental sensitivity before joining the programme. The analysis of Matzdorf and Lorenz (2010) shows that many farmers participating in agri-environmental programmes, already before the decision to take a part in the programme, were characterized by positive attitudes towards nature conservation. At the same time, the share of people with positive views about nature conservation increased due to participation in AES. Some authors emphasize that evoking motivation to implement pro-environmental measures does not guarantee the durability of changes in the attitude of farmers towards the environment unless it is associated with raising the ecological awareness of farmers (Brodzińska, 2012). A similar opinion is presented by Inman et al. (2018). On the basis of a comprehensive review of various studies, Siebert et al. (2006) concluded that the conditions for farmers' participation in agri-environmental measures are very complex and should be considered dynamically, taking into account interactions between different factors.

Undoubtedly, another important element encouraging farmers to participate in AES is utilitarian motives related to obtaining funds or easy adjustment of the farm to the programme requirements (Defrancesco et al., 2008; Sutherland, 2010; Kuhfuss et al., 2016). However, financial incentives are not the only factor prompting participation in AES. This means that it is impossible to create an effective agri-environmental policy based only on financial incentives. A sense of farmer's responsibility is also important. But unfortunately, European solutions are mainly based on financial incentives (Siebert et al., 2006).

The importance of social factors is often emphasized in this context (Burton et al., 2008). Matzdorf and Lorenz (2010) indicate that, in addition to financial incentives, result-oriented AES could provide social incentives to improve the intrinsic motivation of farmers. In their case, e.g. farmers are proud to produce colourful, species-rich meadows, which people enjoy looking at. In this context, it is worth adding that Schroeder et al. (2015) observed that the premise motivating pro-environmental activities of farmers may also be social pressure and the influence of agricultural advisors. As emphasized by Matzdorf and Lorenz (2010), result-oriented environmental incentives have the potential to communicate the farmer's environmental services to society, and in doing so they could contribute to an improved legitimacy for financial supports for AES (Matzdorf and Lorenz, 2010). However the assumption about the willingness of the European public to pay for agri-environmental public goods which are to be generated as a result of implementing AES is disputed (Krom, 2017).

According to Burton et al. (Burton and Paragahawewa, 2011; Burton et al., 2008), the key to understanding farmers' attitudes towards the environment is the so-called "cultural capital". According to the theory presented by Bourdieu (1986), "cultural capital" includes knowledge resources, skills and dispositions and the possession of culturally relevant objects. The thesis on complex socio-cultural conditions, in particular, those related to building social capital (bonding social capital and bridging social capital) is supported by the results of research by Krom et al. (2017) who observed that "farmers' socio-cultural preference for landscape symbols of high agricultural productivity (including 'tidy' land) inhibited farmers' propensity to take environmental action that results in less agriculturally productive and more 'messy' landscapes". It can, therefore, be assumed that the elements constituting "cultural capital" also determine the farmers' propensity to participate in AES. This justifies the search for factors in this area. Hansson et al. (2019) also indicated the need to consider behavioural factors such as attitudes, perceptions, motivation, values, and self--identity in understanding farmers' adaption of ecological approaches. These authors emphasize that farmers' decisions regarding pro-environmental solutions are not only dependent on profitability, but on a whole set of related elements, among which economic factors are only one. Similarly, the importance of behavioural factors is indicated by the extensive literature review provided by Dessart et al. (2019).

A definite obstacle in generating pro-environmental attitudes among farmers through the proposed AES is antagonism, resulting from the fact that in many cases AES tends to limit agricultural production. This observation strengthens the contradiction between economic goals (agricultural production) and environmental goals, and limits the positive impact of these instruments in creating pro-environmental farmers' attitudes towards the environment (Krom, 2017; Burton and Paragahawewa, 2011; Siebert et al., 2006). Farmers receiving financial support may see it mainly as a form of compensation for lost income (and not as a payment for generating public environmental goods), which in the absence of continuation of financial support (especially in the absence of awareness of the relationship between agricultural production and the environment) will lead to a return to previously used practices (effects would therefore be temporary).

Defrancesco et al. (2018) showed that the decision to continue participation in the programme after the end of the 5-year contract is correlated with factors such as a larger farm size, a younger farmer as well as the farm succession perspective and the farmer's positive attitude toward the environment. Thus, identifying factors affecting participation in AES is therefore also important for continuing pro-environmental activities after the programme (or at least joining its next edition).

3.4. Factors determining the participation of farmers in AES in the light of selected studies

On the basis of an extensive literature review, Lastra-Bravo et al. (2015) concluded that the main factors influencing farmers' willingness to participate in AES can be classified into such categories as financial incentives, the fit between the scheme's prescription and farming system, the farmer's characteristics, attitudes and preferences, the underlining financial, geographical and regulatory context, and farm characteristics. This comparison shows that there is no clear distinction in the literature on the subject between motives for farmers to participate in AES (e.g. financial incentives), and factors only correlating with participation (e.g. farm characteristics). This corresponds with the division of factors related to farmers' willingness to adopt pro-environmental attitudes presented by Mills et al. (2013), who indicated that in general these factors can be divided into 2 groups, i.e. factors related to the farmers' awareness (such as personal interests in environmental issues, philosophy, perception of agriculture, a sense of social responsibility and belief in the effectiveness of implemented activities), and factors affecting the practical ability to adapt pro-farming behaviour (related to elements of the farm characteristics such as its size (physical, economic), production type, ecological infrastructure, finance, participation for rent, elements of the farmer and household characteristics, knowledge of nature and access to advice).

In turn, Knowler and Bradshaw (2007) classified the factors found in the literature into four categories such as "farmer and farmers' household characteristics", "farm biophysical characteristics", "farm financial/management characteristics" and "exogenous factors". On the other hand, Mozzato et al. (2018) identified groups of factors such as "farm

factors" covering structural characteristics and management and economic features, "farmer factors" covering socio-demographic characteristics and farmers' attitudes and motivation, "informational factors", "social factors", "value-chain factors" and "spatial factors".

The literature analyses carried out by Brown et al. (2019) identified seven groups of factors important regarding farmers' participation in AES, such as structural factors, financial factors, policy design, socio-demographic, value-based, ecological, political. The list prepared by the cited authors shows that most often in scientific works reference has been made so far to structural factors, and less often to "political factors".

