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Original Research

Farming Systems in High Nature Value (HNV) Farmland: a Case Study of Wigry National Park, Poland

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Abstract

Our research was based on data obtained from a questionnaire administered in 2005 distributed to 80 farms in Wigry National Park in northeastern Poland. The questionnaire concerned agricultural production and the attitudes of farmers for future plans, especially connected with sustainable development, e.g. organic farming. The data were analyzed using a classification based on two-dimensional criteria: farm size (in ha of UAA) and type of production, as well as multivariate statistical methods such as cluster analysis and principal component analysis. From the analyses, six groups of farms were identified according to the characteristics of their farming systems, and the relationships between the examined variables were evaluated. A large percentage of the farms (approximately 32%) were classified as units that served primarily social functions, with an average area of approximately 10 ha. The other groups of farms identified were characterized by medium- or low-intensity agricultural production. Only one group, consisting of approximately 13% of the farms, performed intensive cattle production (LSU above 1 per ha) and used higher levels of fertilization (above 100 kg NPK per ha).

Keywords: farm diversity, HNV, Wigry National Park, farming systems

Introduction

Wigry National Park is located in northeastern Poland in Podlasie Province, and creates part of the functional area known as the "Green Lungs" of Poland. It was created in 1989 to include territory from four communes and covers an area of 15,085.5 ha, with an 11,284 ha buffer zone. The dominant economic activity in the protected areas is farming.

The utilized agricultural areas (UAA) equal 14.8% of the park, consisting of 11.1% arable land (AL) and 3.6% grassland [1]. Conditions are unfavorable for farming due to the severe climate and low agricultural quality of the soils. The average agricultural suitability index value of the soil for communes located within the WNP is 41.1 points, according to the Polish scale [2], which means the soil and climate are very poor for agricultural production. The central part of the park consists of Lake Wigry – the largest and deepest lake in the park, ranked the 12th largest in Poland. To maintain the bacteriological purity of the lake water it is necessary to minimize agriculture, tourism, and other activities in the surrounding areas, especially manure storage [3].

It is common knowledge that to ensure sustainable development and to protect biodiversity in high nature value (HNV) areas such as national parks, low-intensity farming should be practiced [4]. Sustainable agriculture is

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also important for the preservation of traditional agricultural landscapes, which are strongly connected to biodiversity [5]. Changes in land use, through the intensification of agricultural production or its total abandonment, lead to drops in biodiversity as well as changes in the natural habitat and landscape [6-8].

Research conducted in Polish national parks, their buffer zones, and landscape parks examining agricultural production and its intensity indicates that the conventional low-intensity system is most prevalent in these areas [1, 9-11], though these techniques do not guarantee the farm will produce a sufficient level of income.

Opportunities for improving the income of farms in valuable nature areas, as noted by many authors [1, 9, 12, 13], can be observed in the development of non-agricultural activities such as tourism and agrotourism, as well as through small and medium enterprises based on local raw materials. The financial instruments of the EU can also have an important role within the CAP, e.g. the agri-environment program, the afforestation program, subsidies for areas with less favorable conditions (LFA), and predicted EU payments to be made directly to HVN areas [14]. To ensure that funding intended to support environmental protection in HVN areas is properly allocated, the creation of a typology of farms may be helpful in assessing the extent to which farmers' practices are in compliance with environmental protection standards and requirements. Farm typology is a useful tool for predicting and evaluating policies to support diverse types of farms. The identification of farm groups may assist in anticipating changes about to take place on farms, adapting specific forms of support from EU funds, implementing new technologies, introducing environmental directives, and enabling economic simulations for each farm type [15, 16].

The purpose of the study was to determine the diversity of farms in the WNP and divide the farms into homogeneous groups based on characteristics of farming technology and the impact of the farms on the environment. Once identified, the farms were described and evaluated according to their future prospects and their suitability for development within Wigry National Park and its buffer zone. In the evaluation, multivariate criteria concerning agricultural production and environmental impacts were considered.

Materials and Methods

The questionnaire was administered to farmers in Wigry National Park and its buffer zone (WNP) (Fig. 1). Utilizing data specifying environmental conditions and the level of agricultural production, the main regions of agricultural production were identified, and questionnaires were disseminated to randomly selected farms within those regions that engage in agricultural production on an area over 1 ha. The surveys were administered through direct personal interviews with the farm owners.

