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Diversity of floristic composition of midfield baulks under different farming systems implemented on the outskirts of the Białowieża Forest

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Abstract: A study was conducted on changes in the abundance and diversity of floristic composition in baulks and cultivated agrocenoses in the area of the village of Nowokornino, located on the outskirts of the Białowieża Forest. Within the geodesic area of the village, which covers approximately 1,100 ha, agricultural crops are grown under three farming systems: conventional farming, integrated farming and organic farming. In the study area, there are unique marginal ecosystems in the form of mid-field baulks on which various weed species of ecological importance occur. Three study plots were designated on the baulks, and three plots on field crops Floristic surveys were carried out in 2016, 2020 and 2022. The cover of individual species was estimated according to the 7-level Braun-Blanquette scale. A total of 91 plant species belonging to 6 phytosociological groups were found, with the *Stellarietea mediae* group having the highest species richness. The significance of differences in floristic richness between study and control plots was tested by one-way analysis of variance (ANOVA). Statistical analysis showed that the factors differentiating the floristic composition on the baulks were their location within the cultivated agrocenoses, natural soil abundance and interaction with fertiliser factors. The highest species abundance of plants defined as weeds, occurred in fields under the integrated farming system (58 species), the lowest in fields under the conventional system (39 species). The vegetation of the baulks and adjacent arable fields was dominated by plants representing mainly three types of ecological strategies: C, R and C-R.

Keywords: agrocenosis, baulk, biodiversity, farming system, segetal flora

INTRODUCTION

Agricultural land in Poland covers 18,741 thous. ha and accounts for 59.9% of the country's area. There is an average of 0.49 ha of agricultural land per capita (GUS, 2020). In Podlaskie Voivodship, agricultural land covers 1,215 thous. ha (62% of the voivodship's area) and arable land predominates there. The most severe anthropopressure and its effects occur on arable land. Multidirectional agricultural activity affects soil conditions, microclimate, biodiversity (Benton *et al.*, 2003). Polish agriculture until the middle of the 20th century was dominated by family farms with small areas, but at the same time with a large number of crop species. On each farm, crops grown were necessary for personal use and for sale. This type of land use was conducive to high biodiversity at the species and ecosystem level.

The development of urban agglomerations and the migration of people from the countryside to the cities required provision of increasing amounts of food. In the second half of the 20th century, the so-called 'green revolution' began, involving improved farming methods and breeding work to improve crop species. Farms classified as conventional agriculture (intensive, industrialised agriculture) began to emerge. On these farms, large-scale production is carried out with heavy use of industrial inputs and very little labour. Conventional farming successively causes a decrease in the biological activity of the soil, an increase in the threat of erosion, a deterioration of food quality, an increase in environmental pollution. They take the place and function of traditional small- and medium-scale farms included in the integrated farming system. At the end of the 20th century and the beginning of the 21st century, organic farming began to emerge. In the conventional farming system, small fields are replaced by large-scale plant monocultures and larger quantities of mineral fertilisers and pesticides are used (Kiryluk and Kostecka, 2022). Crops of several hundred hectares of cereals or maize are highly productive and at the same time are devoid of many weed species (Marczewska-Kolasa, 2021). Mid-field shrubbery and afforestation are being eliminated, as well as water ponds, drainless depressions of land and baulks. A mid-field baulk is a strip of uncultivated land between two fields (Dajdok, 2020). This element of cultivated ecosystems has been and remains a refuge for many plant species, often referred to as undesirable weeds in monoculture crops. The high availability and use of highly selective and effective herbicides result in permanent destruction of many plant species referred to as weeds (Warcholiński, 1994; Kapeluszny and Haliniarz, 2010; Janicka *et al.*, 2023). Baulks, fallows, ponds, mid-field shelterbelts and other marginal and pro-ecological ecosystems play a very important role in the maintenance of the environment of agricultural land. They reduce soil erosion and improve the microclimate in agricultural fields. Mid-field baulks are becoming marginal and disappearing elements in European and also Polish agriculture. They are currently being eliminated for technological reasons in intensive conventional agriculture. In large-scale monoculture farming, the boundaries between individual fields are becoming roads, very often hardened (asphalt), allowing access for heavy and highly efficient cultivating units and harvesters to harvest crops.

