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Drivers of farmers' willingness to adopt extensive farming practices in a globally important bird area

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Abstract: Agri-environmental schemes have become an integral tool of land use management policies in ecologically valuable river valleys, that are commonly recognized as very important bird habitats. When high adoption of extensive agricultural practices is not only a political goal, but also a necessary condition for conservation of vulnerable ecosystems, understanding of farmers' preferences is utterly important. Therefore, we use the case of Biebrza Marshes – a wetland complex and one of the largest wildlife refuges in Europe, which is located in northeastern Poland – and employ stated preference methods to investigate farmers' preferences for adopting several agricultural practices, such as precision fertilization, crop diversification, catch crops, peatland protection, extensive use of meadows, and the reduction of livestock stocking density. Farmers' willingness to participate in selected practices is explained using farms' and farmers' characteristics, subjectively and objectively measured farmers' environmental knowledge, as well as by experimentally controlled information treatments about environmental benefits of agri-environmental contracts. The results provide new insights into the sources of farmers' preference heterogeneity and show how different motivations relate to participation in agri-environmental schemes. Based on the results and consultations with local stakeholders, we make recommendations for a more efficient design and targeting of land use management instruments, including future agri-environmental schemes.

Keywords: agri-environmental schemes, farmers' preferences, choice experiments, agrobiodiversity protection, agri-environment, payments for ecosystem services

JEL codes: Q18, Q12

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1. Introduction

"*The Valley of Biebrza, the wildest river in Poland, never failed to delight us with harmonic co-existence of people and nature – it is still the same as it was a hundred years ago.*" – National Geographic[1]

The Valley of Biebrza located in the north-eastern Poland is famous for its "wilderness". Inhabited by rare and endangered bird species,[2] it became a destination of ornithologists, birdwatchers and nature photographers from all over the world (Dyrcz 2010). The region is included in protected Natura 2000 area, because it hosts a number of habitats listed in the EU Habitats Directive and Birds Directives as the highest priority of conservation. These environmental conditions are appreciated by policy makers and local stakeholders, who emphasize the need to conserve biodiversity of the region (Chormanski et al. 2009).

Biebrza Marshes are a semi-natural complex, created as a byproduct of extensive agricultural land management decades ago. Its species richness is inseparable from extensive farming practices on lands that are largely privately owned (Natura 2000). As a result, protecting this region requires responsible, cooperative actions from local inhabitants moving away from intensive agricultural practices. Also, passive protection measures would be insufficient as through the process of natural succession they would lead to gradual conversion of these areas to forests (Schmidt et al. 2000, Dembek 2002).

Creating the conditions for the "harmonic co-existence", rather than tensions between farmers and nature in the Biebrza Marches, has been one of the most urgent policy goals for the area. A particularly useful tools in this respect have been provided by the European Union as agri-environmental schemes (AES) – payments to farmers who voluntarily choose to introduce specific environment-friendly practices on their land. The aim of our study is to analyse farmers' preferences for a wide range[3] of AES that are of particular importance for the region. Using state-of-the-art stated preference valuation methods, we investigate willingness to accept (WTA; reservation price for) contracts for improved utilization of

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[1] (English translation) http://www.national-geographic.pl/aktualnosci/biebrza-symfonia-bagien

[2] Birds of open and semi-open habitas, now mainly linked to farmland, but historically to large grasslands in river valeys, are seriously declined over Europe. The most important refugia, especially for some species related to vey extensive way of farmland management, with traditional pastoralism, are located in large river valles (Dyrcz 2010). Biebrza Marshes is one on the best, globally known examples of such a river valley.

[3] Simultaneous analysis of multiple agri-environmental measures is one of the challenges of the field (Uthes and Matzdorf 2013).

fertilizers, crop diversification, introducing catch crops, peatland protection, extensive use of meadows, and the reduction of livestock stocking density. The contracts compared differ with respect to a range of agricultural measures, levels of payment and flexibility (duration and opt-out option). This allows us to study farmers' preferences for contract design features, and hence to provide valuable inputs to policy decisions regarding effectiveness and expected adoption rates of various contracts. In addition, we identify farm and farmers' characteristics related to the uptake of the contracts, using them as explanatory variables of preference (WTA) heterogeneity. This provides further inputs for the land use policy of the area, facilitating the design of more diversified (and hence more economically efficient) contracts (Hasler et al. forthcoming).

To provide further insights into farmers preferences and motivation, we investigate the links between farmers' WTA and their subjective or objectively measured environmental knowledge, and experimentally control information treatments about environmental benefits of agri-environmental contracts. Regarding the former, we measure farmers perceived knowledge of agricultural practices that are the most beneficial for local bird species, and control their familiarity with local bird fauna using a bird recognition test. Regarding the latter, following Christensen et al. (2011) and Greiner (2016) we test if the information concerning environmental goals of AES creates additional incentives for participation. Overall, knowledge and familiarity have been found to impinge on people's preferences and values (e.g., LaRiviere et al. 2014, Needham et al. 2018) and confirming this for the case of farmers could open a way for new education-based interventions (LaRiviere et al. 2018), such as using environmental awareness campaigns to incentivize farmers to adopt more sustainable farming practices. In addition, our study allows to test if the role of an intrinsic motivation, personal satisfaction or attitudes are distinct from an economic motivation in farmers' decision to participate in agri-environmental practices (Vanslembrouck et al. 2002, Maybery et al. 2005, Greiner and Gregg 2011).

From the policy perspective, our results point to the possibility of cost-cutting (or participation increasing) changes in the AES design. To make sure our conclusions are robust and policy relevant we also report the results of qualitative consultations of these results with local stakeholders. Similar mixed-method was used by Austin et al. (2014), and relevance of research results to political decision-making is one of the challenges formulated in Uthes and Matzdorf's (2013) review. Consultation with stakeholders added a policy-oriented context and indicated important weaknesses, tensions, barriers, and validity of the changes to be considered when formulating future land use policies in Poland.

2. Prior studies of farmers' preferences for AES

Studies on farmers' willingness to participate in AES are usually based on revealed or stated preference methods. Revealed preference studies are adoption studies – the results are based on farmers' real response subsequent to implementation of a local agri-environmental policy. They explain observable factors influencing farmers' enrollment into predesigned contracts and identify differences between characteristics of participants and non-participants for a given set of requirements and payment level (e.g., Siebert et al. 2006). Stated preference studies, such as Discrete Choice Experiments (DCE; Carson and Czajkowski 2014), are based on hypothetical choices respondents make in a carefully designed surveys. Farmers make trade-offs between payments and varied requirements of the AES contract, therefore disclosing preferences for contractual attributes and characteristics of the practices (Espinosa-Goded et al. 2010). As a result, it is possible to estimate farmers' WTA for participation in AES – the minimum compensation required in return for compliance with the requirements of a contract – and hence to make the design AES to be more cost-efficient or popular (Colen et al. 2015).