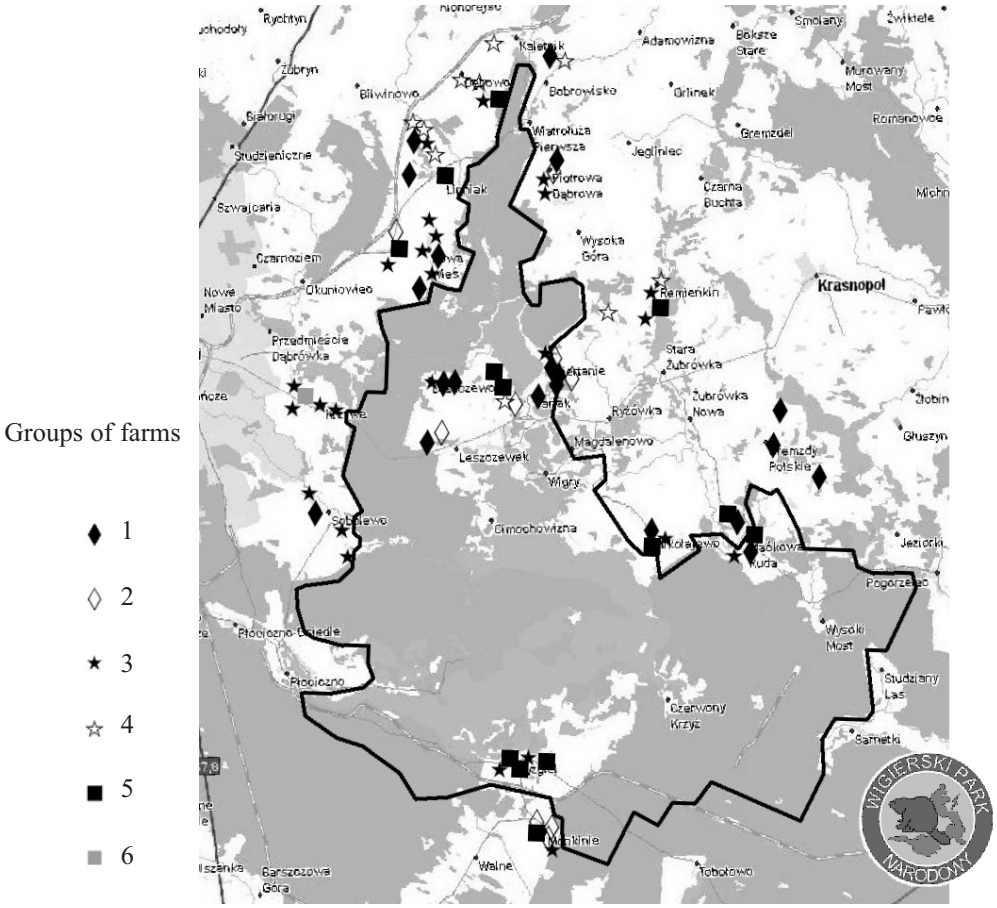

Fig. 1. Wigierski National Park territory and the locations of the assessed farms within Podlasie Province (groups of farms are described in Table 4).

From the research questionnaire conducted in 2005, 80 interviews were obtained, 78 of which were taken into consideration after being subjected to an initial analysis. Of those examined, 23 farms were located in the national park area, while 55 farms were located in the national park buffer zone. The total number of farms located in the area of the park and the buffer zone is approximately 800 (author estimation – lack of official data), but only approximately half of them conduct agricultural production; the smallest farms rent their land to larger farms. The total area of WPN is approximately 15,000 ha, with approximately 15% being utilized for agricultural production. The total area of the buffer zone is approximately 11,300 ha [17], with approximately 50% (author estimation – lack of official data) being utilized for agricultural production. Forests and lakes are prevalent in the WPN, constituting approximately 60% of the total area, while the buffer zone is predominantly agricultural areas and forests. This means approximately 10% of the farms were surveyed (approximately 20% of farms above 1 ha UAA conducting agricultural production) and the area covered by the farms is nearly 20% of the total agricultural area of the national park and the buffer zone.

The questionnaire covered specifications and descriptions of the farm: its utilized agricultural areas (UAA), land use, livestock density, the amount of mineral fertilizer used, ways of using the meadows and pastures, performance of a soil chemical analysis and the application of liming, as well as the level of technical infrastructure in which the farm is equipped. The questionnaire also included questions concerning the farm owners and their households: the farmer's age, level of education, number of persons employed outside the farm, performance of non-agricultural activity on the farm, developmental strategies, and the future plans and intentions of the producers, including possible interest in the organic system of production.

The data obtained from the questionnaire were classified using two methods:

1) Classification based on two-dimensional criteria, i.e., farm size (in ha of UAA) and type of production (livestock density).
2) Ward's method of cluster analysis to distinguish homogeneous groups of farms.

Principal component analysis (PCA) was conducted to obtain information on the relationships between the given variables.

The main aim of the cluster analysis is the evaluation of multivariate similarities of the objects based on multivariate distances, e.g. Euclidean distance. Objects that are similar according to a set of variables are grouped into clusters. To ensure the variables were equally weighted in the analysis, all variables were standardized.

The number of groups to be distinguished was set *a posteriori*, on the basis of a dendrogram obtained in the cluster analysis. A distinction was made on the basis of the variability within and between the distinguished groups. The main criteria were small variability in the groups (homogenous groups) and a rather low number of groups. The F-statistic was based on the analysis of variance for the comparison of the distinguished groups presented, or on the χ^2-statistic, which was based on a chi-square test; the higher the F-value or χ^2-statistic, the higher the diversity between the examined groups (a p-value below 0.05 indicates significant differences between the groups).