4. Concept, methods and empirical strategy of the study

4.1. Conceptual framework

Based on the literature the conceptual framework presenting a hypothetical affecting farmers' involvement in AES was designed (Fig. 1). The main assumption was that in general farmers' participation depends on their abilities and willingness to adopt AES (Mills et al., 2013). We assumed that a farmer may want to apply for AES but does not meet certain criteria (farm size, farm type, knowledge, education, training, successor etc.), or vice versa – used to have the opportunity to participate but does not do so for subjective/behavioural reasons.

Jointly it was assumed that the ability of AES adoption depends on certain farm characteristics (ability), and farmers' willingness to adopt AES, which in line with the random utility theory is determined by expected farmers' utility from undertaking additional commitments. Farmers' expected utility is determined by several groups of factors, though we assumed that the final decision depends on farmers' characteristics (socio-demographic and behavioural factors) and economic factors described by the results of past activities and expected outcome of future actions (e.g. payments from AES). Researching under this assumption requires the use of information on farm characteristics and data on farmers' characteristics and their attitudes/motivations. Thus two data sources were used in our analysis. The first was FADN data, which could deliver information on farm resources, production structure and economic results for each farm in the sample. Moreover having historical accountancy data for observed farms makes it possible to assess farmers' attitudes (e.g. risk aversion coefficient (Antle, 1987). However such a dataset seems to be incomplete in the case of analysing farmers' system of beliefs (e.g. willingness to protect the environment). For this reason, we identified a need to supplement the FADN dataset with data acquired directly from a representative sample of farmers.

4.2. Data sources and modelling approach

In the analysis, we used a popular approach involving the use of econometric discrete choice models. This approach has been used many times based on probit, Tobit or logistic regression models. So far, however, no such analyses are known for Polish agriculture (except a few analyses based on several regions or the entire EU, e.g. Zimmermann and Britz, 2016). The logistic regression model was used to determine the impact of the analysed factors on the farmers' accession to AES. The dependent variable explained in the model was the farmer's declared participation in the agri-environmental scheme (AES).

An innovative approach, previously not used to solve similar problems, was the use as explanatory variables of accounting data collected in the FADN database, associated with data from interviews with farmers. As a result, the accounting information from the FADN database was supplemented with data on farmers' attitudes, their beliefs and practices used in farm management collected in the survey. To assess the usefulness of additional information representing mainly behavioural aspects of farmers' participation in AES, the results of model analyses were presented in two variants, i.e. the model based solely on FADN data and the model extended by additional variables obtained in interviews with farmers.

The Polish FADN database consists of approximately 12,100 farms which represent 749.6 thousands commercial farms, which are only a part of the sector (less than 54 % of all farms), but at the same time provide over 94.6 % of production to the market (FADN 2016). Their activities and production practices are therefore crucial for the impact of agriculture on the environment. In the group covered by the farm survey, 41 % of farms participated in any agri-environmental programme in the five years preceding the survey. The farms represented by Polish FADN constitute over 14 % of the farms represented by FADN in the EU.

From this sample, 594 farms were drawn, using the Neyman optimal allocation scheme to maintain the representativeness of the sub-sample. In these selected farms in 2017, agricultural advisors dealing with FADN data, conducted interviews with farmers. During interviews, farmers were asked questions about: their opinion on the impact of agriculture on the environment; the state of the environment at their place of residence; the method of obtaining information needed to run a farm; specific local conditions (erosion threats, distance to urban centres); the impact of environmental restrictions (eg. "Greening" of the CAP) on their way of farming; the importance of public goods generated by agriculture; the level and management of CAP support for agriculture (including support for the creation of public goods by the farming sector); the economic situation of the farmer.

The collected data were supplemented with accounting data for the surveyed farms from the FADN database. In the analysis, both the FADN from 2017 and some historical data were used. Data from the FADN database covered information on land resources and the way they are used (total area, agricultural land area, permanent grassland area, area of rented land), location of farms in LFA (less-favoured areas[4]), resources and outlays of own and contract work, the volume of production generated, expenditure used, income level, of farming and economic size of farm.

Based on the data acquired from the FADN database for 2017, several indices were estimated e.g.: production profitability per 1 ha of UAA and own labour inputs, the level of farming the land with production factors, the structure of an agricultural area.

Using the historical data for farms from the FADN sample, the following indicators were estimated:

level of risk aversion of farmers (Arrow-Pratt and Down Side risk aversion coefficients (Antle, 1987); income variability and gross margin (coefficient of variation), dynamics of production scale, production and organization intensity, land productivity.

The method used required an additional description for the calculation of the Arrow-Pratt absolute risk aversion coefficient. The values of this coefficient were calculated based on farmers' production decisions, recorded in the FADN database. A stepwise procedure was used which starts with the construction of a model explaining revenue by levels of inputs (e.g., fertilizers, seeds, pesticides, labour), and then an estimation of two other models: one explaining the influence of the considered variables on the square, and another on the cube of residuals from the revenue model. The next step was calculation of the marginal impact of each input on the conditional moments of profit followed by estimation of the FOC (first-order conditions) equation system using computed marginal impacts for all considered inputs. For this purpose, the seemingly unrelated regressions (SUR) model was applied. Estimation of the FOC equation system was carried out separately for each farmer. The exact description and derivation of the procedure are elaborated in the original work of Antle (1987), while a specific application to the estimation of Polish farmers' risk attitude is described by Kobus and Was (2017). Due to cyclical adjustments in the FADN farm selection plan, data from the last 3 years (2015–2017) were used. The use of data from a

[4] Council Regulation (EEC), 1999 of 17 May 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations (article 17).