Revealed preference studies of AES have an important limitation – many of the attribute-level combinations are never observed in the market, and the ones that are observed are often highly correlated or even collinear. Conversely, the ability to exogenously vary attributes of alternatives from which the respondent chooses in stated preference studies serves the joint purpose of allowing for clean identification (e.g., allaying endogeneity and collinearity concerns associated with market-observed attribute level combinations; Angrist and Pischke 2010, Freeman et al. 2014, Phaneuf and Requate 2016); and increasing the efficiency of preference parameter estimation (Scarpa and Rose 2008).[4] Stated preference data is usually free of these limitations, and hence, it is increasingly used for policy-relevant analysis in many fields of applied microeconomics, such as agricultural, environmental, health, transportation or public goods economics (Hanley and Czajkowski 2017).

[4] Note that stated preference choices do not usually include implausible combinations of attribute levels. Instead, choice situations are prepared in a way that reveals the most information from an individual choice. This is not the case with revealed preference data.

Villanueva et al. (2017) list 54 stated preference studies of farmers' preferences for AES. These studies can be tailored to specific sectoral contexts (e.g., gardens, winegrowers, dairy farms, crop farms, pastoralists and grazers, foresters), type of land (e.g., arable land, meadows, wetlands), and geographic regions. In turn, characteristics of a given context influence preferences on AES characteristics, such as the length of the contract or the required compensation. Interestingly, very few studies looked at AES in ecologically valuable river valleys and marches (e.g., Saxby et al. 2018). Filling this gap offers an opportunity for transferring our results to other regions with similar land use challenges.

2.1. Farmers' preferences for selected attributes of AES

The WTA estimates can be decomposed into parts specific to each attribute of the scheme, providing information on which characteristics of the contract were most favored or disliked by farmers. Obviously, financial compensation is a necessary condition for farmers to enroll into AES (Siebert et al. 2006). The higher is the monetary compensation for participation, the more likely farmers are to enroll into hypothetical contracts (Schulz et al. 2014).

The general conclusions that can be drawn from the literature with respect to farmers' WTA for other contractual attributes relevant to our study is that the contract length, termination flexibility, rigidity of requirements and possibility to maintain prior agricultural activities, and area and share of land enrolled are all important drivers of farmers' decisions. WTA is lower for contracts that are shorter (Ruto and Garrod 2009, Christensen et al. 2011, Greiner 2016, Vaissière et al. 2018), with an opt-out possibility (Broch and Vedel 2011, Christensen et al. 2011), in which farmers freely decide on the parcel, area or share of land enrolled or re-enrolled each year (Wynn et al. 2001, Espinosa-Goded et al. 2010, Christensen et al. 2011, Alló et al. 2015), have less stringent requirements (Ruto and Garrod 2009), and that allow to continue prior agricultural activities, management strategies (Espinosa-Goded et al. 2010), and unrestricted managerial decisions (Schulz et al. 2014, Alló et al. 2015).

Other factors in existing studies include monitoring, fines, advisory assistance and technical support, and administrative burden. Monitoring of a contract is often used to enhance compliance, but increases compensation required by farmers (Broch and Vedel 2011, Vedel et al. 2015). Greiner (2016) shows that external monitoring is preferred to self-monitoring, but it is of lesser importance than other contractual attributes, such as flexibility or the length of a contract. Alló et al. (2015) show that introduction of fines reduces probability of farmers' acceptance of contract. Moreover, farmers enrollment is more likely in the case of advisory support and limiting administrative or paper work (Ruto and Garrod 2009, Christensen et al. 2011).

Not all abovementioned features are equally important to farmers. For example, in Christensen et al. (2011) study of pesticide-free buffer zones the flexibility of the terms of a contract, that is the length and possibility to break the contract, is much more important to farmers than administrative burden (lack of assistance in applying for subsidies) and flexibility in practical management (buffer zone width or restrictions on the use of fertilizers). All these features prove significant, but their effect on the reduction of WTA is secondary. It is therefore important to look at the preferences of the targeted groups of farmers to identify features that are most relevant for the adoption of AES, as most of the more stringent requirements are linked to environmental benefits. The general conclusion from previous research is that most farmers prefer to keep more flexibility (in land management restrictions and duration), less burden and more support in implementing AES. Contracts with these features generally require lower compensations. Therefore, introducing corresponding changes in the design can considerably either reduce costs or increase participation. On the other hand, there is a conflict between environmental benefits/goals and cost minimization: farmers prefer more flexibility, but environmental benefits often require stable, long-term implementation of stringent environment-friendly practices in the entire high value nature area.

2.2. Drivers of farmers' preference heterogeneity

A well-established observation is that there is large observed and unobserved heterogeneity of farmers' preferences. The results of several DCE studies show that farmers' preferences can be described using discrete classes – those who want to participate in conservation schemes for a subsidy, and a relatively less common group of those who strictly oppose and never choose to participate in AES (Christensen et al. 2011, Beharry-Borg et al. 2013, Schulz et al. 2014). The unwillingness to participate in the AES can partly be due to high entry or nonoperational costs related to agri-environmental measures, that exceed potential compensation (Ducos et al. 2009, Mettepenningen et al. 2009). Morris and Potter (1995) and Fish et al. (2003) propose a method allowing for identification of participating and non-participating farmers a priori, depending on their willingness to participate in agri-environmental measures and to adopt the prescribed practices.

Part of the heterogeneity of farmers' preferences for AES can be attributed to differences in personal and farm characteristics, as these affect either non-monetary preferences or income forgone due to the implementation of conservation measures. Vanslembrouck et al. (2002) presents a conceptual model of willingness to participate in agri-environmental measures with two broad categories of factors. The first involves characteristics of the decision subject that include characteristics of the contract (type of measure, related costs and benefits of implementation) and market conditions (demand for farm products, demand for environmental goods, compensation). The second deals with the characteristics of the decision maker, that is farms' and farmers' characteristics. For example, Villanueva et al. (2017) list three types of factors differentiating the farms: (1) type of production, referring to farm characteristics, physical and agronomic factors, farming system and management; (2) farm and farmer characteristics, such as socio-economic features, ownership, socio-demographic characteristics, attitudes and knowledge; and (3) factors extrinsic to the farm, for example markets, regulatory environment, and social norms.

Schulz et al. (2014) show that opportunity costs are higher for specialized and intensive farms, arable farms on highly productive land and dairy farms with high stocking rates, and therefore such farms are less likely to implement pro-environmental measures. Previous participation in AES resulted in no observed systematic effects; similarly to size of the farm or property (Christensen et al. 2011). A number of other explanatory variables, such as age or farm size, proved insignificant or gave mixed results (Christensen et al. 2011, Schulz et al. 2014, Greiner 2016). This can be attributed to the findings of Vanslembrouck et al. (2002), who evaluated two AES on the same group of Belgian farmers and showed that significant determinants can vary by the respective agri-environmental measures. They conclude that in addition to technical and environmental dimension, education and understanding of the AES impacts, attitudes, experience, and behavioral aspects should be considered.

Overall, understanding of local drivers of heterogeneity in farmers' preferences can help design more efficient AES for a particular case. Some farmers' or farm's characteristics are universally found to influence participation and WTA in a particular way, while others appear contract or case-study specific.