In western European agriculture, baulks have long ceased to exist in agricultural practice. In some countries restoration programmes are being introduced, which consist of weed-sowing of non-cultivated areas on farms (Ihse, 1996; Marshall, 2002; Kozłowski, 2004; Tryjanowski *et al.*, 2011). Mid-field woodlots and baulks in the north-west of the USA provide habitat and a migration route for forest species. Forest taxa were abundant in the herbaceous layer of such thickets (Corbit *et al.*, 1999). In the Polish countryside, baulks also had cultural and economic significance. With highly fragmented arable fields, baulks were an important boundary separating peasant fields. They did not always have legal and geodetic justification, which caused conflicts very often. Due to the lack of grassland on farms, baulks were grazed by cattle and horses and supplemented the meagre fodder base. The most important function of baulks has been, and still is, the maintenance of a high biodiversity of flora species in the conventional farming system, as well as in the developing organic farming (Ługowska *et al.*, 2016; Skrajna and Bogusz, 2020). Baulks provide an important refuge for many species of small mammals, avifauna, insects and other living organisms. There they can hide from agricultural machinery, predators, raise their young and find food sustenance from wild plants (Kryszak *et al.*, 2017).

Prior to the large-scale introduction of conventional agriculture, there were about 200 species of wild plants in cultivated fields, which are an important component of the Polish flora. Most of these species are melliferous plants that provide a source of food for bees and other beneficial pollinating insects during flowering. The yield of about 75% of crop species depends on pollination, and the most commonly helpful pollinators are: *Agrostemma githago*, *Bromus secalinus*, *Centaurea cyanus*, *Lithospermum arvense*, *Avena fatua*, *Chenopodium album*, *Lamium amplexicaule* (Marczewska-Kolasa, 2021). The agri-environmental and climate programmes under the Rural Development Programme (RDP) 2023–2027 also take into account the environmental values of baulks and mid-field shelterbelts within the framework of so-called ecoschemes. This involves, among other things, leaving 5% of the area on a farm for ecological focus areas (EFA). These can include, among other things, afforestation and mid-field baulks (at least one metre wide). This will ensure that they do not disappear from our landscape in the near future (Zbyryt, 2023). Farmers who adopt agricultural practices that benefit the climate and the environment can receive additional payments as compensation for reduced production and reward for protecting natural resources and providing public goods. These measures, which benefit society as a whole, are not commonly reflected in the market prices of the agricultural products obtained. Countries of EU, according to the Common Agricultural Policy (EC (no date)) rules, have to allocate about 30% of their income to payments for greening and other pro-environmental measures. There is a lack of broader and detailed studies in the literature on mid-field baulks as one of the pro-environmental elements in environmental and landscape terms. The paper presents the floristic diversity of mid-field baulks and the structure of plant communities developing within their boundaries under the influence of different farming systems. The results obtained can be helpful in implementing pro-ecological measures in developing the most appropriate EU agricultural policy.

MATERIALS AND METHODS

Nowokornino village is located in the eastern part of the Podlaskie Voivodships in Hajnówka district, approximately 6 km from the Białowieża Primeval Forest complex (Fig. 1).

The geodetic area and about 1,100 ha are mainly arable land and buildings. There are a few farmers left in the village,

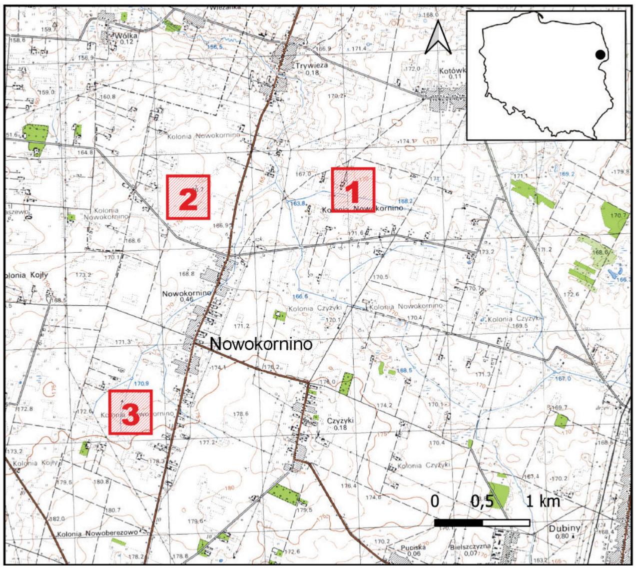

Fig. 1. Location of the study area near the village of Nowokornino on the western outskirts of the Białowieża Forest (NE Poland); *1* = crops in the conventional farming system, *2* = crops in the integrated farming system; *3* = crops in the organic farming system; the map was generated using the QGIS 3.16.11-Hannover software; source for the map: GUGiK (no date)