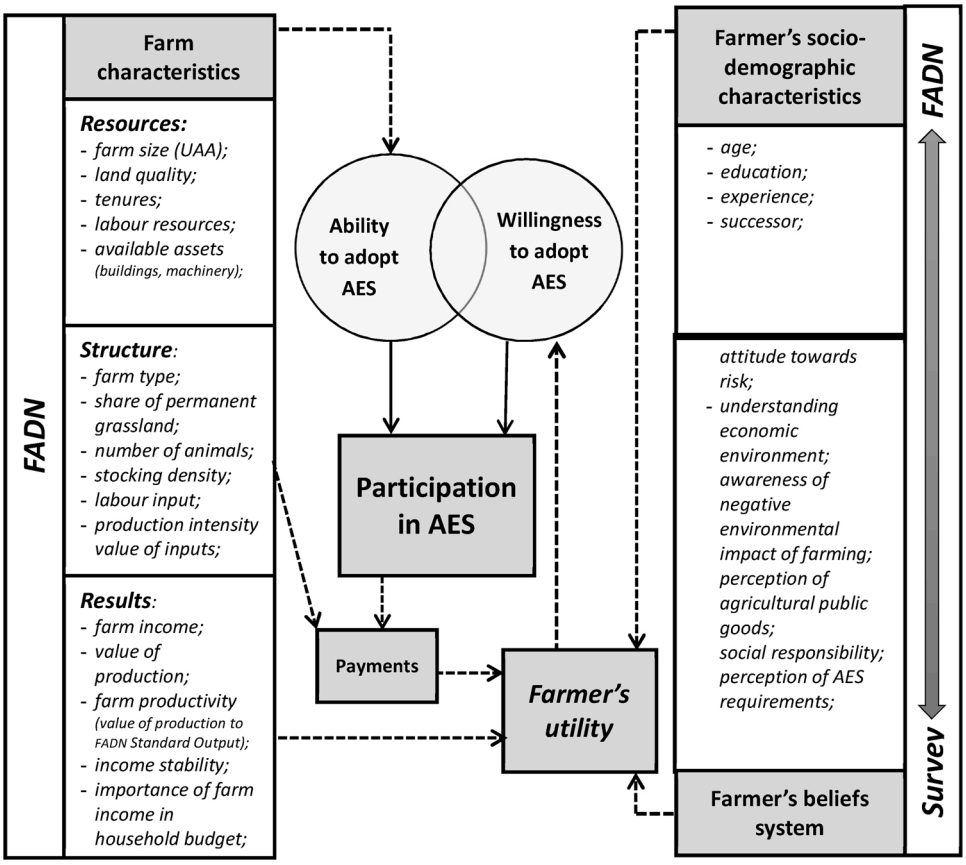

Fig. 1. Conceptual framework of AES adoption.

longer period would cause a drastic reduction in the number of farms in the sample. Finally, data from 594 farms were included.

The first part of the dataset, taken directly or calculated based on FADN, consisted of 34 variables. Those variables were used to estimate the "FADN" model based solely on FADN data. To see what explanatory value adding behavioural aspects to the analysis had, the accounting data were supplemented by data acquired in the farm survey, which consisted of an additional 38 variables. The total dataset of 594 farms and 72 variables was used to estimate the final model "FADN + SURVEY". A list of variables used to estimate the final model with basic descriptive statistics is provided in the Appendix A.

Stepwise logistic regression was used. In the first stage, the optimal model was estimated using the Akaike information criterion (AIC) (Akaike, 1974). The optimal model, with the lowest value of the AIC, was then supplemented with variables that, based on literature review and substantive analysis, were considered important for farmers' participation in AES. Finally in the model, based solely on FADN data, 18 variables were taken into account, while after complementing with behavioural variables "FADN + SURVEY" the model consisted of 27 explanatory variables. The goodness of models' fit was assessed using McFadden (1974) and McKelvey and Zavoina (1975) R squared measure. Additionally, estimated models were tested for their share of correctly estimated cases.

5. Results and discussion

The literature review presented in section 3 shows that the participation of farmers in AES could be determined by many different factors, both in terms of farm characteristics and behavioural factors (Siebert et al., 2006; Lastra-Bravo et al., 2015; Hansson et al., 2019; Dessart et al., 2019; Brown et al., 2019).

The list of estimated parameters for the variables finally included in the logit models is presented in Table 2. This table presents two models - the first "FADN"-based on solely FADN variables, the second one "FADN + SURVEY" is based on FADN data supplemented by data from the farm survey. The results of both models are convergent - almost all variables that were significant in the "FADN" model were also significant in the "FADN + SURVEY" model. In the extended version of the model with behavioural variables derived from interviews with farmers, several additional variables turned out to be significant, and the final degree of fit of the model measured by R^2 McFadden was slightly higher than in the case of a solution based solely on FADN. This indicates the legitimacy of including in the analysis both the characteristics of the farm as well as related behavioural factors indicating the attitudes and beliefs of farmers. In the following part of this study, we shall refer to the results of the extended model, indicating possible significant differences between these solutions. The sign next to the parameter indicates the direction of impact - positive signs (+) mean that a given variable increases the probability of a farmer's participation in AES, while variables with a negative sign (-) reduce the likelihood of participation in AES. For the factor variables, the impact is presented always concerning the reference level of variable e.g influence of farm type on participation in AES is presented in relation to the arable farms (TF1).

The results presented (Table 2) also include measures of the model fit. As indicators, McFadden and McKelvey Zavoina pseudo R^2 was used. Both indicators are commonly used for assessment of binary or logit regression models. Note that for the McFadden estimator, the values between 0.2–0.4 are recognized as an excellent fit of the model (McFadden, 1977), while McKelvey Zavoina is recognized as the best approximation of the "true R^2" in the OLS regression (Langer, 2016). Based on that, it might be concluded that variables selected for modelling explain nearly half of all determinants of farmers' participation in AES. Additionally, for both models, the number of correctly classified cases (using 0.5 probability as the cut-off) was estimated at the level of

Table 2
Results of the model estimations.