2.3. Knowledge and information

Scientific innovations in design of AES aim at improving the environmental performance and the cost-effectiveness. State-of-the-art ideas that further these goals include collective actions (encouraging group rather than individual participation), spatial coordination of participation, payments for environmental outcomes rather than actions (this means result-orientation, which relates to often raised issue of measurement of environmental benefits of changes in land management), and the use of behavioral mechanisms targeted at farmers (Hanley 2018). Examples of respective mechanisms from the DCE literature include introducing collective bonuses that are shown to increase participation and lower compensation (Kuhfuss et al. 2015), and the agglomeration bonuses for foresters (Sheremet et al. 2018). In this regard, stated preference studies offer a unique opportunity for testing the effectiveness of behavioral interventions before implementing them in the field (Hanley and Czajkowski forthcoming).

A separate avenue of investigation focuses on the role of knowledge and information in environmental preferences and behavior formation. Building on the assumptions of the classic model of reasoned action (Ajzen and Fishbein 1980), this approach proposes knowledge as a catalyst for the attitudes and norms that, in turn, stimulate pro-environmental behavior (Polonsky et al. 2012, Taufique et al. 2016). In particular, it has been found that specific environmental knowledge positively interrelates with the specific conservation behavior (Frick et al. 2004), WTP (Needham et al. 2018), and generally influences decision making (Sandorf et al. 2018). Frick et al. (2004) have also found that the „effectiveness knowledge", i.e. knowledge how particular types of behavior translate into environmental benefits, increases willingness to engage in conservation activities. The mechanisms though which knowledge operates refer to activating motivations necessary for prescribed behavior, increasing personal environmental efficacy, but also by moderating the relevance of classic economic incentives.

Our contribution analyzes the impact of providing farmers with information about ecological rationale of implementing selected AES (i.e. "effectiveness knowledge"), while controlling for their prior level of environmental knowledge. In previous research, farmers' preferences were found to depend not only on the characteristics of agri-environmental contracts but also on the objectives of the policy (Broch and Vedel 2011). Similarly, greater knowledge, ecological literacy, and learning about the beneficial aspects of AES measures can increase likelihood of engagement (Heong et al. 1998, Pretty and Smith 2004). We propose that by experimentally varying the information provided we provide a reminder about positive external impact of agri-environmental practices, which may work as an incentive to participate (Christensen et al. 2011, Greiner 2016). On the other hand, while soil or water protection can influence farmers' profits significantly in a positive way, biodiversity may have mixed effects. In the Biebrza Valley, the tension between farmers and ecologists signals that biodiversity can have a negative impact on agricultural profits.[5] Therefore, we test the effect of information about the purpose of AES on preferences of a representative sample of farmers.

3. Data and methods

3.1. Case study area

Our case study area is the Biebrza Valley, particularly the two Natura 2000 sites there: "Dolina Biebrzy" (SCI, PLH200008) and "Ostoja Biebrzańska" (SPA, PLB200006) in northeastern Poland. The valley and its wetlands are partly located in the Biebrza National Park. The two Natura 2000 sites cover 14,148,508.8 ha. According to the Central Statistical Office of Poland, there are approximately 17,000 farmers is the 20 municipalities under study. The number of farms operating in the region can be much smaller, especially since roughly 70% of registered farms has an area of less than 15 ha. Similarly to Adams et al. (2014), we decided that the smallest farms are not be good candidates for the program, therefore the effective universe of the survey was around 5,000 farms.

We analyze the provision of public goods (mainly biodiversity, with unique species of birds) by the river valley agricultural system in the context of intensification of agricultural land use and abandonment of extensive agricultural practices because of their increasing alternative costs. Over the period of 30 years, the abandonment of traditional agriculture and subsequent intensification of agricultural land use have led to changes in the mosaic of unique wetland habitat types and a decline of biodiversity. Forest cover of the area has grown by nearly 95% over the period of 30 years, and non-forested ecosystems continue to diminish, as farmers chose to abandon the most demanding wet meadows (LIFE11 2019). Extensive mowing and grazing on wet meadows constitutes a good example of an extensive farming practice. At present, grazing and mowing is often being replaced by less work-intensive uses of the ecologically valuable pastures and meadows. Farmers are reluctant to choose extensive practices that create this unique ecosystem, because they are labor demanding and costly.

The protection of biodiversity typically comes at an opportunity cost to landowners and results in the loss of financial reward to farmers, due to reduced production and sales and

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[5] In particular, in the Biebrza Valley we found news on farmers' protests against authorities from the Biebrza National Park. Farmers demanded that the State Treasury should compensate loss of crops due to protected farmland birds. See for example: http://bialystok.tvp.pl/20872010/protest-rolnikow-przed-siedziba-biebrzanskiego-parku-narodowego (Available online on 5 July, 2018)

the lack of private benefits for delivering public goods. To protect the bird breeding grounds (and stop natural succession of forests) specific environment-friendly agricultural practices are required, and encouraged through the AES.[6] However, the current system of AES addresses the problem of underprovision of public goods to an unsatisfactory extent, hence giving raise to the necessity of changes in how the system is designed (Lachmann et al. 2010, Gotkiewicz and Mickiewicz 2015, Doboszewski et al. 2017).

3.2. Design and implementation of the stated preference study

To investigate farmers' preferences for future AES we designed and implemented a stated preference survey, using DCE to elicit their WTA for selected attributes of the program.

The structure of the questionnaire was as follows. To help incentivize the survey, the respondents were informed about its consequentiality – they were told that the results will be presented to local and European authorities and that the responses can impact future agricultural policy in Poland and the design of future AES. We ensured anonymity and advised that we want to know their truthful opinions. Second, we asked introductory questions about farm's production, current practices, and land use. This allowed us to present the respondents only with the hypothetical contracts that were applicable to their farms. Next, the possible AES and their attributes were explained. They included experimental treatments with additional information about the goals and environmental benefits of selected AES, and were followed directly by the DCE. The survey ended with follow-up questions on environmental and policy attitudes, knowledge self-assessment, a quiz on the knowledge of local bird species, and socio-demographic questions. Socio-demographic variables collected include household size, sex, age, the highest educational qualification, the field of education (also agricultural training), employment within and outside of the farm, the number of children, socio-demographic characteristics of other household members, percentage of farm income over total household income, household income.

3.2.1. The discrete choice experiment

The respondents of our survey were asked to imagine that in the beginning of 2018, all current agri-environmental schemes would cease (other instruments, including direct payments, would

[6] Similar actions are implemented by governments throughout the EU, co-financed by the European Commission and EU member states, and are based on 5-years contracts.

be maintained). Each farmer could enroll into new contracts. We then presented the respondent with hypothetical choices of AES that would apply to his or her farm. One of the available alternatives was always “No contract”, which meant no requirements, but also no agri-environmental payments.

The AES considered were related to four different land/production types: (1) on arable land we proposed three practices – improved utilization of fertilizers, crop diversification, and catch crops; (2) for peatlands – basic or extended protection practices; (3) for meadows – extensive mowing or grazing; and (4) for livestock owners – the reduction of stocking density. We wanted to propose realistic contract to farms, so descriptions of the hypothetical schemes were based on the Agri-Environment Climate Measures already present in the Rural Development Programme 2014-2020 for Poland. Language adaptations were made to facilitate farmers’ understanding (we used terms that farmers are familiar with).

