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Meat production and maintaining biodiversity: Grazing by traditional breeds and crossbred beef cattle in marshes and grasslands

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Abstract

Questions: Sustainable rangeland utilization considering traditions and economic reasons is compulsory for harmonising the needs of the agricultural and nature conservation sectors. For proper rangeland management it is crucial to compare the grazing effects of traditional breeds and crossbred animals of the same species that might have different effects on the rangelands. To fill this knowledge gap, in a grazing experiment, we investigated the effect of cattle breeds on the vegetation to test the effects on nature conservation value and agricultural production value. We hypothesized that the effects of cattle grazing on habitat conservation values and forage quality depend on the grazing breed, because breeds differ in selectivity, body size and trampling effect.

Location: Marshes and alkaline wet grasslands in Hortobágy National Park, Hungary.

Methods: We recorded the percentage cover of vascular plants in three consecutive years in a total of 60 plots in 12 areas grazed by traditional (0.61 AU/ha) and large-sized crossbred beef cattle (0.68 AU/ha).

Results: We found that the effect of cattle breed on the habitat conservation values and forage quality is dependent on the habitat type. The traditional breed maintained a significantly higher species number and Shannon diversity in marshes than the crossbred beef cattle. Grazing of crossbred cattle led to decreasing moisture indicator values in marsh habitats.

Conclusions: Our findings revealed that traditional breeds should be prioritized in the management of wet alkaline grasslands and marshes. Crossbred beef cattle might be a substitute but only in case traditional breeds are not available for the management of alkaline wet grasslands. In marshes, however, we recommend prioritizing the traditional breeds as they maintain higher diversity compared to crossbred beef cattle.

KEYWORDS
alkaline grassland, grazing intensity, grazing regime. livestock, pasture, rangeland, wetland

1 | INTRODUCTION

Grazing by large herbivores is a major driver of the ecosystem processes in open landscapes worldwide (Metera, Sakowski, Słoniewski, & Romanowicz, 2010; Leiber-Sauheitl et al., 2015; Rupprecht, Gilhaus, & Hölzel, 2016). Grazing animals shape species composition through the consumption of biomass, redistribution of nutrients via deposition of dung and urine (Gillet, Kohler, Vandenberghe, & Buttler, 2010; Ma et al., 2016), soil compaction and erosion via trampling (Eichberg & Donath, 2018), and dispersal of seeds on their fur, hooves or via their dung (Couvreur, Verheyen, & Hermy, 2005; Will & Tackenberg, 2008; Freund, Carillo, Storm, & Schwabe, 2015). Via these mechanisms, grazers alter habitat conditions and create micro-habitats for plant species (Smit & Putman, 2011; Deák et al., 2017).

The effect of grazing on vegetation and its suitability as a conservation tool largely depend on the livestock type and the grazing intensity (Metera et al., 2010; Tóth et al., 2018). Cattle grazing is considered less selective compared to sheep and horse grazing (Rook et al., 2004; Sebastià, Bello, Puig, & Taull, 2008); thus, it can maintain higher diversity in rangelands due to supporting the co-existence of several plant species by reducing intra- and interspecific competition (Tóth et al., 2018). Several studies have compared the effects of different livestock types on grasslands (e.g., cattle and sheep: Socher et al., 2013; Tóth et al., 2018; cattle and horses: Cauwer & Reheul, 2009; Nolte, Esselink, Smit, & Bakker, 2014), but the differences between the grazing effects of different breeds of the same species still need to be discovered (Rook & Tallowin, 2003; Pauler, Isselstein, Braunbeck, & Schneider, 2019).

Traditional and robust cattle breeds are increasingly involved in conservation projects (Török et al., 2016). Several studies reported that extensive cattle grazing is effective in suppressing noxious species and creates a mosaic of short and tall species in the short run, which enables maintenance of high species richness in the landscape (Török et al., 2016; Kelemen et al., 2017; Tóth et al., 2018). The Hungarian Grey cattle feeds in habitats along a broad moisture gradient including marshes and alkaline grasslands; thus, in highly mosaic landscapes it is well suited for grazing (Török, Valkó, Deák, Kelemen, & Tóthmérész, 2014). Traditional breeds are less suitable for fattening and meat production, because of their moderate growth rate and poor meat quality (Bartosiewicz, 1997). The production index of Hungarian Grey cattle is not competitive with that of crossbred beef cattle, but it is important due to its unique gene pool and special delicacy meat products (called "hungaricums"). Therefore, the Hungarian Grey cattle became an important iconic animal of national parks, nature conservation and rural development programs in Hungary (Török et al., 2014).

It is an important question whether crossbred beef cattle can be a feasible substitute of traditional breeds for maintaining the habitat diversity. Among the crossbred beef cattle, Charolais and Limousin are considered as quality beef cattle worldwide due to their excellent growing ability and the quality of their meat (Herd Book Charolais, 2004; Bene et al., 2007). Because of their large body mass and growth rate they are more demanding regarding the forage quality. They play a subordinate role in rangeland management for nature conservation, despite their excellent grazing ability, feed utilization and ability to adapt to extreme conditions. Due to their large body size, they have a considerable trampling effect on soil and vegetation, which may be a problem particularly in wet areas. Usually, these breeds are suitable primarily for the grazing of high-productivity dry or mesophilous rangelands.