Variables		FADN		FADN + SURVEY	
		Estimate	p - value	Estimate	p – value
	Intercept	−4.53***	0.0001	−4.0920***	0.0006
	1. Utilised Agricultural Area (ha)	−0.0047	0.4873	−0.0055	0.4412
	2. Share of tenured land in total area (%)	−0.0459	0.9134	−0.0717	0.8681
	3. Location on LFA areas (yes)	0.0720	0.7314	0.0750	0.7290
Farm resources	4. Family members working on the farm (persons)	0.1998**	0.0311	0.1873*	0.0518
	5. Assets value without land (PLN)	−0.000001*	0.0983	−0.000001*	0.0825
	6. Assets value without land per ha of UAA (PLN/ha)	−0.000003	0.5590	−0.000003	0.5612
	7. Threat of erosion - farmers' opinion (1 if in farmers' opinion at least part of the plots is threatened by erosion)	survey[a]		0.2100	0.3024
	8. Farm type TF 2 – horticulture	−0.633	0.4870	−0.4462	0.6304
	TF 4 – permanent crops	−2.106*	0.0539	−2.1180*	0.0541
	TF 5 – dairy cattle	−0.9522*	0.0343	−1.0180*	0.0286
Farm structure	TF 6 – beef cattle	−0.3013	0.5285	−0.3286	0.5078
	TF 7 – pig and poultry	−0.2087	0.7039	−0.2664	0.6345
	TF 8 – mixed	0.2837	0.2874	0.2316	0.3954
	9. Number of animals (LU)	0.0051*	0.0956	0.0055*	0.0984
	10. Forage crop area (ha)	0.032**	0.0313	0.0383**	0.0120
	11. Farm Production/Standard production (PLN/PLN)	0.1293	0.6549	0.1959	0.5115
	12. Family Farm Income per UAA	−0.0001**	0.0288	−0.0001**	0.0351
Farm performance	13. Land productivity - 3 year dynamics (PLN/ha)	1.19**	0.0360	1.3600**	0.0211
	14. Total Subsidies excluding on investment	0.00001**	0.0235	0.0000**	0.0130
	15. Total Subsidies excl. on investment per prod. value	1.558***	0.0088	1.4120**	0.0200
	16. Share of Farm income in Total household income	survey		−1.0370**	0.0230
	17. Farmers age (years)	0.02243	0.0439	removed[b]	
	18. Managing farm (years)	survey		0.0332***	0.0056
Farmer -	19. Education (secondary)	0.3249	0.1210	0.2291	0.2831
demographic	(higher)	0.6636**	0.0331	0.4296	0.1963
	20. Successor (1 = no)	−0.3723	0.1911	−0.4179	0.1507
	(3=do not know)	0.3363	0.1818	0.3621	0.1519
	21. Arrow Pratt risk aversion coefficient (numeric)	0.3077*	0.0538	0.3246**	0.0468
	22. Quality of environment (0 = very bad condition; 6 = very good condition)	survey		0.1871*	0.0894
	23. Quality of surface waters (0 = very bad condition; 6 = very good condition)	survey		−0.1203	0.2116
Farmer beliefs	24. The usefulness of spoken communication to increase knowledge (frequency 0=never; 6=very often)	survey		0.0393	0.6294
system	25. Taking part in training in the last two years (1 = yes)	survey		−0.0940	0.6964
	26. Self-assessment of understanding economic environment (1−3) (2=medium)	survey		−0.3830*	0.0752
	(1−3) (3= poor)	survey		−0.5393*	0.0912
	27. Share of public good support in CAP budget (1/2/3) (2 - should be as it is)	survey		0.2113	0.5726
	(1/2/3) (3 - should be higher)	survey		0.3237	0.3843
	N (number of farms)	594		594	
	Mc Fadden pseudo R^2	0.1422		0.1647	
Model fit parameters	McKelvey Zavoina pseudo R^2	0.7066		0.6852	
	Share of correctly classified cases	68.35 %		68.5 %	
	AIC	743.27		745.09	

Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.
Source: own calculations based on Polish FADN and survey results.
[a] data from the survey – not included in "FADN only" model; [b]removed due to better performance of farmer experience (survey).

68 % and 67 % respectively. Having in mind, as indicated in the literature, that a decision on participating in AES depends on a complex set of factors, our results seems to be satisfactory.

5.1. Influence of farm characteristics on farmers' participation in AES

According to the conceptual framework presented earlier, it can be stated that the ability to adopt AES is determined by farm characteristic. As expected, the farm characteristic is described by the amount of available resources, farm structure and its performance.

5.1.1. Farm resources

One of the main indicators of farm size is the Utilized Agricultural Area (UAA). From the descriptive statistics of the sample presented in Appendix A, it can be seen that the most significant differences between the two groups of farms - participating and not participating in AES were found in the case of farm size. Farms participating in AES had a larger utilized agricultural area (46 ha for those farmers participating in AES vs. 33 ha for farmers not participating), a larger size of rented land (15 ha vs. 9.5 ha), and significantly larger forage area (9.1 ha vs. 5.8 ha), which indicates that they were larger farms but with a rather extensive organization. This preliminary observation is also supported by the lower relation of farm production to standard production value (measured by Standard Output[5] value per farm), lower assets value (without land) per ha of agricultural land, and lower family farm income per hectare.

In our model, however, the size of Utilized Agricultural Area had rather a marginal impact and was not statistically significant. The issue of the impact of farm size on participation in AES is not clear. For example in a summary prepared by Brown et al. (2019) four studies (two from England, one from Germany and one from Slovenia) found that

[5] SO - the standard output of an agricultural product (crop or livestock), is the AVERAGE monetary value of the agricultural output at farm-gate price, in euro per hectare or per head of livestock. There is a regional SO coefficient for each product, as an average value over a reference period (5 years). The sum of all the SO per hectare of crop and per head of livestock in a farm is a measure of its overall economic size, expressed in euro (EUROSTAT glossary https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Standard_output_(SO)).

farmers with larger farms were far more likely to participate in environmental schemes, while four others (from Finland, Austria, Spain and Switzerland) found that participation was more likely among smaller farmers. However, Gailhard and Bojnec (2015) suggest that the issue of the importance of farm size should be looked at in a broader context, as their research showed that differences in the level of participation in AES for small and large farms were also associated with other factors. Our results do not confirm the observations that larger farms find it easier to adopt less intensive practices and may, therefore, find it easier to participate in an AES (Lastra-Bravo et al., 2015; Pavlis et al., 2016).

In the context of the long-term perspective of the duration of the farm, it is also worth mentioning the potential impact of land tenure. This issue is important in the context of farmers' attitudes towards the need for soil protection because it can be expected that landowners who perceive the long-term need for soil use will behave differently from farmers temporarily managing the area. This factor was rarely included in the analysis of determinants of participation in AES. Our analysis shows, however, that the surface of the tenures had a negative impact, although it was statistically insignificant. This could be an effect of structural changes resulting in acquiring land by bigger more intensive (more productive) farms which are keen to use tenured land. However, the issue of land tenure turned out to be irrelevant in Capitanio et al., 2011 analyses.

Our analysis shows that the location of the farm in areas at risk of erosion is a factor that positively affects participation in AES, although it is not statistically significant. This can be interpreted as positive information because one of the goals of AES is to reduce the negative impact of agriculture on the environment. This is in line with the general observation of Brown et al., 2019, that farmers on marginal, low-yielding land are more likely to be scheme participants. In this context, it is worth mentioning the importance of environmentally friendly farming practices, the environmental sensitivity of farmers and the social factors that shape it (Mozzato et al., 2018; Hyland et al., 2015; Story and Forsyth, 2008; Inman et al., 2018).

One of the factors explaining the impact of AES participation of farmers is localization. In our sample, 53 % of farms were located in Less-favourite areas (LFA). This variable was finally not significant in the model, but the direction of relationship obtained in the final model confirms the results from the literature that farmers in areas with lower agricultural capacity are more likely to adopt the AES (Lastra-Bravo et al., 20155).