The attributes of the contracts included duration, option to terminate contract (opt-out), and payment per ha per year. We selected these attributes as the most relevant (often found significant in the literature) and situationally representative (representing actual contractual characteristics at the time of the study). Current AES in Poland are 5-year voluntary contracts. Payments in the 2014-2020 program vary between 40 and 700 EUR for different measures. There is no termination option, which means that a farmer must implement the action once he/she enrolled in it, otherwise he/she is obliged to return all payments. Many agri-environmental schemes available in the Natura 2000 area are spatially targeted and aim at very specific habitats and birds protection. We used some of the more general ones. Table 1 summarizes the attributes and attribute levels as used in our DCE.

Table 1. Choice experiment attributes and levels

Attributes (characteristics of contracts)	Description	Attribute levels (by type of land)			
Type of land / production		**Arable land**	**Peatlands**	**Meadows**	**Livestock**
Agricultural practice	▪ respondents were familiarized with the requirements of each of the practices included in the considered AES ▪ the requirements were based and complied with the current AES in Poland[7] ▪ Labelled experiment – alternatives represented contracts for specific practices	▪ improved utilization of fertilizers ▪ crop diversification ▪ catch crops	▪ basic peatland protection ▪ extended peatland protection	▪ extensive mowing and grazing	▪ reduction of livestock stocking density to 0.5 unit/ha ▪ reduction of livestock stocking density to 1 unit/ha ▪ reduction of livestock stocking density to 1.5 unit/ha[8]
Duration	▪ the contract will last for a specified number of years	1, 2, 3, 5, 10, 20			
Termination	▪ possibly to terminate the contract	▪ with refund (the requirement to pay back all the subsidies one has acquired) ▪ without refund (the requirement to pay back the subsidies one has acquired)			
Subsidy	▪ Enrolling in a particular contract means receiving payment for adopting the required practices. The payments would be paid annually per hectare enrolled.	100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400 PLN/ha/year	Basic protection: 100, 200, 300, 400, 500, 600, 700, 800, 900 PLN/ha/year Extended protection: 200, 400, 600, 800, 1000, 1200, 1400, 1600, 1800 PLN/ha/year	100, 200, 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800 PLN/ha/year	200, 300, 400, 500, 600, 700, 800, 900, 1000, 1100, 1200, 1300, 1400, 1500, 1800, 2100, 2400, 2700 PLN/year

The attributes and their levels were carefully explained to respondents in the survey. They were asked to assume that the alternatives were the same with respect to any characteristics not explicitly listed in the choice situations. The survey was designed according to the state-of-the-art recommendations for stated preference studies (e.g., Champ et al. 2017, Johnston et al. 2017). In particular, in the design stage of the study utilized extensive qualitative pretesting and the main survey was preceded by a pilot. In addition, the design and wording of the survey was consulted with environmental and agricultural experts, to make sure the information we provide was relevant.

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[7] The full wording of descriptions (and survey questions) are available from the authors upon request.
[8] Only alternatives that apply were presented (e.g., farmers with current intensity of 1.4 units/ha were shown contracts for reductions to 0.5 and 1 units per ha).

Each respondent was presented with up to 6 choice situations regarding arable land and livestock reductions, and up to 3 choice tasks regarding peatlands and meadows, provided these AES applied to his or her farm. The combinations of the attribute levels presented in each of the choice tasks (i.e., the experimental design) were selected in a Bayesian-efficient way (Ferrini and Scarpa 2007, Scarpa and Rose 2008), that is, to minimize the determinant of the expected AVC matrix of the estimates (*D-error*) given the priors on the parameters of a representative respondent's utility function derived from a pilot survey. [9] An example of a choice card is given in Figure 1.

	Improved utilization of fertilizers	**Crop diversification**	**Catch crops**	**No contract**
Duration	**5** years	**2** years	**10** years	
Termination	Possible **without** refund	Possible **with** refund	Possible **without** refund	
Subsidy	**400** PLN/ha	**200** PLN/ha	**900** PLN/ha	
Your ranking from the most (1) to the least preferred (4)	□	□	□	□

Figure 1. Example of choice card for arable land (translation)

The survey was administered as computer assisted personal interviews (CAPI) in June – August 2017 (270 surveys) and in March 2018 (200 surveys) by local agricultural advisors from the Agricultural Consulting Centre of Podlaskie Voivodeship in Szepietowo. Using the advisors who normally work in the area, and who respondents are familiar with allowed to limit potential communication problems and to minimize the refusals rate. Respondents were selected by a stratified quota sampling method, to assure representativeness of the sample for the target population, i.e. farmers who make managerial decisions on areas within the two Natura 2000 sites. In total, we collected responses from 463 farmers.

3.2.2. Information treatments

We tested the impact of additional information about the goals and environmental benefits of AES on the likelihood to participate by creating a between-group random treatments. In

[9] The order of choice situations, alternatives, and attributes was randomized to avoid potential ordering effects.

the treatment, immediately before the elicitation of preferences, subjects were presented with additional factual explanation for why a specific agricultural practice is introduced and what are its benefits. The incentive we used is rather soft – a reminder of environmental goal of AES. It matched specific AES for which preferences were collected. Table 2. presents translation of information treatments. The full wording of treatments with translation are available in an online supplement to this paper.

Table 2. Information treatments (translation)

Arable land
– Rational use of fertilizers reduces inflow of nutrients, in particular nitrogen (N) and phosphorus (P) loading, to surface waters and groundwater. Thus, rational use of fertilizers improves quality of water used for drinking, open water swimming and recreation, and contributes to clean environment. – Crop diversification protects soil from loss of organic matter. Greater diversification is also beneficial to the local environment around the farm, as it improves conditions for other plants and animals. – Growing crops between successive plantings of a main crop reduces water pollution and the soil erosion. Catch crops prevent minerals being flushed away from the soil and protects water against nutrient pollution from fertilizers, in particular with nitrogen and phosphorus, plant protection products and of their residues, and other toxic substances. Catch crops contribute to plant diversification on the farm, so it also improves conditions for other plants and animals.
Peatland
Peatlands are a habitat of many species of plants and animals. Often, they are the last natural places where rare and endangered species occur. Peatland protection practices enable restoration of good ecological conditions, or at least prevent the land from worsening degradation. Such practices improve conditions for birds that have their habitats there.
Meadows
These practices support the existence of the meadows and pastures, a form of traditional rural landscape; they also improve conditions for endangered birds, whose nesting habitats occur in a permanent grassland; finally, they improve ecologic conditions of extremely valuable natural habitats on meadows and pastures.
Livestock / mixed crop-livestock production
Reduction of livestock stocking density improves quality of surface and groundwater, it also increases biodiversity on meadows and pastures.

3.2.3. Measures of respondents' knowledge

One of the aims of our study was to identify the relationship between provided information, farmers' environmental knowledge and the likelihood of participation in the schemes. To this end, we use measures of subjective and objective knowledge of local bird species. The first measure is based on a question about how much a farmers think they know about protected bird species and agricultural practices used for conservation. The wording of this question was "Please indicate to what extent you agree with the following sentences: (1) I know a lot about protected species of birds in the Biebrza Valley (2) I know agricultural practices needed to protect these species of birds in the Biebrza Valley" that was used with a 5-point Likert response scale (1 – completely disagree, 2 – somewhat disagree, 3 – neither agree, nor disagree, 4 – somewhat agree, 5 – completely agree).