Table 1. Description of the observed variables used for distinguishing the types of assessed farms in WPN.

Code	Variables	Units
X1	Use of co-financing from EU funds (excluding direct payments)	binary scale: 1 (yes), 0 (no)
X2	Size of utilized agricultural areas (UAA) in the farm	ha
X3	Conduction of non-agricultural activities (activity that generates income but is not connected with crop and livestock production)	binary scale: 1 (yes), 0 (no)
X4	Share of cereals in AA (arable area)	%
X5	Rate of NPK in mineral fertilizers	kg·ha^{-1} UAA·year^{-1}
X6	Cattle density	LSU·ha^{-1} UAA
X7	Livestock density	LSU·ha^{-1} UAA

PCA is a multivariate method that allows the researcher to present relationships between variables and to characterize objects (in this case, the farms). If new variables, i.e. principal components, explain most of the total variability, it is possible to reduce a set of traits to a limited set of PCs (e.g. PC1 and PC2) and present the relationships in two-dimensional space. PCA was conducted on the basis of a correlation matrix and assumed a linear relationship between the analyzed variables.

The final set of traits taken into consideration in the statistical analysis included 7 variables selected under a subjective rating of all of the data obtained in the questionnaire. The variables give broad information about the functioning of agricultural farms in the studied area. Variables that did not show significant variability or resulted in highly inhomogeneous groups, in terms of production, were removed. The variables that were included in the analysis have been presented in Table 1.

Results

Description of the Farms

The total area of the utilized agricultural areas (UAA) in the WNP farms included in the study (n=78) was 1,455.5 ha, while the average area of UAA on each farm was 18.7 ha, and was greater for those farms located in the buffer zone (20.6 ha; n=55) in relation to the farms within the territory of the park (14.0 ha) (Table 2).

The largest group in the WNP consisted of farms with total area ranging from 10 to 20 ha and from 20 to 50 ha (35.9% and 30.8%, respectively). In 35.9% of the farms, the land was leased from other farms. It should be noted

Table 2. The total area of the studied farms and the average area per farm for the park and buffer zone of the WNP.

	Number of farms	∑ [ha]	Average [ha]	Standard deviation [ha]
Total	78	1455.5	18.7	15.0
Park	23	322.0	14.0	7.16
Buffer zone	55	1133.5	20.6	16.9

that many farmers admitted that they lease land without any official agreements. The structure of the UAA among the farms included in the questionnaire is presented in Fig. 2.

Arable land (AA) within the territory of the studied farms encompassed 66.2% of the utilized agricultural areas, 3% of which was left as grassland on arable land. Permanent grassland in the WNP covered 27.6% (18.1% – meadows, 9.5% – pastures). Land excluded from agricultural production constituted only 2.4%; uncultivated land 3.7%; and orchards covered an insignificant fraction of the surface area. A common practice in the WNP is the exclusion of land from agricultural production and the presence of uncultivated land, which is a valuable nature area. The presence of uncultivated land was reported in approximately 65% of the farms. Animal production was maintained in almost 95% of the farms. The majority of farms reared and bred cattle at the same time (approximately 76%), and almost always kept pigs (82.1%). Horses were bred on 36% of the farms. Apart from the common keeping of poultry (approximately 76%), the keeping of other animal species was occasionally practiced.

The average farm livestock density in the studied farms amounted to 0.56 LSU·ha^{-1} UAA. It is worth pointing out that farms with livestock exceeding 2 LSU·ha^{-1} UAA were very uncommon (only one farm), and farms where the livestock exceeded 1.5 LSU·ha^{-1} UAA constituted only 2.6%. The majority of farms had a low cattle density that on average amounted to 0.36 LSU·ha^{-1} UAA. Pig density on average amounted to 0.098 LSU·ha^{-1} UAA, while the horse density was equally low and constituted 0.094 LSU·ha^{-1} UAA. The average poultry density amounted to 0.01 LSU·ha^{-1} UAA.

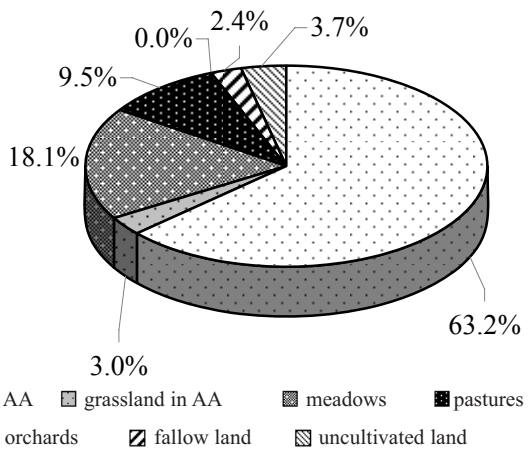

Fig. 2. Land use of the studied area based on survey results.