At the same time, a higher probability of participation in AES corresponds to a higher number of family members working on the farm, suggesting that larger farms in terms of labour resources are more interested in participating. This could be linked with motivation to effectively allocate redundant own labour resources and the possibility of sharing management decisions with other family members, which is important particularly for early adopters (Mozzato et al., 2018).

Higher capital resources represented by the value of assets without land decrease the probability of participation in AES. Extensification of production, which is usually necessary to participate in AES would lead to a decrease in the use of machinery and buildings. Farmers having exploited, less valuable equipment are keener to decrease the production and usage of the equipment. While having valuable, especially very specific assets, increases transaction costs of adjusting the farm to the AES requirements (Ducos and Dupraz, 2007).

5.1.2. Farm structure

Regarding the farm type, model results indicate generally a lower propensity to join AES in specialized farms while mixed farms are more likely to participate in AES. This could be explained by the intensity of production and higher value of equipment in specialized, labour-intensive types of farms, which pushes farmers to intensive exploitation of natural resources and usually more extensive practices in diversified mixed farms. This is confirmed by the positive relationship between the forage area and participation in AES and the positive relationship between production types characterized by lower production intensity (e.g. mixed). This observation pointing to a positive impact of forage areas is consistent with the results e.g. of Wilson and Hart (2000), who noted that extensive grassland farms (i.e. mixed farms) were more likely to adopt AES than arable farms. Of course, the forage area is related to the scale of animal production - consequently, a larger number of animals expressed in LU have a positive and significant impact on participation in AES. This confirms the conclusions that larger farms are more interested in AES, especially with a large number of animals. Other authors also pointed to the relationship between production type/specialization and participation in AES, stressing that farms with animals are usually more likely to participate in AES (Lastra-Bravo et al., 2015; Polman and Slangen, 2008). A review of various studies prepared by Mozzato et al., 2018shows that mixed farms are often predisposed to implementing environmentally-friendly practices, which is associated with the fact that such practices often imply a farm diversification (Meraner et al., 2015). The review of Mozzato et al., 2018 shows that later adoption of environmentally friendly practices is more common in more difficult or risky situations i.e. in specialized and smaller farms.

5.1.3. Farm performance

The above-mentioned factors suggest the importance of economic conditions in making decisions about participation in AES. It is interesting that the direction of the impact of income level per ha on farmers' participation in AES, according to our model, is negative (i.e. the higher the income per ha, the lower the probability to join AES). This suggests that farmers from farms with lower profitability are more likely to participate in the AES. This could mean that they have a lower opportunity cost of participating and that they can perceive AES as a way to improve their economic performance. Many authors also take into account economic parameters related to income. When assessing the importance of income, however, one should take into account the fact that they are to a large extent a consequence of the production potential resulting from the quality of land; hence there are no unequivocal results in the literature on this issue. Many analyses take into account not only farm income but also the share of farm income in total household income. Our analysis shows that the higher the share of farm income in the farmer's family budget, the lower the chance to participate in AES. Other authors also observed a similar direction of dependence (Defrancesco et al., 2008; Barreiro-Hurle et al., 2010; Mathijs, 2003). It can, therefore, be concluded that farmers who are not focused on success in commercial agricultural production are more interested in participating in the AES.

Negative relationship was observed between the variable reflecting the ratio of farm production to standard production, and participation in AES. This means that the more efficient the farms are in comparison with potential possibilities, the lower the chance of participating in AES. This leads to the conclusion that economically strong farms (high level of absolute production) with a rather extensive organization might be particularly interested in AES. This is confirmed by the dynamics of land productivity (significant variable) which increases the probability of participation. This could indicate that farms with low land productivity, which can be relatively easily increased, are more likely to join AES. This seems to be in line with the observation of Lastra-Bravo et al., 2015 that *"the schemes are seen as an additional source of income for the farm that helps to compensate for the lower productivity of the land and offset some of the risks associated with agricultural production"*.

The small impact of the physical size of the farm, described in the farm resources section, could be explained by the significant impact of the operational subsidies. In Poland, the payments are granted under SAPS (simple area payment scheme), which means that a significant part of the payments depends on the cultivated agricultural area. Note that the total amount of subsidies received by farmers for operating activity is particularly important. Our models show that as the level of subsidies received increases, the likelihood of participation in AES increases as

well, meaning that the farmer is more willing to decide on AES enrolment, the more he or she can absolutely (nominally) gain.

The likelihood of participation in AES is positively affected by the relationship between subsidies and production, which can be treated as a specific measure of intensity, since the amount of subsidies well reflects the size of the farm and the production value – production results. Thus, the low share of subsidies in production characterises small farms with large production (high intensity), while the large share of subsidies in relation to production indicates large farms with relatively small production (low intensity). It can, therefore, be assumed that the lower the intensity (the higher the ratio of subsidies to production), the greater the probability of participation of the farm in AES. The higher chance of participation of less intensive farms in AES has been repeatedly emphasized by other authors (Zimmermann and Britz, 2016; Lastra-Bravo et al., 2015; Peerlings and Polman, 2009). The observation about the impact of production intensity on participation in AES also corresponds with the observation about the role of the production type.

5.2. Influence of farmers' characteristics on participation in AES

While farm characteristics represent the ability to adopt AES, the farmer decision and his/her active participation could be described as a willingness to adopt AES. It is assumed, in line with the theory, that willingness depends on farmers' expected utility from participation. This is reflected in the model by farmers' socio-demographic characteristics and his/her beliefs system.

5.2.1. Socio-demographic characteristics

Demographic factors are a fairly common area of analysis of farmers' participation in AES. Our study shows that a higher level of education has a positive impact on participation in AES, although this variable was statistically significant only in the model using only FADN data. This observation confirms conclusions of other authors. Many analyses emphasize that the likelihood of participation in AES increases with higher levels of education (e.g. Mathijs, 2003; Barreiro-Hurle et al., 2010; Brown et al., 2019; Defrancesco et al., 2008; Capitanio et al., 2011) although this effect was not always significant (Polman and Slangen, 2008).