cultivating large-scale cereal crops (Photo 1), rapeseed, sunflower and maize. There is also an organic farm, growing a variety of herbaceous plants on several hectares (Photo 2). There remain a few small farms growing cereals and vegetables using traditional methods (sustainable agriculture). The predominant area has soils of classes III and IV, made mainly of clay, very fertile but difficult to cultivate, constituting good wheat (goodwheat) and good rye (goodrye) complexes. Arable fields, local meadows and pastures were drained in the 1970s with a system of drainage ditches and a drainage network. The floristic research was conducted within the geodesic area of the village of Nowokornino. The floristic research was conducted on three baulks occurring at the border of different field crops in three farming systems: baulk in conventional farming (BC) (Photo 3), baulk in integrated farming (BI) (Photo 4) and baulk in organic farming (BO) (Photo 5). In fields in the conventional system (AC), winter rape was grown in 2016, 2018, 2020, and winter wheat in 2017, 2019, 2021. In the fields of the integrated system (AI), winter wheat maize, cereal mixtures were grown alternately in 2016–2022. The most stable crops were grown in the fields of the organic system (AO). The following herbaceous plant species were present in the fields of the organic farm during the study period: *Plantago lanceolata*, *Echinacea purpurea*, *Cynara cardunnculus*, *Sanguisorba officinalis*, *Melissa officinalis*, *Mentha piperita*, *Alchemilla monticola*, *Rhodiola rosea*, *Ruta graveolens*, *Leonurus cardiaca*, *Calendula officinalis*. In fields in the conventional system (AC), a simplified strip-till system was used for maize cultivation. Crops in the integrated system (AI) used shallow plough tillage. The fields in the AC and AI systems were sprayed with pesticides (herbicides and insecticides). Mineral fertilisation was also applied at a level of approx. 120 kg NPK·ha^{-1}. The fields in the organic farming (AO) system did not use deep ploughing, but only inter-row soil loosening and weed control.

Within the baulks, the study plots were rectangular in shape, with the longer side being 100 m and the shorter side being defined by the width of the baulks (0.6–1.0 m). Within the agrocenoses, the occurrence of plant species was recorded over an area of 20 m^2 (4×5 m). Six such plots were established within the adjacent arable fields in each of the three management systems. In the study area, annual rainfall totals were: 2016 – 801.0 mm; 2020 – 536.9 mm; 2022 – 637.5 mm. The average annual precipitation of the multi-year period was 589.8 mm. There is a high variability of precipitation from year to year with

Photo 1. Winter wheat in the fields of Nowokornino village in conventional farming under soil drought conditions (phot.: *A. Kiryluk*)

Photo 2. *Calendula officinalis* in organic agriculture in Nowokornino (phot.: *A. Kiryluk*)

Photo 3. Species diversity of vegetation on baulks in conventional farming (phot.: *A. Kiryluk*)

Photo 4. A community of *Centaurea cyanus* at the edge of an oilseed rape field under the integrated farming in Nowokornino (phot.: *A. Kiryluk*)

Photo 5. Baulk in fields in an organic farming (phot.: *A. Kiryluk*)

predominantly dry periods. The highest monthly totals were recorded in the months of June to August. Precipitation below the multi-year average that occurred in 2000 had a negative impact on the condition of field crops in the integrated agriculture (AI) and conventional agriculture (AC) systems. Herbaceous crops in the organic system (AO) located on humus and compact soils survived the periodic droughts without major losses. The mitigation of soil drought in the study area also occurs through the influence of the microclimate of the nearby Białowieża Forest. It has also been reported that average annual air temperatures remain in the range of 7.0–7.9°C.

Floristic inventories were made in each study plot (Tab. S1). The cover of individual species was estimated according to the 7-level Braun-Blanquette scale (1964):

r – coverage is negligible, only one specimen present,
+ – coverage is slight, number of specimens is 2–5,
1 – species cover <5% of the surveyed area, number of specimens 6–50,
2 – species cover 5–25% of the surveyed area, number of specimens – large,
3 – species cover 25–50% of the surveyed area, number of specimens – arbitrary,
4 – Species cover 50–75% of the surveyed area, number of specimens – any,
5 – species cover 75–100% of the surveyed area, number of specimens – any.

Two floristic censuses were carried out within the boundaries of each baulk – at the beginning of the growing season (May) and in August. Observations were carried out in 2016, 2020 and 2022.