To measure farmers' knowledge objectively, we used a quiz with 6 bird species, which respondents were asked to recognize: Aquatic warbler, Ruff, Black-tailed godwit, Eurasian curlew, Northern lapwing, Eurasian wigeon. All these birds occur at the local river, and are popular or specific for the region. Aquatic warbler and Ruff are considered to be the symbols of the Biebrza Valley. Black-tailed godwit and Eurasian curlew are protected with agri-environmental schemes. Northern lapwing and Eurasian wigeon are just popular birds.[10] These 6 species were selected as their recognition is a non-trivial task, but differs with respect to the level of difficulty. The selection of pictures was consulted with the authorities from the Biebrza National Park. Figure 2. presents the translation of the quiz with pictures.

[10] The selection of birds was based on Kuczyński and Chylarecki (2012); the species presence maps is available online at www.ornitho.pl.

Please select a species name:[11]		
		
a) Meadow pipit b) Skylark c) Aquatic warbler d) I don't know	a) Northern lapwing b) White-winged tern c) Montagu's harrier d) I don't know	a) Black grouse b) Ruff c) Western capercaillie d) I don't know
		
a) Corn crake b) Black-tailed godwit c) Great snipe d) I don't know	a) Eurasian curlew b) Montagu's harrier c) Common snipe d) I don't know	a) Eurasian wigeon b) Common starling c) Greater white-fronted goose d) I don't know

Figure 2. Bird species knowledge quiz questions (translation)

3.3. Econometric framework

Modeling consumers' preferences using discrete choice data draws on theories of economic value (Lancaster 1966) and the random utility theory (McFadden 1974, McFadden 2001). It assumes that the utility an individual receives from an alternative chosen depends on observed characteristics (attributes) and unobserved idiosyncrasies, which are represented by a stochastic component. The utility of individual, i, resulting from choosing alternative, j, in situation, t, can be expressed as:

$$U_{ijt} = \mathbf{X}_{ijt}\boldsymbol{\beta} + e_{ijt} . \quad (1)$$

[11] Picture sources:
(1) Aquatic warbler: http://ptaki.info/wodniczka;
(2) Northern lapwing: http://www.bird-watching.pl/picture.php?/3036/category/110 (author: Marcin Łukawski);
(3) Ruff: http://www.birdwatching.pl/galeria/ostatnio-dodane/zdjecie/37759 (author: Tomasz Skorupka);
(4) Black-tailed godwit: http://ptaki.info/imgekoprojekty/image/ptaki/komentarze/367.jpg (author: Łukasz Talaga);
(5) Eurasian curlew: http://www.birdwatching.pl/galeria/kategoria/191-kulik-wielki-numenius-arquata/zdjecie/52068 (author: Adam R. Markowski);
(6) Eurasian wigeon: https://ciechus.flog.pl/wpis/6805645/swistun (author: Adrian Ciechanowski).

The utility expression is separable in the observed choice attributes, $\mathbf{X}_{ijt}$, with the corresponding vector of parameters, $\boldsymbol{\beta}$, and the stochastic component, e_{ijt}, accounting for factors other than those observed by an econometrician. Assuming that the stochastic component (e_{ijt}) follows an independent and identical extreme value (type I) distribution,[12] it leads to familiar logit probability specification, used in simple conditional logistic regressions:

$$P(j|J) = \frac{\exp(\mathbf{X}_{ijt}\boldsymbol{\beta})}{\sum_{k=1}^{J}\exp(\mathbf{X}_{ikt}\boldsymbol{\beta})}, \tag{2}$$

which can be used for deriving the maximum likelihood estimator of the utility function parameters, conditional on individuals' observed choices and attribute levels associated with choice alternatives.

Given that we are interested in the marginal rates of substitution with respect to the monetary attribute p, it is convenient to introduce the following modification of (1), which is equivalent to using a money-metric utility function (in our case, it means estimating the parameters in WTA space) (Train and Weeks 2005):

$$U_{ijt} = \alpha\left(p_{ijt} + \boldsymbol{Y}_{ijt}\,\boldsymbol{b}/\alpha\right) + e_{ijt} = \alpha\left(p_{ijt} + \boldsymbol{Y}_{ijt}\boldsymbol{\beta}\right) + e_{ijt}. \tag{3}$$

In this specification (rescaling of the utility function), the vector of parameters, $\boldsymbol{\beta} = \boldsymbol{b}/\alpha$, can be directly interpreted as a vector of implicit prices (marginal WTAs) for the non-monetary attributes, $\boldsymbol{Y}_{ijt}$, facilitating an interpretation of the results.

Finally, note that in the above formulations, consumers' preferences are assumed homogenous across the entire sample (the parameters, $\boldsymbol{\beta}$, are the same for all respondents). This results in a multinomial logit model (MNL). One way of relaxing this assumption – that is, allowing for some level of (unobserved) preference heterogeneity and, possibly, correlations between the alternatives and choice tasks – is to is to include consumer-specific parameters, $\boldsymbol{\beta}_i$, which leads to a mixed logit model. A commonly used approach is to make mixing distribution continuous. If individual parameters are assumed continuously distributed following a parametric distribution specified a priori by a modeler, $\boldsymbol{\beta}_i \sim f(\mathbf{b}, \boldsymbol{\Sigma})$, with means, $\mathbf{b}$, and

[12] Note that normalizing variance does not change the ordering provided by the utility function – it still represents the same preferences.

variance-covariance matrix, $\boldsymbol{\Sigma}$, the random parameters mixed logit model is formed (RP-MXL, McFadden and Train 2000, Hensher and Greene 2003).

3.4. Participative approach

As noted earlier, the design of the study involved extensive qualitative research. Local stakeholders were included in the iterative process of identification of the environmental problems of the Biebrza Valley and the design of the discrete choice experiment. The results of the study were discussed at the workshop with local stakeholders and the authorities from the Biebrza National Park. They contributed to validating the results, placing the modelling exercise in a broader context, with special emphasis on current policy making process, a discrepancy between environmental goals and cost minimization, and existing obstacles in efficient implementation of agri-environmental schemes. The results of these consultations are indicated in the discussion section of our paper.

4. Results

We start by presenting the general overview of respondents' preferences through the random parameters mixed logit (RP-MXL) model. Table 3 presents the estimates of means and standard deviations of the distributions of respondents' WTA for contract characteristics. The mean WTA for the types of contract refer to a one-year contract of a particular type, with no contract being the reference.