Farm management experience of the farmer, measured by the length of self-management of the farm, has a significant impact on participation in AES[6] .On the other hand, the negative impact of the declaration of having a successor on participation in AES is consistent with the results of previous studies (Lastra-Bravo et al., 2015). In the case of Polish farms, this can be explained by the fact that declarations confirming motivation to the succession of the farm are much more frequent in the case of intensive, large commercial farms, which seem to be an attractive workplace for young people. In the case of extensive, non-specialized farms, it is slightly more difficult to obtain a declaration of staying on the farm by potential successors, while extensive and non-specialized farms are more predestined to participate in AES. It can, therefore, be assumed that lack of the perceptible vision of economic development of the farm in the long term encourages farmers, especially older (more experienced) ones, to become more involved in AES. Other authors have also attempted to link farmers' propensity to participate in programmes with their perception of the future of the farm and observed significant relationships in this matter (Defrancesco et al., 2008). Synthetically, it can be concluded that farmers with longer experience are more likely to participate in AES.

[6] in the first model, instead of the "experience", the variable "farmer's age" from FADN was used, resulting in a worse fit of the model, which, in a methodological sense, indicates the usefulness of the data obtained later in the survey.

5.2.2. Farmers' beliefs system and other behavioural aspects

As mentioned earlier, a fairly rare practice in analysing factors determining participation in AES is to study the impact of production risk. Our analysis clearly shows that the higher the Arrow-Pratt's risk aversion ratio, the higher and very significant is the propensity to participate in AES. Thus, we empirically confirmed the assumptions of the expected utility theory in the context of the impact of AES on risk. This suggests that as part of agricultural policy, it is worth considering integrating agri-environmental measures with measures to improve risk management, which is particularly important in the context of mitigating climate change. In several analyses, the issue of risk has been addressed, but mainly in the context of farmers' attitudes towards innovation and "risk-oriented management", demonstrating the positive effect of such attitudes on the implementation of environmentally-friendly practices. The issue of risk was also analysed in the broader context of adopting sustainable measures, by Trujillo-Barrera et al. (2016). Payments under the AES, however, seem to change the conditions significantly in this area as they usually lead to extensive production (Wossink and van Wenum, 2003). A farmer joining AES gives up, following the theory of expected utility and a state-contingent approach (Hardaker, 2000; Quiggin and Chambers, 2006), part of the uncertain remuneration for production, and in return receives guaranteed (but often lower than the expected value from production) remuneration under AES. Therefore, by definition, farmers with higher levels of aversion and / or higher production volatility should be more willing to join the programme.

Our research also shows an interesting observation that farmers who positively assess the state of the environment have a higher propensity to participate in AES, which can be interpreted as a desire to protect natural resources. This observation is consistent with results of other authors' studies who indicated that positive attitudes towards the environment, or to the adoption of environmentally-friendly farming practices can be a significant determinant of farmers' willingness to participate in an AES (Lastra-Bravo et al., 2015, Defrancesco et al., 2008; Barreiro-Hurle et al., 2010). This is also indirectly confirmed (although not statistically significant) from assessing the degree of support for the generation of environmental public goods under the CAP. Farmers who rated this support too low were more likely to participate in AES, unlike farmers who thought that support for this goal was too high. The significant attitudes of farmers, including their opinions on the subject of the natural environment, towards their decision to participate were indicated by, among others, Cullen et al., 2018, though they emphasized the complexity of these relationships.

It is generally observed that a higher level of social capital (expressed in various factors, including the level of environmental awareness/sensitivity) promotes involvement in pro-environmental activities such as participation in AES. The importance of factors related to social capital was emphasized by, among others, Burton et al. (2008). In our case, the positive effect of using personal spoken communication (with advisors or input suppliers) was also observed, but this variable turned out to be statistically insignificant. The positive impact of advice from private or public extension services has been underlined and discussed many times in the literature (Lastra-Bravo et al., 2015; Polman and Slangen, 2008; Mathijs, 2003; Barreiro-Hurle et al., 2010). It can, therefore, be concluded that traditional communication methods are probably still one of the most effective ways to reach farmers with different (socially useful) ideas. This observation cannot be confirmed by the positive impact of farmers participating in training for using AES. However, it must be emphasized that due to the broad offer of training for farmers which became available after accession to the EU, many farmers, especially those running big farms, might feel competent enough to not bother with participating in the training. Owners of bigger farms also use the services of consultants to set up an agri-environmental scheme and draw up an application, and thus do not participate in training. At the same time, the model's results indicate that farmers who hardly understand the economic environment mechanisms often

participate less in AES. Sutherland et al. (2013) emphasized the importance of social factors such as personal trust (particularly in advisors). In turn, Schroeder et al. (2015) drew attention to socio-psychological factors and identified the positive impact of pressure from the social-environment (especially family) and the positive, although weaker influence of agricultural advisors.

5.3. Money matters

The results presented above show that most of the factors relating to the attitudes and beliefs of farmers turned out to be relatively irrelevant regarding the participation of farmers in AES in Poland. As emphasized earlier, the main goal of implementing agri-environmental programmes is to strive to protect and improve the natural environment in rural areas. Although the EU approach to the issue of environmental protection in rural areas assumes that agriculture can perform positive functions by generating environmental public goods, in reality, most agri-environmental programmes focus on production extensification, which is to reduce agriculture's pressure on the environment (Krom, 2017; Burton and Paragahawewa, 2011; European Commission, 2005; Lastra-Bravo et al., 2015). For a farmer with relatively intensive production, this means the need for extensification, which usually leads to a reduction in income. Of course, in the context of utility theory, it can be assumed that a farmer can also derive utility from socially and environmentally useful activities (such as extensification of production, protection of the agricultural landscape, improving animal welfare etc.). Also, in the literature on the subject, it is often noted that economic motivation in the process of deciding about participation in AES dominates over other considerations. This is noticed, for example, by Gallagher (2018) or (Darragh and Emery, 2017), who generally show that farmers demonstrate a pragmatic approach in which economic-oriented thinking dominates. van Herzele et al. (2013) highlight the complexity of factors determining farmers' participation in AES, indicating that money is an important driver for participation. However, money plays widely differing roles depending on the level of farmers' reasoning (farm enterprise, single practice or landscape feature) and the importance they give to other considerations (environmental effect, the production potential of land, goodness of fit, etc.). According to these authors, participation in AES is not simply a matter of weighing the money against the effort required for adoption. In the literature, many examples can be found showing that issues of the social usefulness of pro-environmental activities may be important for farmers (Matzdorf and Lorenz, 2010; Schroeder et al. (2015).