The classification and ordering of plant patches was carried out using Syntax 5.01 software (Podani, 1993). For cluster analysis the UPGMA method (unweighted pair group method with arithmetic mean) was used. The percentage difference (PD) coefficient was applied as a measure of distance. Correspondence analysis (CA – software as above) was used to show differences in the floristic composition of plant patches located in the field baulks (BI, BC, BO) and reference plots distributed within crops (AI, AC, AO).

To determine the differences in floristic diversity of the vegetation patches, the Shannon index (Shannon, 1948) was calculated for each study and control plot established within field baulks and adjacent agrocenoses. The proportion of each plant species was determined by comparing the cover of the species with the sum of the cover of all species in the study plot.

In the preparation of the input data matrix in the procedures for classification and ordination of plant patches, as well as in the calculation of the Shannon index, cover percentage approximations of the Braun-Blanquet cover-abundance scale were transformed according to Maarel van der (1979).

The significance of differences in floristic richness between study and control plots was tested by one-way analysis of variance (ANOVA). The normal distribution of the data was tested with the Shapiro-Wilk test at the significance level of $p < 0.05$ and the homogeneity of the variance of the samples was examined with the Levene's test. Statistical calculations were made in the JASP 0.16.2 program (JASP Team, 2022). The names of vascular plant species are given according to Rutkowski (2013), while the assignment of individual plant species to syntaxonomic (ecological) groups is based on Matuszkiewicz (2017).

In order to ascertain the potential influence of soil conditions on floristic composition (abundance and diversity of species), soil samples were taken from 6 study sites: BI, BC, BO and AI, AC, AO. Soil samples were taken with an Egner–Rhiem stick in 2016 and 2023. Soil tests were carried out in the accredited Laboratory Chemical-Agricultural Station in Białystok (accreditation no. AB 823). Acidity was determined in 1 N KCl. Organic carbon was determined using the Tiurin method and the dry combustion method using a TOC-TN 1200 thermal analyser. The content of bioavailable forms of mineral elements in mineral soil (P, K, Mg) was determined in mg·(100 g)$^{-1}$ using the methodology specified in standards: PN-R-04020:1994/Az1:2004 (2004), PN-R-04022:1996/Az1:2002 (2002), PN-R-04023:1996 (1996). Agronomic categories of soil were determined on the basis of the study of granulometry composition (PN-Z-19012:2020-02, 2020).

RESULTS AND DISCUSSION

FLORISTIC RICHNESS AND DIVERSITY

The floristic richness and floristic diversity of the baulks, which were preserved in the agricultural landscape within agrocenoses cultivated by different methods, varied considerably. The baulks maintained under the system of organic farming proved to be the richest and most floristically diverse. A total of 80 plant species were found within them (Tab. S1). Between 56 and 67 species were recorded there in the vegetation patches (an average of 60.5). Shannon coefficient values ranged from 3.95 to 4.13 (average 4.04) in individual phytocenoses. The baulks surrounded by conventionally managed crop fields were floristically the poorest. They were built by a total of 43 plant species, and floristic lists made within their boundaries recorded 30–37 taxa (average 34.3; Tab. S1). Of all the objects included in the study, the floristic diversity of these baulks was at the lowest levels (Shannon coefficient 3.35–3.56).

Baulks that were maintained between crops under the integrated farming system presented an intermediate level with regard to floristic richness. The flora of these sites consisted of a total of 57 plant species (41–50 species per floristic inventory, with an average of 46; Tab. S1), and the level of their floristic diversity was determined by a Shannon coefficient of 3.67–3.86 (Fig. 2). Baulks under various farming systems differed significantly from each other in terms of both floristic richness and species diversity (ANOVA, $p < 0.001$). Baulks remaining in landscape with a predominance of conventional and integrated agriculture did not differ with respect to floristic richness and diversity from the surrounding agrocenoses. Statistically significant differences in this matter were visible only between the baulks in the organic farming system and the arable fields located in their vicinity (average number of species 60.5 vs. 41.7, average Shannon coefficient 4.04 vs. 3.66; ANOVA, $p < 0.001$) (Fig. 2).