Table 3. Farmers' reservation prices for (WTA) participation in new agri-environmental contracts (in EUR per ha per year)

	Mean	St. Dev.
Fertilization	-18.76 (25.72)	222.83*** (30.36)
Diversification	-136.10*** (21.00)	213.09*** (29.43)
Catch crops	-90.69*** (22.86)	195.22*** (44.95)
Basic protection of peatlands	31.10 (33.38)	118.04 (77.70)
Extended protection of peatlands	-27.81 (32.17)	153.97*** (27.78)
Extensive meadow use	-61.36*** (10.81)	108.29*** (9.87)
Livestock reduction	-40.55*** (7.20)	77.26*** (19.54)
Length - Fertilization	-27.83*** (3.19)	24.74*** (4.35)
Length - Diversification	-26.81*** (3.46)	14.70*** (2.74)
Length - Catch crops	-26.55*** (2.97)	21.26*** (3.98)
Length - Protection of peatlands	-8.01** (3.24)	25.16*** (3.96)
Length - Extensive meadow use	-14.75*** (1.23)	18.97*** (1.97)
Length - Livestock reduction	-23.94*** (2.79)	21.59*** (2.99)
Possibility to cancel - Fertilization	42.90** (16.70)	132.69*** (27.77)
Possibility to cancel - Diversification	71.32*** (20.97)	120.51*** (31.36)
Possibility to cancel - Catch crops	102.84*** (20.92)	149.42*** (24.39)
Possibility to cancel - Protection of peatlands	-0.97 (21.97)	99.77*** (26.84)
Possibility to cancel - Extensive meadow use	52.11*** (10.12)	68.49*** (16.84)
Possibility to cancel - Livestock reduction	136.27*** (31.74)	243.59*** (40.38)
Model diagnostics		
LL at convergence	-5,308.08	
LL at constant(s) only	-6,849.26	
McFadden's pseudo-R^2	0.2250	
Ben-Akiva-Lerman's pseudo-R^2	0.4577	
AIC/n	1.6419	
BIC/n	1.6867	
n (observations)	6,518	
r (respondents)	463	
k (parameters)	43	

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Standard errors provided in parentheses. All WTA distributions were assumed normal. The coefficient associated with the confounded subsidy level and the scale parameter was assumed log-normal. Detailed results, including DCE-specific scale controls are available in an online supplement to this paper.

We find that the studied farmers required the highest compensations for crop diversification (136 EUR per contracted ha per year) and catch crops (90 EUR), followed by extensive meadow use (61 EUR) and livestock reduction (41 EUR per livestock unit reduced per year). The farmers' reservation price associated with one-year contracts for basic and extended protection of peatlands and for improved fertilization contracts were not statistically significantly different from zero indicating that these contracts are relatively easiest and cheapest to implement by farmers. The longer contracts required higher compensations, as indicated by negative and statistically significant coefficients of mean WTA for the length attribute. The estimated coefficients of length are relatively similar, irrespectively of the contract type. They indicate that each additional year of contract length leads to an increase in an average farmer's reservation price of approximately 25 EUR per ha.[13] Finally, we observed farmers preference for the option of cancelling the contract. It reduced the WTA for an average contract by from 136 EUR (livestock reduction) and 103 EUR (catch crops), through 71 EUR (diversification), to 52 (extensive meadow use) and 43 EUR (fertilization). The mean WTA change resulting from the option to cancel the contract for peatland protection, which was associated with relatively easiest to satisfy requirements and with fewer alternatives for these areas, was not significantly different from zero.

Finally, we note that there is substantial unobserved heterogeneity of the estimated WTA between farmers, as evidenced by relatively large and significant estimates of standard deviations of the WTA distributions. We are able to explain part of this heterogeneity using observable farmer and farm characteristics in the next section.

4.1. Observed heterogeneity of farmers' preferences

We now turn to explaining the results of the model with observable characteristics of farms and farmers. This is done by introducing explanatory variables of the means of random parameters associated with the choice attributes. The results are presented in Table 4.

We observe that farmers' WTA differs with respect to whether they are mainly crop producers, mixed crop and livestock producers or focus on livestock production only. For example, crop producers required lower compensations for implementing catch crops and extensive meadow use contracts, while livestock producers had substantially higher reservation

[13] In a side analysis, we investigated the functional relationship of the length of the contract and its resulting WTA increase, by including a set of length-specific dummy variables. We found that the relationship was close to linear.

prices for nearly all types of contracts, but on the other hand, valued the possibility to cancel a contract lower.

The WTA new contracts also differs with respect to the scale of production on a farm. The farms with more arable were less likely to accept extensive meadow use and catch crop contracts, but more appreciative of livestock reduction and the possibility to cancel. As expected, farmers with more types of crops on their lands were more likely to accept contracts for diversification; at the same time they were more positive about extensive meadow use, and the possibility to cancel. Farms with larger intensity of livestock production had lower reservation prices for catch crop contracts, and higher WTA for livestock reduction. Once again, the higher the intensity of production, the larger the implied benefits of the possibility to cancel.

Regarding the work force available at the farm, we find that these types of farms have lower reservation prices for most types of contracts (except for livestock reduction) and value the possibility to cancel a contract lower.

With respect to the location of the farm, we find that farms with streams or rivers in their area to be more positive about all types of contracts, and particularly about the extended protection of peatlands. On the other hand, farms with areas that are subject to flooding are more in favor of fertilization and livestock reduction contracts, but prefer diversification contracts less. We also find that farms that have larger share of their land in Natura 2000 are substantially more willing to participate in basic protection of peatland and extensive meadow use contracts. Finally, we observe that farmers who participated in AES in the past are generally less negative about the length of a contract and value the possibility to cancel less, indicating that their experience with AES contracts is positive.

In summary, our study allowed for providing a detailed picture of respondents' preference heterogeneity with respect to their socio-demographic and farm characteristics. Our results can be used to predict reservation price of a particular farmer, and this information could be used to tailor more effective AES in the future, by making them more cost-efficient and increasing their adoption. As a result, our results provide a direct input to policy making.

Table 4. Farmers' WTA for participation in new agri-environmental contracts – socio-demographic and environmental interactions (in 100 EUR per ha per year)

	Main effects		Interactions					
	Mean	St. Dev.	Crop prod. (vs. mixed prod.)	Livestock prod. (vs. mixed prod.)	Arable land	Number of crops	Livestock / ha	Work force normalized
Fertilization	-143.82***	181.10***	-55.52	-117.32***	1.76	27.78*	28.60	30.50**
	(52.31)	(11.04)	(46.18)	(41.79)	(13.52)	(14.48)	(22.80)	(12.71)
Diversification	-124.66**	160.57***	6.24	-165.91***	-0.74	49.88***	45.68*	57.26***
	(52.50)	(9.41)	(44.68)	(40.69)	(13.85)	(14.52)	(23.40)	(12.99)
Catch crops	-245.89***	146.52***	88.25**	-133.80***	-36.74**	13.15	128.97***	54.46***
	(51.45)	(8.24)	(42.14)	(40.68)	(14.46)	(14.12)	(23.74)	(13.16)
Basic peatland protection	-139.13	79.10***	69.08	-230.98***	7.67	26.28	18.02	-5.56
	(86.83)	(20.47)	(71.66)	(62.21)	(23.62)	(18.97)	(28.24)	(30.89)
Extended peatland protection	-356.34***	69.98***	130.56*	-136.95**	-4.72	-2.95	25.40	67.86**
	(110.38)	(19.48)	(77.88)	(66.61)	(26.32)	(24.53)	(32.17)	(33.75)
Extensive meadow use	-266.32***	213.53***	68.03**	-25.91	-80.63***	56.72***	-7.24	10.37
	(34.74)	(12.94)	(27.00)	(18.71)	(11.83)	(9.50)	(10.51)	(10.50)
Livestock reduction	-156.05***	79.55***	-43.21	-17.78**	15.66***	-21.87***	-9.85***	-7.76***
	(18.49)	(8.77)	(32.90)	(7.14)	(2.00)	(3.48)	(2.08)	(2.58)
Length	-6.27**	24.16***	-5.29**	-6.50***	4.06***	-2.45***	-0.34	2.17**
	(2.93)	(1.19)	(2.19)	(1.96)	(0.61)	(0.78)	(0.66)	(0.87)
Possible to cancel	156.26***	113.62***	-16.46	-62.35***	26.02***	18.48***	36.92***	-15.35**
	(19.46)	(6.55)	(16.01)	(13.80)	(5.47)	(5.86)	(8.49)	(6.95)