Arable land was mainly farmed with cereals; the average share of cereals in the studied farms amounted to almost 78.5%, which is higher than the maximum amount, guaranteeing a balanced method of farming (66%). Among the remaining plant species, root crops dominated.

The average share of land used to cultivate potatoes in the studied farms amounted to 6.48%. The average share of fodder crops was 11.3%, which may be due to the animal production orientation of the studied farms. Industrial crops were rarely cultivated, and their share on average constituted 1%. The average share of the remaining crops amounted to only 2.05%.

The average age of farm owners was 43.5 years. The average number of inhabitants per farm in the territory of the WNP was 4.97 persons, 2.55 persons were employed on the farm, and approximately 1.09 persons worked outside the farm.

Agricultural production in the majority of farms was conducted in a conventional system with a varied degree of intensity; only 1.3% of farms possessed a certificate of conformity for organic farming.

The desire to increase the size of their farm was declared by 47.7% of farmers, while the desire to increase agricultural production was declared by 14.4%. Maintaining the current level of production was a desire declared by 37.2% of respondents. None of the respondents declared the desire to reduce the size of the farm by giving up land through lease or sale. One farm owner expressed the desire to give up agricultural production by putting the whole farm up for lease. The studied farms were divided into groups based on two approaches: the first approach is based on farm size and type of production, while the second is based on a multivariate classification using cluster analysis.

Grouping Farms on the Basis of Size and Type of Production

The study farms were divided using two-dimensional criteria, i.e. farm size and type of production. The first criterion is farm size, i.e., three groups of farms were distinguished: small – below 10 ha of UAA, medium – between 10 and 25 ha, and large – above 25 ha of UAA. The second criterion was livestock production, wherein three groups of farms were distinguished: farms with a crop farming system where the livestock density is below 0.5 LSU per ha, farms with a mixed crop-livestock system where the livestock density is between 0.5 and 0.85, and farms with a livestock density above 0.85 LSU per ha. The criteria were similar to the FADN classification system used in Poland [18].

Table 3. Grouping of farms based on farm size and type of production.

Size of farm (ha of UAA)	Number of farms	Share of cereals in AA %	Rate of NPK in mineral fertilizers (kg per ha)	Livestock density (LU per ha)	Age of farmer	Use of co-financing from EU funds %	Number of farm residents working outside the farm
Crop farming system							
Large >25 ha	3	93.7	80.1	0.24	40.00	0.0	0.67
Medium 10-25 ha	17	83.3	40.3	0.28	44.29	29.4	0.35
Small <10 ha	14	79.4	37.7	0.28	49.14	0.0	1.14
Total	34	82.6	42.7	0.28	45.91	14.7	0.71
Mixed crop-livestock farming system							
Large >25 ha	5	73.8	90.8	0.57	36.60	20.0	0.40
Medium 10-25 ha	11	83.4	64.4	0.64	44.18	18.2	0.45
Small <10 ha	2	84.7	69.5	0.74	45.50	0.0	0.50
Total	18	80.9	72.3	0.64	42.22	16.7	0.44
Livestock farming system							
Large >25 ha	5	52.2	114.4	1.05	42.00	40.0	0.40
Medium 10-25 ha	4	80.6	109.4	1.22	46.25	50.0	0.00
Small <10 ha	4	75.1	72.1	1.36	44.75	0.0	1.00
Total	13	68.0	99.9	1.20	44.15	30.8	0.46
Farms conducting non-agricultural activity							
Large >25 ha	4	80.6	106.9	0.68	41.50	0.0	0.50
Medium 10-25 ha	5	75.0	62.4	0.42	35.80	20.0	0.60
Small <10 ha	4	76.2	64.7	0.53	38.75	0.0	0.25
Total	13	77.1	76.8	0.53	38.46	7.7	0.46

The farms that conducted non-agricultural activity were distinguished as a separate group.

The results of the grouping are presented in Table 3. Most of the farms were classified as farms with a crop farming system. Farms in this group are characterized by a high share of cereals in AA and low NPK fertilization. The size of almost all of the farms in the group was small or medium, less than 10% of farms had a large size (above 25 ha). The second group contained farms with a mixed crop-livestock farming system. Most of the farms in that group were medium size (between 10 and 25 ha), medium NPK fertilization, and had a small number of residents working outside the farm.

The third group contained farms with a livestock farming system. The number of farms in the group was rather small. The farms are characterized by a lower share of cereals in UAA and higher NPK mineral fertilization. These farms use co-financing from EU funds more often.

Some farms in which activities other than crop and livestock production are significant sources of income have a high livestock density and a high level of NPK fertilization.

Results of Cluster Analysis

The set of variables used in the analysis and the mean values of the variables for the 6 identified groups of farms is presented in Table 4.

In the WNP, the greatest diversity between the identified farm groups occurred for the trait non-agricultural activity (the highest F-value), though large inter-group diversity also occurred for cattle density, livestock density and the use of funds from EU co-financing (excluding direct payments) sources. A relatively small amount of diversity was found in terms of the following variables: share of cereals in the structure of cropland and the rate of NPK·ha^{-1} used. All of the variables used for cluster analysis were statistically significantly different between groups as the P-value in the analysis of variance amounted to under 0.001.