SPECIES COMPOSITION

Regardless of the type of management, the floristic composition of the plant communities occurring within the baulks was determined by the same syntaxonomic groups of plant species, and differences in the abundance of various groups were not

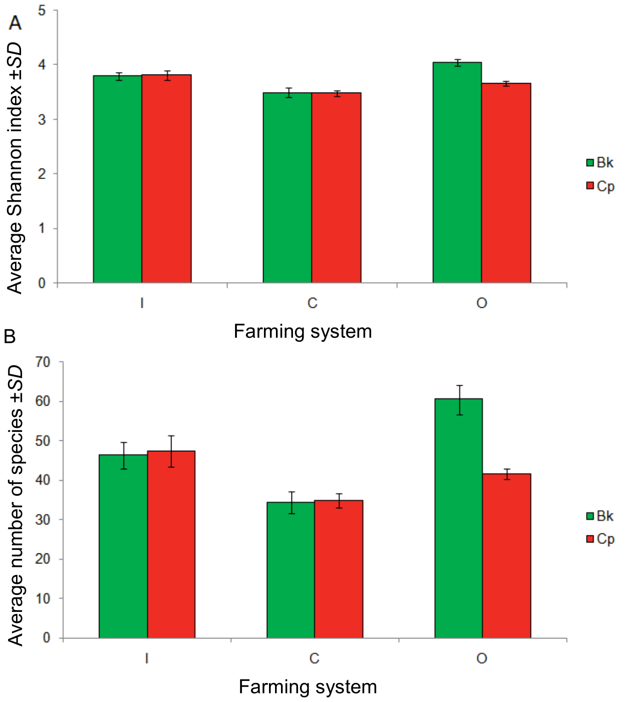

Fig. 2. Differentiation of floristic diversity (A) and richness (B) of plant patches located within baulks and surrounding crops under different farming system; Bk = baulks; Cp = crops; I = integrated agriculture system; C = conventional agriculture system; O = organic agriculture system; *SD* = standard deviation; source: own study

significant. The most important in shaping the vegetation of the baulks were the annual and biennial plants accompanying crops and ruderal areas (*Stellarietea mediae*). Their share in the structure of plant patches in each type of baulk ranged from 31.6 to 40% (Tab. 1). An important component of the plant communities in these sites was also a group of species associated with meadow and pasture communities (*Molinio-Arrhenatheretea*), which accounted for 14% (BO) to 21% (BC) of the floristic composition. Slightly fewer species of showy perennials (about 14% within the baulks of each type) that are typical for nitrophilous ruderal communities (*Artemisietea vulgaris*) were recorded in the compiled floristic lists. The abundance of individual syntaxonomic groups in patches located within nearby agricultural fields was in similar proportions. More significant differences applied only to agrocenoses with conventional management and organic farming, which, relative to the baulks, were poorer in grassland/pasture species (12.8 vs. 20.9%) and nitrophilous species (8 vs. 13.7%), respectively. In contrast, farmlands in the integrated farming system were distinguished by a slightly higher abundance of crop-associated therophytes (37.9 vs. 31.6%). Despite the possibility of long-distance dispersal of plant seeds (Horn *et al.*, 2001), the close proximity of the Białowieża Forest, and the presence of small forests and thickets in the agricultural landscape, no forest plants were found within the baulks. Both the vegetation of the baulks and adjacent arable fields was dominated by plants representing the same ecological strategies (Grime, 2001): strategy C (species with high competitive abilities), strategy R (species inhabiting environments subject to disturbance) and strategy C-R (species growing under conditions of low environmental stress and competition limited by disturbance). The proportion of all these plant groups ranged from 22 to 32% (Tab. 2). Plants with other strategies (S, C-S, S-R) were absent or negligible within baulks and cultivated fields.

Analyses indicate that there is little variation in the floristic composition of plant patches within individual types of baulks, as well as adjacent agrocenoses under different farming systems, and the observed differences reach only a dozen or so percent. Baulks in the system of integrated agriculture differ the least from arable fields in terms of floristic composition, while baulks in the system of organic agriculture differ the most from surrounding farmlands in this aspect (Figs. 2, 3). Moreover, "ecological baulks", due to their slightly different floristic composition and significantly higher species richness differ from this type of biocenoses found in other farming systems (Figs. 2, 3). Our research also indicates that the vegetation of individual baulks and surrounding segetal communities changes over time (2016–2022) to a small extent.

The flora of the mid-field baulks was dominated by species representing two taxonomic units, *Poaceae* and *Asteraceae*.