	Interactions							
	Farm with streams or rivers	Farm with areas subject to flooding	Share of land in Natura 2000 and National Park	Has participated agri-env schemes	Subjective bird knowledge normalized	Subjective AE practices for birds knowledge normalized	Number of birds recognized	Info treatment
Fertilization	26.49 (23.06)	82.67*** (22.32)	78.11 (119.70)	264.54*** (30.99)	33.57* (18.18)	-53.61*** (18.66)	0.00 (6.85)	-82.51*** (22.56)
Diversification	70.66*** (24.32)	-66.76*** (24.16)	62.15 (108.33)	188.48*** (30.15)	4.85 (18.50)	-12.24 (19.29)	8.96 (6.64)	-50.47** (22.38)
Catch crops	98.82*** (24.39)	-0.96 (22.96)	-1.09 (124.18)	182.54*** (30.19)	23.37 (18.01)	-41.50** (18.13)	23.59*** (6.64)	-52.85** (21.74)
Basic peatland protection	135.69** (65.97)	55.78 (69.17)	778.20*** (217.35)	30.49 (63.64)	23.65 (22.35)	-18.11 (23.53)	32.35*** (11.98)	-12.74 (38.72)
Extended peatland protection	211.45*** (71.19)	-12.50 (76.32)	365.45 (228.31)	27.38 (73.98)	-6.97 (23.00)	-10.67 (24.84)	51.20*** (13.71)	29.54 (43.08)
Extensive meadow use	23.84 (18.31)	22.68 (19.15)	353.26*** (75.19)	203.62*** (26.04)	-26.26** (12.50)	32.98** (12.87)	24.55*** (6.67)	6.14 (18.12)
Livestock reduction	18.78*** (6.16)	40.83*** (10.41)	42.39*** (13.94)	71.85*** (8.85)	-1.36 (3.73)	13.90*** (1.96)	6.68*** (2.17)	-6.32 (6.13)
Length	-7.18*** (1.80)	3.69** (1.67)	14.61 (9.60)	-0.36 (1.81)	5.04*** (0.79)	2.93*** (0.81)	-3.54*** (0.51)	-0.88 (1.41)
Possible to cancel	45.37*** (14.21)	-24.18* (13.52)	199.54*** (65.52)	-24.42* (12.61)	-23.24*** (6.54)	11.41 (7.26)	-20.72*** (3.15)	-6.70 (10.62)

Model diagnostics	
LL at convergence	-3,873.96
LL at constant(s) only	-5,453.10
McFadden's pseudo-R^2	0.2896
Ben-Akiva-Lerman's pseudo-R^2	0.4927
AIC/*n*	1.5417
BIC/*n*	1.7460
n (observations)	5,237
r (respondents)	367
k (parameters)	163

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Standard errors provided in parentheses. All WTA distributions were assumed normal. The coefficient associated with the confounded subsidy level and the scale parameter was assumed log-normal. Detailed results, including DCE-specific scale controls are available in an online supplement to this paper. Selected explanatory variables were normalized for zero mean and unit standard deviation in the sample, to facilitate convergence and allow for easier comparisons between the relative influence of various normalized variables. Detailed results, including DCE-specific scale controls are available in an online supplement to this paper.

4.2. Knowledge and information as drivers of farmers' preferences for AES

In addition to controlling for various socio-demographic and farm characteristics, our model also allows to investigate the links between respondents' subjective knowledge levels and their preferences, expressed in terms of WTA for various attribute levels (see Table 2 for details). We found that respondents who subjectively declared higher knowledge levels of protected bird species had higher reservation prices for extensive meadow use, lower WTA for lengthier contracts and valued the possibility to cancel less. At the same time, those who believed that they know more about which contracts are best for protecting birds had higher reservation prices for fertilization and catch crop contracts, and lower WTA for extensive meadow use and livestock reduction.

Somewhat conversely to subjective levels of knowledge, respondents with higher objective level bird knowledge, verified using our quiz, were more likely to accept most of the considered AES contracts and valued the possibility to cancel lower. At the same time, they required higher compensations for longer contracts. This interesting dichotomy between the effects of subjective knowledge of birds and AES aimed at the conservation of birds versus the actual knowledge of birds could be a manifestation of a Dunning-Kruger effect (Kruger and Dunning 1999), which stipulated that people with lower ability assess their cognitive ability higher, as a result of the lack of the awareness of their self-incompetence.

Finally, our experimental treatment allowed to test if providing respondents with extra information about the environmental aims and benefits of various AES influenced their participation decisions. Interestingly, we found that providing respondents with an information about the environmental benefits of leads to higher reservation prices for fertilization, diversification and catch crops contracts. In other words, respondents who learn about the benefits of these contracts require higher compensation for their implementation. This result is potentially at odds with the policies that aim at promoting awareness and knowledge, as means to increase participation. In our case, the results can be interpreted as an evidence for farmers' propensity to maximize profits and mercantile approach to AES.

5. Discussion of the results with local stakeholders

The results presented in section 4 were discussed with local stakeholders.[14] The DCE results were in line with practitioners' expectations. The levels of required payments for the studied measures can be related to alternative costs of their implementation and therefore transferable to other regions with similar environmental problems. However, direct estimates of WTA have limited transferability between countries, as differences in levels of payments within EU may serve as anchors, leading to substantial differences between countries.

The stakeholders often observed that current levels of AES payments in Poland are too low to be effective, particularly when compared with other EU countries and considering the rising costs of implementation, including both alternative costs related to the intensification of agricultural production and the production and labor costs. In this region of the Valley, the forgone profits resulting from reduced mowing can be substantial, as many farms in the Biebrza Valley are milk producers and the price of hay significantly influences local market conditions. According to the European Agricultural Fund for Rural Development payment levels for AES should be based on the principle of compensation for profits foregone, compensate for additional costs incurred and income foregone, with up to an additional 20 per cent of premium to cover transaction costs. In our case, this does not make AES the first choice from the profitability point of view, which leads to non-inclusion of the most demanding but at the same time the most ecologically valuable land. The stakeholders also generally expressed their concern that the farmers in the region are pure profit maximizers, motivated solely by financial incentives. This may lead to potential motivational crowding-out towards other good farming practices caused by an increase in agri-environmental payments.