The following groups of farms in the WNP were identified by cluster analysis:

1. Mixed farm medium intensity, whose farmers did not show initiative in use of co-financing from EU funds.
2. Low intensity farms, usually plant production, whose farmers frequently benefit from co-financing from EU funds.

Table 4. WPN – mean values of the traits in separate groups of farms and letters indicating statistically significant differences between types of farms.

	Type of farm (Types of farming systems)						Total	Significance of difference[a]
	1	2	3	4	5	6		
Farm numbers	20	9	25	10	13	1	78	
% of farm	25.6	11.5	32.1	12.8	16.7	1.30	100	
Variables used in cluster analysis								
Use of co-financing from EU funds	0.0a	88.9	0.0	40.0	7.7	0.0	16.7	***
Size of utilized agricultural areas (UAA in ha) in the farm	20.9	17.3	10.6a	25.9	20.3	95.0	18.7	***
Conduction of non-agricultural activities %	0.0	0.0	0.0	0.0	100	0.0	16.7	***
Share of cereals in AA %	83.1	64.6	87.5	61.6	77.1abc	99.9c	78.9	***
Rate of NPK fertilizers kg·ha^{-1} UAA·year^{-1}	79.2b	54.4ab	34.3a	105.3b	76.8b	71.1ab	64.8	***
Cattle density LSU·ha^{-1} UAA	0.377b	0.222ab	0.153a	1.103c	0.302ab	0.031a	0.363	***
Livestock density LSU·ha^{-1} UAA	0.647b	0.386ab	0.300a	1.236c	0.534ab	0.107a	0.555	***
Other variables								
Manure pad %	25.0a	11.1a	8.0a	20.0a	15.4a	100a	16.7	ns
Sludge storage tank %	35.0a	22.2a	20.0a	60.0a	46.2a	100a	34.6	ns
Age of farmer	44.1a	41.7a	46.7a	42.8a	38.5a	43.0a	43.5	ns
Number of persons in the farm household working outside of agriculture	0.500a	0.667a	0.720a	0.400a	0.462a	0.000a	0.564	ns
% Interested in running production in the organic system	35.0a	44.4a	36.0a	20.0a	46.2a	100a	37.2	ns

[a] – continuous variable analysis of variance was applied, and the F-statistic is presented, while a chi-square test was applied for the binomial variables, and the χ^2 statistic was presented.
*** Indicates significant differences between the groups of farms.
ns – Indicates no significant differences between the groups of farms.
Explanation of types of farms: 1 – mixed farm medium intensity, 2 – low-intensity farms, 3 – low-intensity farms with a high share of cereals, 4 – farms specialising in animal production, 5 – farms where non-agricultural activity is conducted, 6 – farms with a higher scale of production.

3. Low-intensity farms, with a prevalence of plant production and a high share of cereals in the structure of AA.
4. Farms specializing in animal production – cattle keeping, medium intensity.
5. Farms where activities other than crop and livestock production are significant sources of income.
6. Farms with a significantly higher scale of production than the remaining farms.

Mixed Farm Medium Intensity

The distinguished group of farms (n=20; 25.6%) was characterized as medium with an average farm area of 20.9 ha.

The average value of cattle density and share of cereals for the group was medium and amounted to 0.377 LSU·ha^{-1} and 83.1% in AA, respectively. Manure pads were used in 25.0% of farms, while sludge storage tanks were used in 35.0%. Of the total respondents, 35% of them would be interested in organic farming in the future.

Low Intensity Farms

The low intensity farms (n=9, 11.5%) have a medium UAA size – 17.3 ha was characterized by a low variability of benefiting from co-financing from the EU – from which almost 89% of farmers benefited. The EU funds benefiting farmers were from the following: co-financing for semi-subsistence farms – 55.6%, agri-environment program – 22.2%, and 11.1% co-financing for the construction of manure pads, subsidies for young farmers and course co-financing (some benefited from more than one source of co-financing). The share of cereals in the AA with an average of 64.6% was relatively low in comparison with other groups of farms. There were usually low doses of mineral fertilizers used, and these amounted to, on average, 54.4 kg NPK·ha^{-1} (two farms were certified for agricultural production in organic farming). Manure pads were used in 11.1% of the farms, and sludge storage tanks were used in 22.2%.

Low-Intensity Farms with a High Share of Cereals

The average area of farmland in good agricultural condition in this group of farms (n = 25, 32.1%) was 10.6 ha. This is much lower in size when compared with the other groups of farms. This group also stands out from the others by having a very low level of fertilization, with an average size of 34.3 kg NPK·ha^{-1}. The average age of farmers on this type of farm is nearly 47 years, and this value was the highest in relation to the other groups. Average livestock density was only 0.30 LSU·ha^{-1}, and cattle density achieved a very low average value of 0.15 LSU·ha^{-1}. Very few farms constructed manure pads (8.0%) and/or a sludge storage tank (20.0%).