Table 1. Participation of plant species representing different syntaxonomic groups[1)] in plant patches located within baulks (B) and crops (A) under integrated (I), conventional (C) and organic (O) farming system

Phytosociological groups	Field baulks						Agrocenoses					
	BI		BC		BO		AI		AC		AO	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Agropyretea	3	5.3	2	4.7	3	3.8	3	5.2	2	5.1	3	6
Artemisietea vulgaris	8	14	6	14	11	13.7	9	15.5	6	15.4	4	8
Festuco-Brometea	2	3.5	–	–	2	2.5	1	1.7	–	–	1	2
Koelerio-Corynephoretea	2	3.5	1	2.3	2	2.5	2	3.5	2	5.1	2	4
Molinio-Arrhenatheretea	11	19.3	9	20.9	11	13.7	9	15.5	5	12.8	9	18
Stellarietea mediae	18	31.6	16	37.2	32	40	22	37.9	16	41.1	18	36
Other	13	22.8	9	20.9	19	23.8	12	20.7	8	20.5	13	26
Total number of species	57	100	43	100	80	100	58	100	39	100	50	100

[1)] Syntaxonomic groups acc. to Matuszkiewicz (2017).
Source: own study.

Table 2. Participation of plant species representing different ecological strategies[1)] in plant patches located within baulks (B) and crops (A) under integrated (I), conventional (C) and organic (O) farming system

Type of ecological strategy	Field baulks						Agrocenoses					
	BI		BC		BO		AI		AC		AO	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
C	16	28.1	12	27.9	18	22.5	17	29.3	12	30.8	11	22
S	–	–	–	–	–	–	–	–	–	–	–	–
R	14	24.6	11	25.6	25	31.3	15	25.9	10	25.6	16	32
C-S	2	3.5	2	4.7	1	1.3	2	3.4	2	5.1	–	–
C-R	17	29.8	15	34.9	21	26.3	18	31	13	33.3	14	28
S-R	1	1.8	–	–	3	3.8	1	1.7	1	2.6	2	4
C-S-R	7	12.3	3	7	12	15	5	8.6	1	2.6	7	14
Total number of species	57	100	43	100	80	100	58	100	39	100	50	100

[1)] Ecological strategies acc. to Grime (2001).
Explanations: C = competitors; S = tolerant to stresses, R = ruderals.
Source: own study.

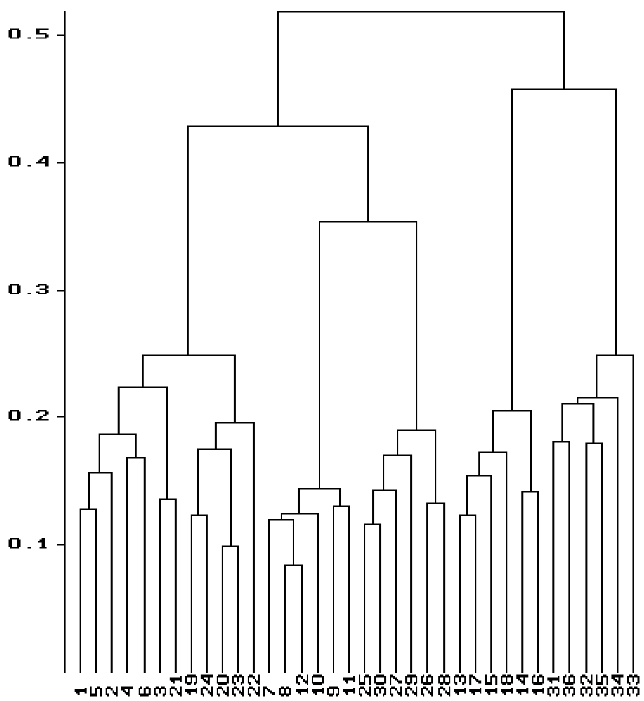

Fig. 3. Floristic similarity between phytocenoses distributed within field baulks and crops presented in form of a dendrogram; *1–6* = crops in the integrated agriculture system (AI); *7–12* = crops in the conventional agriculture system (AC); *13–18* = crops in the organic agriculture system (AO); *19–24* = baulks in the integrated agriculture system (BI); *25–30* = baulks in the conventional agriculture system (BC); *31–36* = baulks in the organic agriculture system (BO); source: own study

Similar observations were made under the agricultural conditions of Wielkopolska (Kryszak *et al.*, 2017). These researchers found the highest number of plant species on the baulk separating crops grown by traditional methods on small-scale farms. The high number of species on this baulks caused by low nutrient abundance (Feledyn-Szewczyk, 2007; Malecka *et al.*, 2015), as well as the lack of interference with the communities in the form of mowing (grazing) or pesticide spraying. Most species on the baulk produce seeds generatively, and there were favourable conditions on the baulks for their maturation and seeding (Brągiel and Trąba, 2013).