However, synthesizing the results of our model, we can state that the issue of economic factors influencing participation in AES seems to be of key importance for Polish farmers. Other factors associated with the affirmation of generating public goods are not a significant source of utility. This is not surprising if we consider that European measures are mainly based on financial incentives (Siebert et al., 2006; Krom, 2017). Other authors have also pointed out that money is an important incentive for farmers to participate in AES (Vollenweider et al., 2011; Brown et al., 2019; Wilson and Hart, 2001; Gorman et al., 2001; Hejnowicz et al., 2016). The literature on the subject, however, notes that following crowding-out theory, providing economic incentives for public goods can reduce farmers' intrinsic motivation for such provision. However, it is also noted that farmers' decisions in this respect are conditioned by many intrinsic and extrinsic factors. Therefore, it is difficult to describe easily the relationship between farmers' motives, practices and intentions, and we can see that farmers have a favourable view of conservation-oriented practices if they are financially rewarded (Gallagher, 2018; Darragh and Emery, 2017).

In the context of the importance of financial incentives, however, there is the problem of sustainability of farmers' pro-environmental attitudes. If they derive utility only from financial compensation for lost income, and they are not aware of the importance of pro-environmental activities for society and the economy, then their pro-environmental attitudes will probably be impermanent. This has been established in many studies indicating the shortcomings of existing agri-environmental programmes (Siebert et al., 2006; Krom, 2017; Burton and Paragahawewa, 2011; Defrancesco et al., 2018; Calveta et al., 2019). Therefore, one can formulate a postulate to combine financial incentives with more effective educational activities aimed at promoting positive behaviour after the end (or reduction) of financial support. Furthermore, relatively few examples have shown that farmers' attitudes to adopting environmentally-friendly practices show a negative effect when farmers' decisions are driven mainly by economic motivation (Mozzato et al., 2018).

6. Conclusions

Agricultural policy plays a crucial role in shaping the pro-environmental behaviour of EU farmers. Understanding the motives of farmers to participate voluntarily in AES is important for policymakers who wish to increase the likelihood of adoption of more environmentally-friendly practices by farmers. Such a diagnosis has been carried out in many countries (mostly in Western Europe) but is missing for countries of Central and Eastern Europe which have a shorter experience of AES, of which Poland has the largest agricultural sector. Additionally, literature results on the subject are often ambiguous, which indicates that many conditions are locally-determined and require more detailed recognition in a geographical context, including rarely-studied behavioural aspects and attitude of farmers to risk. The current system of support for agri-environmental measures in the EU is input-oriented, which means that farmers receive financial compensation for undertaking specific actions, often manifested in the abandonment of specific practices, resulting in the extensification of production. The results of our analyses, based on data from a representative sample of Polish farmers, indicate that, as in most other countries studied, the probability of participation in AES is positively affected by an extensive production model, especially characterized by large areas of permanent grassland. Besides, greater interest in participation could be seen in non-specialized farms (crop, mixed), less well-equipped with production factors. On the other hand, "more efficient" farms (e.g. with a better ratio of actual output to average (standard output) or higher income per UAA / hectare) are less likely to participate in AES. At the same time, the share of non-farm income in the household budget has also significantly increased the chances of farmers participating in AES, which shows that implementation of programmes is more likely by farmers whose maximization of agricultural income is not the only priority.

The observations above are supplemented by adding the impact of behavioural factors. One of the most significant is the impact of risk aversion characterizing individual farmers (expressed by Arrow-Pratt's risk aversion ratio) to the analysis of participation in AES. Farmers who had a lower risk aversion (risk takers) were less likely to participate in AES, while farmers with higher aversion were more likely to use this tool. This leads to the conclusion, confirming our hypothesis, that the use of programmes can be seen by farmers as part of risk management, because by joining AES they give up part of their income agreeing to reduce production, but in return for which they receive a guaranteed amount of payment. As a result, however, this leads to a reduction in subsidies, especially on relatively extensive farms. This is due, *inter alia*, to a favourable mechanism for setting bids based on the average benefits lost in participation in AES. As a result, well-functioning specialized farms run by relatively young farmers with relatively high production outputs and, as a result, relatively high income remain outside the reach of AES. Our study also indicates that other behavioural aspects considered in the study, relating to the attitudes and beliefs of farmers, turned out to be of relatively minor importance in explaining farmers' participation in AES. Thus, we conclude that the issue of economic factors influencing participation in AES seems to be of key importance for Polish farmers. Progressive climate change will potentially result in a significant reduction in the production potential of agriculture; hence there is a

need to look for solutions enabling the effective implementation of climate policy (environmental protection) goals without significantly reducing the productivity of agriculture (this is manifested, for example, in the growing discussion on the concept of "sustainable intensification"). It seems that a certain solution to this issue may be a change of the AES model from input to output-oriented, which is being emphasized more and more in recent years. The effect should be to reward farmers for environmental effects they achieved. The possibility of maximizing environmental effects, and thus obtaining subsidies greater than average lost benefits, could be an incentive for more efficient farms to take action to protect nature. Given the volume of production, produced on intensive and specialized farms, the environmental benefits of introducing such practices can be significant compared with reducing production on extensive farms. Of course, output-oriented activities carry some risk for farmers (if the goal is not achieved), though, as our research indicates, there is a chance that they can accept them (they represent a greater risk propensity). This approach is one of the assumptions of the new CAP, but the construction of a specific programme for a given country requires good recognition of its socio-environmental conditions. Considering that the EU area is very diverse in terms of environmental conditions and problems, such tools must be even more adapted to the conditions of the given country or even region. For this reason, an important element of the actions undertaken should be recognition of factors (characteristics of farms and farmers) determining participation in current and "new/future" AES.