Farms Specializing in Animal Production

The next group of farms that was identified (n=10, 12.8%) had a relatively high average farm size of 25.9 ha. The average cattle density was the highest in this group and amounted to 1.10 LSU·ha^{-1} UAA. Additionally, they had the smallest share of cereals in the AA – an average of 61.6% and a greater share of fodder crops in the UAA.

Farms where Activities Other Than Crop and Livestock Production are Significant Sources of Income

In this group (n=13, 16.7%), non-agricultural activity was conducted on all of the farms. 61.5% of this consisted of agrotourism, 15.4% was from small grocery stores, and the same percentage came from services for other farms, while 7.7% was for processing their own milk. The average size of farms in this group was quite high and amounted to 20.3 ha. The average age of the farm owner was almost 38.5 years – lower in comparison with the other groups. Only one farm benefited from EU funding (agritourism co-financing).

Farms with a Significantly Higher Scale of Production Than the Remaining Farms

In the last of the identified groups, there was only one farm with a surface area of 95 ha UAA, and it was involved in cereal production.

Principal Component Analysis Results

The results of PCA demonstrated a strong positive correlation (lines for these traits in Fig. 3 are close to parallel and in the same direction) between the amount of cattle density on the farm, livestock density, and the rate of NPK used (Table 5). The relationship between the high livestock density and cattle density indicates that the farms specializing in livestock production have moved toward cattle keeping. Simultaneously, a positive correlation between the livestock density value and the rate of mineral fertilizers used was obtained, which identifies these farms as having the highest input of production resources per ha.

Table 5. Correlation coefficients between variables and values of the first and the second principal components (PC1 and PC2).

Variables	PC1 (33.6%)	PC2 (16.8%)
Use of co-financing from EU (excluding direct payments)	0.35	0.50
Size of utilized agricultural areas (UAA) in the farm	0.33	- 0.49
Non-agricultural activities	- 0.01	- 0.64
Share of cereals in AA	- 0.43	-0.33
Rate of NPK fertilizers	0.65	-0.40
Cattle density	0.88	0.03
Livestock density	0.85	0.08

The low share of cereals in the arable area compared with high concentrations of the above-mentioned traits results from a higher share of fodder crops in those farms. Farms with high values of the first principal component, PC1, namely farms specializing in livestock production, are presented on the graph on the right (Fig. 3) – group number 4.

A very different group than No. 4, group No. 3 was the set of farms characterized with a high share of cereals in the structure of cropland and low values of following traits like livestock density, cattle density, and the rate of NPK used.

On the graph (Fig. 3), farms with high values for variable use of EU funds are located on the top, whereas those with a high UAA surface area and more often conducting non-agricultural activity are in the lower part.

The first principal component, PC1, explains 33.6% of the total variability, while the second, PC2, explains only 16.8% of the total variability of the set of traits, because correlations between PC2 with other variables are less important.

Discussion

The level of agricultural production and statements from agricultural producers as to the maintenance and development of agricultural production in Wigry National Park and its buffer zone indicate that the maintenance of the rural character of these areas in the near future can be assured, which indicates a substantial attachment of these farm owners to the land. This means the problem of farmers abandoning land that is often in the HNV [9, 14] does not apply to the research area in Wigry National Park and its buffer zone.

Just as in studies by other researchers [1, 9-11], the results of the present study confirmed that the most common system of agricultural production is the conventional system with low intensity. In studies by Gotkiewicz [1] in four national parks (Wielkopolska, Biebrza, Wigry, and Kampinos) and four landscape parks in Poland (Mazury,

Brudzeń, Elbląg Uplands and Iława Lake District), the share of other farming systems (organic farms) was 10.7%, 1.4%, 9.3%, and 5.7% for the national parks, respectively, and 8.9%, 0.0%, 3.3%, and 4.1% for the landscape parks, respectively. Organic farming can become an alternative activity for this group of farms, particularly in areas of high natural value, with an attractive landscape and significant labour force [1, 19]. The average size of the surveyed households in the WNP (14.0 ha in the national park and 20.6 ha in its buffer zone), just as in the study conducted by Gotkiewicz [1], was relatively high when compared with the area of farms in Poland, amounting to 8.44 ha in 2002 [20]. The presence of fallow land and uncultivated land (3.7%), particularly among the smallest holdings in the WNP, indicates the presence of valuable semi-natural habitats, which occur more often on low-intensity farms [15].

Permanent grassland in the WNP, in the total area of holdings, accounted for 27.6%, far more than the national average of approximately 20.5%, which was also stated by Gotkiewicz [1] in a study of national parks. A major problem in protected areas are grasslands that are excluded from use [1, 9] and can become degraded; however, this problem did not occur in the examined farms where pastures were either regularly grazed or regularly mowed meadows (usually 2 times a year).