SOIL PROPERTIES

All soil samples tested were characterised by an acid reaction (Tab. 3). The highest acidity occurred in the soils on the baulks in the integrated system, while the least acidic soils were found in winter wheat crops in the conventional system. The high acidity of soils is mainly due to the lack of liming of soils. Currently, farmers in the Podlasie province do not have a sugar factory nearby so that relatively cheap defecation lime, a by-product of sugar beet processing, can be used for deacidification. The low content of phosphorus, high magnesium and average potassium indicate the use of inappropriate fertiliser doses in the form of mineral fertilisers. The occurrence of a high diversity of flora in fields and baulks can also be explained by the high nutrient richness of the soils (Skrajna and Bogusz, 2020). In such conditions, species of the *Poaceae* family and also dicotyledonous, nitrogen-loving species with a large leaf mass and surface area occurred: *Polygonum hydropiper*, *Rumex obtusifolius*, *Cirsium oleraceum*, *Urtica dioica*. Such species occurred infrequently on the edges of cultivated fields and adjacent baulks.

Most arable soils in Poland are low in humus as its average content is 1.25%. According to the European Commission (EC (no date)) and IUNG (Stalenga, Brzezińska and Jarzombkowski, 2016) research, soil humus content below 1.75% and simultaneous soil water shortages in our latitude are symptoms of progressive desertification (Kuś, 2015). In the studied soils, the humus content was high (Tab. 4), which is mainly due to the regular (annual) application of a large amount of manure under cereal and root crops in the second half of the 20th century. In the period before the area and technological restructuring of agriculture, there were medium-sized farms of 7–12 ha in the study area. Each farm produced manure under shallow barn

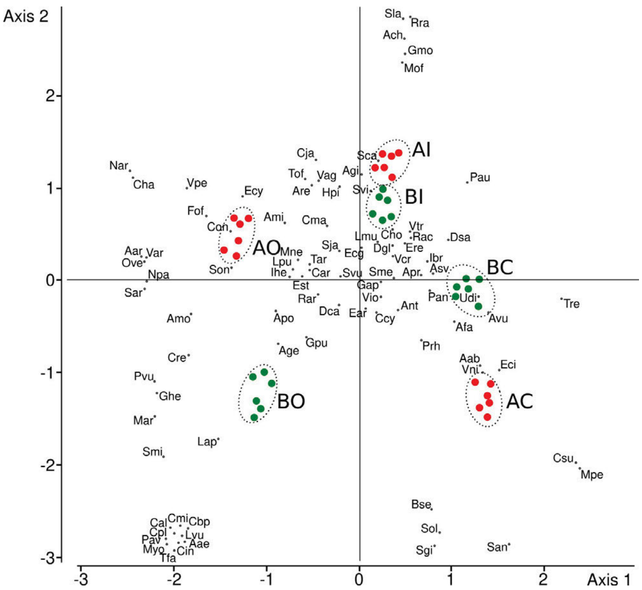

Fig. 4. Correspondence analysis ordination biplot of releve's showing the overall diversity in the floristic composition of vegetation patches located within field baulks (green dots) and crops (red dots) under different farming systems; variance explained by axis 1 (management gradient) – 28.2%; variance explained by axis 2 (trophic state gradient) – 18.7%; AI, AC, AO, BI, BC, BO as in Fig. 3, abbreviations of plant species names in Tab. S1; source: own study

conditions. There was a need to export and apply manure under most field crops. Manure was applied mainly to root crops, as well as to cereals. Moreover, the relatively high species diversity of segetal flora in cultivated fields and on baulks was due to the transfer of seeds of many plants by this form of organic fertilization. A large number of weeds was found in cultivated fields with high humus content.

In the Nowokornino area, the soils were formed on the basis of post-glacial till (light clay and heavy clay). Prior to land reclamation, these soils showed permanent excess moisture. Currently, as a result of reduced precipitation and lack of irrigation as well as the use of active tillage machinery, agronomic categories II and III, determined according to the proportion of granulometric groups, are found in the prevailing area. There are four agronomic categories of soils in Poland (1 – very light, 2 – light, 3 – medium, 4 – heavy) applied in tillage and irrigation treatments. The category was distinguished based on the proportion of granulometric groups and float contents.