CRediT authorship contribution statement

Adam Wąs: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Writing - original draft, Writing - review & editing. **Agata Malak-Rawlikowska:** Conceptualization, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. **Matteo Zavalloni:** Writing - original draft, Writing - review & editing. **Davide Viaggi:** Conceptualization, Writing - original draft, Writing - review & editing. **Paweł Kobus:** Formal analysis, Methodology, Validation. **Piotr Sulewski:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. List of variables and their average values

Variable	unit	Total	AES	non AES
1 Soil quality index	index 0.05−1.95	0.8361	0.8071	0.8566
2 Number of family members working on the farm	persons	2.56	2.60	2.53
3 Total labour input	Annual Work Unit (AWU)	1.84	1.776	1.886
4 Own labour input	Family Work Unit (FWU)	1.581	1.565	1.592
5 Hired labour	AWU	0.2594	0.2,104	0.2,941
6 Number of animals	LU	28.41	30.707	26.79
7 Stocking density	LU/ha	0.905	0.8518	0.9426
8 Assets value without land	PLN	684 924	714 611	663 939
9 Assets value without land per ha of agricultural land	PLN/ha	27 382.8	18 826	33 431.7
10 Age of farmer	years	47.09	47.51	46.8
11 Working on the farm	years	27.58	28.38	27.02
12 Managing the farm	years	21.19	22.19	20.48
13 Production value	PLN	264 679	273 413	258 505
14 Economic size	EUR	49 041	53 128	46 152
15 Economic size	PLN	191 709	207 686	180 414
16 Production/Standard production	PLN/PLN	1.32603	1.23,241	1.3922
17 Family farm income	PLN	105 413	112 604	100 329
18 Share of farm income as % total household income	%	080.68	078.59	082.15
19 Threat of erosion - farmer's opinion	no 0-1 yes	0.3418	0.3902	0.3075
20 Influence of agriculture on surface waters	−5 to +5	−1.145	−1.171	−1.126
21 Influence of agriculture on air quality	−5 to +5	−0.4495	−0.4512	−0.4483
22 Influence of agriculture on biodiversity	−5 to +5	−0.1683	−0.1463	−0.1839
23 Influence of agriculture on landscape	−5 to +5	0.5303	0.561	0.5086
24 Influence of agriculture on climate	−5 to +5	−0.6296	−0.6707	−0.6006
25 Influence of agriculture on soil	−5 to +5	−0.1818	−0.02,032	−0.296
26 Quality of environment	0−6 high	3.833	3.943	3.756
27 Quality of surface waters	0−6 high	3.345	3.415	3.296
28 Influence of environment protection on economy in long term	0−6 high	4.14	4.041	4.21
29 Usefulness of publications to increase knowledge	0−6 high	3.554	3.541	3.564
30 Usefulness of internet sources to increase knowledge	0−6 high	2.088	2.0058	2.147
31 Usefulness of spoken communication to increase knowledge	0−6 high	4.119	4.165	4.086
32 Remoteness - travel time to closest city	minutes to drive	29.28	30.43	28.47
33 Are the environment requirements limiting farm production	no 0-6 yes	2.887	2.919	2.865
34 Stability of income	0−6 stable	2.673	2.715	2.644
35 Self-assessment of understanding economic environment	low 1–3 high	1.562	1.508	1.601
36 Coefficient of variation of gross margin	coefficient	0.32114	0.32267	0.32006

(*continued on next page*)

(*continued*)

Variable	unit	Total	AES	non AES
37 Coefficient of variation of family farm income	coefficient	0.7354	0.7609	0.7173
38 Arrow Pratt risk aversion coefficient	coefficient	1.391	1.407	1.3798
39 Down Size risk aversion coefficient	coefficient	−0.8557	−0.8878	−0.833
40 Are environmental requirements easy to fulfil	no 0 - 1 yes	0.1296	0.1423	0.1207
41 Wealth self-assessment	0 - poor 1-rich	0.5859	0.6057	0.5718
42 Importance of traditional agricultural landscape for the farmer	0−6 -important	4.736	4.65	4.796
43 Importance of biodiversity for the farmer	0−6 - important	4.429	4.467	4.402
44 Importance of rural culture heritage for the farmer	0−6 - important	4.471	4.492	4.457
45 Importance of animal welfare for the farmer	0−6 - important	4.473	4.431	4.503
46 Importance of surface waters protection for the farmer	0−6 - important	4.978	4.955	4.994
47 Importance of soil fertility for the farmer	0−6 - important	5.059	5.045	5.069
48 Average agricultural public goods importance for the farmer	0−6 - important	4.691	4.673	4.704
49 Assessment of level of taxpayers' expenditures on public goods generated by agriculture&forestry	too low 1-3 too high	1.907	1.894	1.917
50 Suggested level of expenditures for CAP - farmer's opinion	PLN/household	300.7	286.1	311.0
51 Share of public good support in CAP budget	too low 1−3 too high	2.387	2.415	2.368
52 UAA (utilized agricultural area)	ha	37.45	46.33	31.18
53 Rented land area	ha	11.614	14.662	9.459
54 Forage crop area FADN	ha	7.207	9.1235	5.852
55 Value of intermediate consumption	PLN	156 722	171 094	146 562
56 UAA area (ha), 3 year dynamics, 1= no changes	index	1.0205	1.0161	1.0236
57 Land productivity (production/area), 3 year dynamics, 1= no changes	index	1.0544	1.0567	1.0528
58 Value of production/std. output, 3 year dynamics, 1= no changes	index	1.0694	1.0717	1.0678
59 Intensity of production (intermediate consumption/UAA), 3 year dynamics	index	1.002	0.9971	1.0054
60 Total subsidies excluding on investment	PLN	50 138	64 075	40 287
61 Production intensity	PLN/ha	5 665.7	3 959.6	6 871.7
62 Production value per ha	PLN/ha	9 836.5	6 246	12 375
63 Family farm income per own labour unit	PLN/FWU	67 010	72 928	62 826
64 Family farm income per UAA	PLN/ha	3,408	2,396	4,123
65 Total subsidies excluding on investment divided by value of production	PLN/PLN	0.3689	0.53755	0.2497
66 Share of tenured land in total area	share %	24.42	25.97	23.33
67 Farm type TF 1 – arable farm	share %	29.5	31.7	27.9
	share %	4.2	0.8	6.6
a (TF8) TF 2 – horticulture				
	share %	3.0	0.4	4.9
a TF 4 – permanent crops				
	share %	17	13.4	19.5
a TF 5 – dairy cattle				
	share %	5.9	8.1	4.3
a TF 6 – beef cattle				
	share %	7.6	6.5	8.3
a TF 7 – pig and poultry				
	share %	32.8	39	28.4
a TF 8 – mixed				
68 Location on LFA areas	% LFA area	53.4	58.1	50.0
	% grammar&professional	39.4	37	41.1
69 Education	% secondary	46.6	47.2	46.3
	% higher	14	15.9	12.6
	% no	27.1	26	27.9
72 Successor	% yes	21.4	20.3	22.1
	% do not know	51.5	53.7	50.0
75 Taking part in trainings in last two years	% yes	78.8	80.5	77.6
	% good	55.9	59.8	53.2
76 Self-assessment of understanding economic environment	% medium	32.0	29.7	33.6
	% poor	12.1	10.6	13.2

Source: own calculations based on Polish FADN and survey results

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