The presence of livestock production occurred in almost 95% of the surveyed households. This should be interpreted as an advantageous situation because it can be used as a proxy for a balanced farming system [14], because a large proportion of farmland without the presence of livestock indicates deficiencies in ensuring a positive balance of organic matter. If the content of organic matter in the soil is not playing a role, than the prospects of such farms functioning in the long term is questionable, especially those with poorer quality soils [21].

Livestock density in the surveyed households (cattle, pigs, and horses) was 0.56 LSU·ha^{-1} UAA and was higher when compared with the average density of 1 ha UAA found in Poland in 2005 (0.49 LSU·ha^{-1} UAA), which is also an attribute of other national parks [1].

By contrast, Dzienia [11] reported a low stocking density (9.2-12.3 large heads per 100 ha agricultural land) in Iński Landscape Park, and deficiencies from fertilization with manure, which could not ensure the minimum requirements needed to compensate for the balance of the soil's organic matter.

Common to all of the farms was a high share of cereal crops on arable land (average 78.5%), which was higher than the acceptable levels (65%) specified in the packet "Sustainable Agriculture" distributed by the agri-environmental program. The acceptable level for the share of cereals was only found in group 4, due to the breeding of cattle, which resulted in a higher percentage of foraging. A similar problem, with too large of a share of cereals in the crop structure, also occurred in the households surveyed in Iński Landscape Park [11]. On the basis of land use, farms from the WNP could be classified as a seventh group, cereal farms, in the typology of the enlarged EU dimension of land use, proposed by Andersen [15].

Consumption of the means of production, represented in the survey by the quantity of NPK (kg·ha^{-1}), was present in the surveyed farms at a low level (the average for the country in 2005 was 93.6 kg·ha^{-1} AA) and did not exceed the level specified in the Rules for Good Farming Practice, even in the findings from group 4 (animal production). Low consumption of mineral fertilizers is likely the result of disappointing financial returns realized on the farms. Many studies conducted in Poland [1, 9-13] and other EU countries [14, 22] indicate that the financial situation of households located in areas of high natural value is often unsatisfactory. On the basis of FADN [20, 21] and the level of inputs in the WNP (NPK kg·ha^{-1}), it must be assumed that the best financial results were obtained from agricultural production on farms with the largest surface area in the homogeneous group 4 (NPK kg·ha^{-1} close to the national average) with a focus on animal production (1.23 LSU·ha^{-1}, UAA – 25.9 ha). Such types of farm should be regarded as a goal and a best practice for increasing capital.

In Group 3, with the smallest average farm size (10.6 ha UAA) and cereals as a dominant form of production, high-

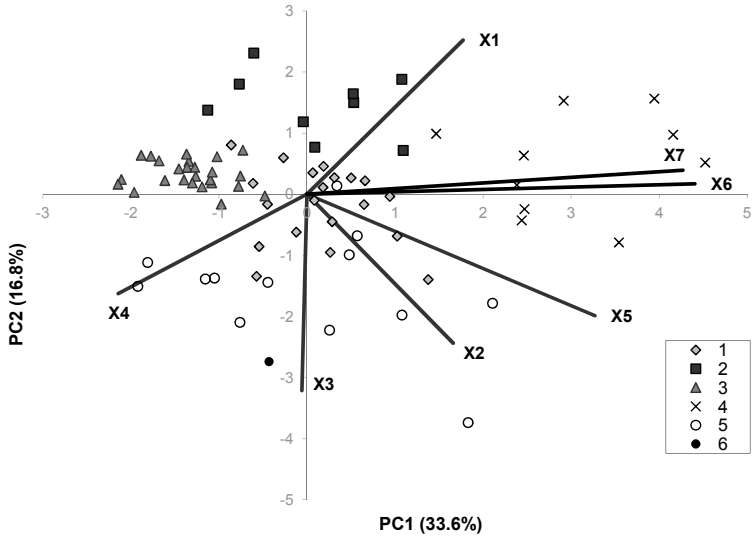

Fig. 3. Biplot of PC1 and PC2 values for six groups (1-6) of farms distinguished in cluster analysis and variables used for analysis (X1-X7).

ly unsatisfactory income and social character should be expected. According to Otoliński and Wielicki [23], the smallest farms, especially in areas with intensified unemployment, fulfil a very important function: maintaining their readiness and ability to work and preventing degradation and social pathologies among rural residents who lost their jobs. The rural population that gets an education and performs work in non-agricultural occupations remains in the country and is often a potential reserve of labor for agricultural production.

As an additional source of income for the extensive holdings in the areas of high natural value, and as a contributor to the sustainable development of these areas, many authors suggest economic activities, among them agrotourism [1, 8, 9, 12, 13]. Such activities were undertaken in 16.7% of the farms (Group 5), of which 61.5% of the households conducted agrotourism activities. In studies from the region of the Bieszczady Mountains [12], the additional economic activity undertaken by the majority (61.7%) was on small farms not exceeding 10 ha, and the largest group engaged in these activities was persons aged 46-60 years old (46.7%). The predominant form of this type of activity there also was agrotourism.