The predominance of heavy soils and their good nutrient abundance, as well as their high humus content, provide opportunities for highly productive crop production. In the context of maintaining high plant species biodiversity, it is advisable to carry out reintegrated farming and organic farming in the area. Such a direction of development of environmentally beneficial agriculture is also indicated by the positive influence of the microclimate of the Białowieża Forest. In years of low

Table 3. Physical and chemical properties of the studied soils in Nowokornino

Symbol of a research facility	Agronomic category of soil	pH (KCl)	Reaction	Bioavailable forms of mineral nutrients (mg·kg^{-1})		
				P	K	Mg
BI	not tested	4.9	acid	22.69 low	415.07 very high	77 very high
BC	III light dusty clay	5.4	acid	43.64 low	104.60 mean	86 high
BO	not tested	5.0	acid	35.35 low	134.48 mean	99 very high
AC	not tested	5.3	acid	44.51 low	153.58 mean	129 very high
AI	II silty clayey sand	5.9	slightly acidic	19.64 very low	157.73 high	103 very high
AO	III light dusty clay	5.2	acid	33.16 low	127.01 mean	93 high

Explanations: BI, BC, BO, AC, AI, AO as in Fig. 3.
Source: own study.

Table 4. Carbon and humus content of the studied soils in Nowokornino

Symbol of a research facility	Agronomic category of soil	Content organic C	Content humus	Assessment of humus content according to Kuś (2015)
		(% of air-dry matter)		
BC	III, light dusty clay	2.00	3.45	1.6–2.5 very high
AI	II, silty loamy sand	2.14	3.69	1.1–1.5 very high

Explanations: BC, AI as in Fig. 3.
Source: own study.

precipitation, most field crops in the area endure longer periods without rain and thus, manage to maintain some crops. Winter cereals, including winter wheat, survive drought periods well.

GREENING IN THE STRATEGIC PLAN FOR THE COMMON AGRICULTURAL POLICY (CAP) IN 2023–2027

Buffer zones and mid-field baulks located on arable land or adjacent with their longer side to agrocenosis cultivated land can be considered pro-environmental areas. The following practices are fundamental to greening of farms: diversification of field crops, pro-ecological areas, permanent grassland (MRiRW 2019).

The paper identifies the problems of protecting mid-field baulks in Poland, including: reducing their width or eliminating them completely, removing trees and shrubs found there, moving mineral fertilisers and plant protection products from the fields. In view of these threats, CAP formulated guidelines for the management of mid-field strips, resulting from the studies. These include: the need to preserve existing marginal habitats in the full spectrum of their diversity, which determines the richness and diversity of associated organisms; the need to diversify the vertical structure of vegetation, as well as treatments for the proper maintenance of plant communities. In practice, it means limited mowing of herbaceous vegetation, abandonment of scrub pruning in selected sections and leaving untreated shrub and woody vegetation, which will contribute to the richness of various groups of animals, including ornithofauna. The results obtained provide some complementary data on the role and diversity of baulks in botanical terms. So far, primarily the importance of these environments for various groups of animals has been pointed out. They may also be useful in the management of ecological areas within the farm, taking into account the ecosystem services they provide and their overall importance in shaping the biodiversity of agricultural areas (Dajdok, 2020; Faisol *et al*., 2022; Zbyryt, 2023). Buffer zones and mid-field baulks located on arable land or adjacent with their longer side to agrocenosis cultivated land can be considered as ecological focus areas (Tryjanowski *et al*., 2011; Stalenga *et al*., 2016). The following practices are fundamental to on-farm greening: diversification of field crops, ecological focus areas, permanent grassland.

CONCLUSIONS

1. Ninety one plant species from different taxonomic units were found on the studied sites (baulks and agrocenoses) in the three farming systems. The highest number (80 species) was found on the baulks in the organic farming system. The fewest species occurred in agrocenoses in the conventional system (39).
2. Baulks under various farming systems differed significantly from each other in terms of both floristic richness and species diversity. Baulks in the conventional and integrated agriculture did not differ with respect to floristic richness and diversity from the surrounding agrocenoses. Statistically significant differences were found only in the case of baulks in the organic farming system.
3. The vegetation of the baulks was shaped by plants associated with crops and ruderal areas (*Stellarietea mediae*), meadow and pasture communities (*Molinio-Arrhenatheretea*) and nitrophilous ruderal communities (*Artemisietea vulgaris*). Despite the close proximity of the Białowieża Forest no forest plants were found within the baulks.
4. The vegetation of the baulks and adjacent arable fields was dominated by plants representing mainly three types of ecological strategies: C, R and C-R. Plants with other strategies were absent or negligible within baulks and cultivated fields.
5. Maintenance of species diversity on the baulks was influenced by the lack of interference of cultivation machinery.
6. The high similarity of segetal communities in the baulks and adjacent agrocenoses of the conventional farming system was probably caused by the use of spraying with selective herbicides.

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SUPPLEMENTARY MATERIAL

Supplementary material to this article can be found online at https://www.jwld.pl/files/Supplementary_material_Kiryluk.pdf.

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