Our results allow for the comparison of farmers' WTA with the current levels of payments. The latter reveals the lower bound of the regulator's valuation of environmental benefits associated with the measures, as they are calculated using the estimated cost approach and implemented only if the estimate does not exceed expected benefits of implementing a measure. Marginal valuation

[14] Specifically, we organized 2 consultation meetings with 11-14 participants each, and 2 on-line surveys filled out by 6-13 respondents. Stakeholders represented management of national parks, agricultural advisors, representatives of NGOs, State Forests, tourism sector, and local authorities.

is particularly difficult, as environmental benefits depend on how commonly the measures are applied. Nonetheless, our study provides policy-relevant information regarding the farmers' WTA. Overall, estimated mean reservation prices for each measure was slightly lower than the levels of payments in the current AES program, which as a result of substantial preference heterogeneity, leads to the conclusion that assuring a wider adoption would require high increase of the subsidy levels. We note that alternative solutions, such as results-based contracts, can be a more economically efficient way of assuring high environmental effects.

Under current European system, agri-environmental payments are regressive in relation to the uptake area. As we observed from qualitative component of our study, this has a disturbing effect on the leasing of agricultural land. Considering that much of the agricultural land in Poland in leased, the directional support related to farm size included in leasing agreements can seize the agri-environmental payments, that goes to the land owner, and not to the farmer involved in the practices and production. Furthermore, farmers can choose the area they lease, and therefore it might be profitable to share a bigger parcel of land between leaseholders, which is an example of potential system abuse. On the other hand, environmental benefits are often significantly higher when a larger field is maintained in an environmentally friendly way instead of many small, disintegrated fields. Overall, this is likely a source of economic inefficiency and a barrier for policy feasibility.

Consultations with local stakeholders have shown that improvement of the information flow between the local stakeholders and the central authorities is needed. It could help to identify the local specificity of the region and its needs in terms of policy. Top-down information is needed on AES coverage and monitoring results, especially on effectiveness. Bottom up flow of information in needed on local knowledge about needs and requirements.

Generality and the lack of specificity of schemes applied to different regions and farms makes policy inadequate to local needs. A disturbing problem that was identified was the lack of a mechanism to conserve unique habitats, which were subject to the same levels of payments as any other farmland. The lack of inclusions of local knowledge on environmental conditions is a significant barrier for the efficiency of current system of AES. A potential solution is empowering local environmental specialists in creation of agri-environmental policy are its further implementation.

Our stakeholder informed us about the need for new AES measures (e.g. for marshes, woodlots) and re-installation of some previously present programs (e.g., the protection of reed beds) accounting for the uniqueness of habitats. Furthermore, rigid implementation of contracts controlled by centralized authorities, regardless of changing weather and flooding conditions, can sometimes be environmentally harmful due to heterogeneity of local conditions. In particular, exemptions and flexibility in termination can be beneficial when seasonal flooding appears.

Important aspects of practices implementation cannot be controlled by central authorities, as they are not included in AES requirements. For instance, poor control over AES selection by farmers was indicated. Selection of schemes requires environmental expertise, but costs of expertise by ornithologists, who give opinion on spices protection practices is lower than expertise by botanist, who suggest protection of habitats, and at the same time payments for „birds" are higher than for habitats. The choice of schemes is often motivated by financial and not environmental factors, which can be seen as a form of rent-seeking by farmers, and can lead to an abuse of the current system. Feedback and cooperation between local and central groups of interest could lead to identification of factors that are perceived as the key drivers of the provision of public goods.

Effective maximizing biodiversity conservation requires a combination of broad agri-environmental measures and specific, targeted measures (Vickery et al. 2004, Feehan et al. 2005). In intensively farmed regions, broad measures can be applied to improve biodiversity condition; targeted measures can be used to protect high nature value areas, but for best effects their implementation requires flexibility in terms of timing and actions taken by local farmers (Vickery et al. 2004, Aviron et al. 2005, Uthes and Matzdorf 2013). The latter was also noticed by the stake holders of our study area.

Finally, we note that for a full cost and benefit analysis one needs information on relevant measures of environmental benefits. Measurement of environmental benefits requires a careful monitoring of agri-environmental schemes' impact on local environmental conditions, which have not been implemented in our case study region. It is therefore unclear how the level of public goods provision performs under changing conditions in the long-run perspective. It was spontaneously brought up by local stakeholders that to improve environmental conditions in the Biebrza Valley, closer monitoring of effects, spatial analysis of effects or even ownership of some areas by the state is needed, because it could increase efficacy of practices implemented.

6. Summary and conclusions

We estimated farmers' reservation prices for participation in AES required to protect biodiversity in the Biebrza Valley. We identified substantive differences in mean WTA for seven agri-environmental practices under study: precision fertilization, crop diversification, catch crops, peatland protection (basic and extended), extensive use of meadows, and the reduction of livestock stocking density.

Similarly to Christensen et al. (2011), Ruto and Garrod (2009) and Broch and Vedel (2011), we observed farmers preference for flexibility, in terms of shorter contracts and the possibility to terminate a contract without additional costs. On the other hand, the delivery of environmental benefits requires stable, long-term implementation of environment-friendly practices. As a result, the current policy may be seen as a consensus between farmers and environmental experts: 5 years is enough for environmental benefits to appear.

We observe substantial preference heterogeneity that can partly be attributed to farm characteristics, such as the area of arable land or livestock stocking density. These results provide policy-relevant insights regarding farmers' motivation and willingness to adopt AES. However, even after accounting for various sources of observed heterogeneity, substantial unobserved preference heterogeneity remains, indicating the diversity of farmers' decision rules and motivations. Interestingly, our results indicate the existence of the path dependency effect – farmers who have past experiences or more knowledge about specific AES are likely to value them differently from others.

In-depth analysis of farmers' intrinsic motivations can generally lead to identification of new cost-efficient ways to increase participation rates in agri-environmental policies, such as the use of information and enhancing knowledge, to safeguard the provision of public goods. Even though the local stakeholders were skeptical about this effect, expecting that farmers' decisions are driven by cost-benefit calculation, we observed a distinct effect of subjective and objective knowledge, as well as providing information about environmental benefits of AES. We found that respondents who *subjectively* declared higher knowledge levels of protected bird species had higher reservation prices for extensive meadow use, lower WTA for lengthier contracts and valued the possibility to cancel less. At the same time, those who believed that they know more about which contracts are best for protecting birds had higher reservation prices for fertilization and catch crop contracts, and lower WTA for extensive meadow use and livestock reduction. Conversely, respondents with higher *objective* level bird knowledge were more likely to accept most of the considered AES contracts and valued the possibility to cancel lower. At the same time, they required higher compensations for longer contracts. We interpret this dichotomy as a manifestation of a Dunning-Kruger effect (Kruger and Dunning 1999), which stipulates that people with lower ability assess their cognitive ability higher, as a result of the lack of the awareness of their self-incompetence.

On the other hand, providing respondents with extra information about the environmental aims and benefits of various AES led to higher reservation prices for fertilization, diversification and catch crops contracts. In other words, respondents who learned about the benefits of these contracts required higher compensation for their implementation. This result is potentially at odds with the policies that aim at promoting awareness and knowledge, as means to increase participation, while it is in line with the interviewed stake-holders' expectations that farmers' decisions are predominantly driven by profit maximization goals.

Overall, our study provides new insights into farmers' willingness to adopt extensive farming practices in globally important bird areas, and more generally – on ecologically valuable farmland. Identification of the social, demographic, economic and behavioral factors that influence preferences for participation in AES can be used to prepare future schemes that will be better tailored to farmers' preferences, and thus more cost efficient and more widely adopted.

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