Gotkiewicz [1] reports that in the national parks he studied, non-agricultural economic activity was undertaken in 18.2% of surveyed households (25.6% in WNP). In Iński Landscape Park [11], non-agricultural economic activity was undertaken in 2 to 23% of households, depending on the municipality.

Against the background of these studies, the holdings in which non-agricultural activity is carried out are relatively larger and are characterized by a younger owner of the farm. As the most important reason for the insufficient development of tourism in areas of high natural value, the authors indicate a financial barrier, as few farmers have the financial resources to invest in tourist accommodations at sufficiently high levels [9, 12, 24]. Another source of additional income for these households is EU funding (Group 2 farms), and among them especially the agri-environmental program, recommended as a supplement farm income and a tool to prevent over-intensification and extensification [e.g. 13, 14, 24-27].

High Nature Value farmland occurs in Europe, where agriculture is usually the dominant land use and where agriculture sustains or is associated with either a high species and habitat diversity or the presence of species of concern for European conservation, or both [28]. The existence of such areas favors HNV farming systems, which are mainly extensive, often traditional farming systems with a high proportion of unfarmed features and semi-natural vegetation [14]. The present profile of farms in the WNP shows that the present system of production is extensive, includes semi-natural habitats, and most likely largely allows the maintenance of biologically diverse habitats. Such farming systems support the preservation of traditional agricultural landscapes and the biodiversity connected with the landscape [4, 5]. The production system, which in the long term can be further developed in the WNP, is organic farming. To prevent abandonment of agricultural production, its intensification, or land conversion, this should be realized through a proper and well-targeted support scheme, even drawing from the available tools properly reshaped and targeted towards HNV farming [14]. As suggested by Caballero [22], financial resources should be allocated only after the identification of HNV farmland and once regional strategies for production and landscape management have been devised. The adaptation of agri-environmental measures to regional needs was also suggested by Schnitzberger [27].

A long-term agricultural policy is especially necessary for the marginal areas located in regions with limitations for agricultural production [28]. A high potential for the development of HNV farmland exists in northeastern Poland (e.g. WPN area) and should be used to conserve landscapes and biodiversity. This demands deeper analysis as to why marginal farmers decide to continue to farm in traditional ways [29, 30]. The farming system typology can be a tool that allows generalized descriptions of types of farms in particular areas, as well as one that fosters nuanced perspectives and proper policies for each type.

One of the approaches for a farming system typology is SEAMLESS (System for Environmental and Agricultural Modeling; Linking European Science and Society), which was developed for the EU area [31]. The system is based on four main criteria: size of the farm, intensity of production, specialization, and land use. The main advantage of the system is its possibility for use in all of the EU countries, while its main disadvantage is its need to have financial data to evaluate the intensity of production and its omission of attributes important for the sustainable development of HNV areas. A better approach for a farming systems typology seems to be a multivariate classification based on attributes important for a particular region [32, 33]. Such a multivariate approach, in which attributes were selected on the basis of existing circumstances, was used in the survey for the WPN area. Understanding the circumstances of agricultural production and the long-term development of farms in HNV areas such as the WPN will be easier if farm typology results were available.

Conclusions

Most of the WNP farms in the EU farm classification system should be classified as “cereals, oilseeds, and protein crops” (EU code – 13) or “mixed crops-livestock” (EU code – 8) with low intensity [15] and a very high share of cereals (more than 65% in arable area). On the basis of land use, farms from the WNP could be classified as group seven, cereal farms, in the typology of the enlarged EU dimension of land use proposed by Andersen [15].

Six homogeneous groups of farms distinguished in the analyses differ mainly according to livestock density and the size of the farm (UAA).

Farms with the smallest area of arable land (approximately 10 ha) primarily served a social function. This group reported the lowest consumption of the means of production, the lowest livestock density and the highest share of cereals in the crop structure, which predicts the gradual

depletion of the soil's organic matter and nutrients. In this group, a gradual giving up of agricultural production is expected.

Non-agricultural activities (mainly agritourism) were conducted on larger farms (an average area of 20.3 ha), with a majority of their income coming from crop production and a medium intensity of production. This type of farm seems to be most beneficial for the area of the WPN and its buffer zone because it connects agricultural production and agritourism. This ensures the sustainable development of the area without the negative impacts from agriculture on the environment, and it provides a better opportunity for the development of tourism. This method of farming provides long-term proper management and ensures that the land will not be desolate and abandoned. Future financial subsidies from the EU funds should support the development of such farming systems in HNV areas such as the WNP.

Abbreviations

AA/AL – arable area/arable land
CAP – common agricultural policy
HNV – high nature value
EU – European Union
FADN – Farm Accountancy Data Network
LFA – less favored areas
LSU – livestock unit
NPK – nitrogen, phosphorus, and potassium
UAA – utilized agricultural area
WNP – Wigry National Park

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