Due to the large body size of cattle, grazing intensity should be carefully chosen to prevent soil erosion (Salvati & Carlucci, 2015). Several studies found that high grazing intensity leads to land degradation, due to intensive trampling, nutrient input and excessive defoliation (Brinkert, Hölzel, Sidorova, & Kamp, 2016; Symeonakis, Karathanasis, Koukoulas, & Panagopoulos, 2016; Deák et al., 2017; Gaitán et al., 2018). Tölgyesi, Bátori, Erdős, Gallé, and Körmöczi (2015) emphasized that grazing intensity should be harmonised with the specific habitat types and plant productivity. They found that for wet meadows, intensive grazing is a proper management tool, but in dry grasslands a lower grazing intensity maintains the highest plant diversity. Many authors found that extensive grazing is a proper tool for the management of wetlands and grasslands (Ausden, Hall, Pearson, & Strudwick, 2005; Jones, Fraser, & Curtis, 2011; Schrautzer, Breuer, Holsten, Jensen, & Rasran, 2016; Deák et al., 2017). However, extensive grazing can also have negative effects on plant species richness (Fleischner, 1994; Haarmeyer, Schmiedel, Dengler, & Bösing, 2010), if grazing intensity is too low to effectively control biomass accumulation and encroachment of woody species.

There are multiple dilemmas for practitioners during the management of rangelands for biodiversity conservation: intensive management may lead to land degradation and loss of biodiversity, while extensive management may lead to succession from open landscapes to woodland and the loss of grassland habitats (Valkó et al., 2018). Drainage, land use changes and agricultural intensification led to a loss of wetland and grassland habitats and species over the past decades (Thompson & Finlayson, 2001; Valkó et al., 2018). In response, agricultural policy in Europe targets the protection of the remaining habitats by integrating the need for a viable agriculture with the need for conservation and restoration of biodiversity.

The overall aim of this study was to test whether conservation targets can be achieved by grazing marshes and alkaline wet grasslands by profitable breeds. We studied the effects of grazing a traditional breed and crossbred beef cattle on the conservation values of the habitats (i.e., species richness, diversity, naturalness and moisture indicator value), but also considering several variables relevant for animal husbandry (i.e., cover of sedges and rushes, legumes, absolute weeds, and conditional weeds) in order to harmonise the demands of the nature conservation and agricultural sectors which is essential for effective rangeland conservation and management. We hypothesized that the effects of cattle grazing on the habitat conservation values and forage quality depends on the grazing breed, because breeds differ in their grazing selectivity, body size and trampling effect.

2 | METHODS

2.1 | Study area

Our study sites were in the Hortobágy National Park, which is located in the Great Hungarian Plain at an average altitude of 88–92 m. The climate is continental, the average annual temperature in the region is 9.5°C and the average annual precipitation is 550 mm (Lukács et al., 2015). The Hortobágy National Park harbours one of the largest open landscapes in Europe, characterized by alkaline and alluvial soils (Deák, Valkó, Török, & Tóthmérész, 2014b). The landscape is characterised by a diverse mosaic of open wet and dry habitats (Kelemen, Török, Valkó, Miglécz, & Tóthmérész, 2013), which have traditionally been managed by cattle grazing (Godó et al., 2017). Most of the pastures were traditionally grazed by Hungarian Grey cattle, herded across large areas of several thousand hectares. The herds used to be out in the pastures throughout the whole year until the early 20th century, but in modern times the grazing season lasts from mid-April to mid-October only.

2.2 | Studied habitat types

We studied two habitat types: alkaline marshes (*Bolboschoenetum maritimi*) and wet alkaline grasslands (*Beckmannion eruciformis*), called hereafter marshes and grasslands, respectively (Deák, Valkó, Alexander, et al., 2014a). Both habitat types are of special conservation interest in the European Union and are included as priority habitats "Pannonic salt steppes and marshes" in the Natura 2000 system (Deák, Valkó, Török, et al., 2014b). They harbour several endemic or rare plant species, such as *Cirsium brachycephalum*, *Limonium gmelinii* ssp. *hungaricum*, *Ranunculus lateriflorus* and *R. polyphyllus*. The marshes are situated in deeper areas inundated for a longer period (generally until midsummer) than the grasslands (Deák, Valkó, Tóthmérész, & Török, 2014c). Typical species of the marshes are *Bolboschoenus maritimus*, *Eleocharis palustris*, *Eleocharis uniglumis*, *Agrostis stolonifera*, *Carex melanostachya* and *Potentilla reptans*. Wet alkaline grasslands occur at higher elevation than the marshes, but lower compared to dry alkaline and loess grasslands (Deák, Valkó, Alexander, et al., 2014a). Typical species are *Alopecurus pratensis*, *Agrostis stolonifera*, *Carex praecox*, *Carex stenophylla* and *Festuca pseudovina* (Deák, Valkó, Alexander, et al., 2014a).

2.3 | Grazing regime and sampling setup

We selected study sites where both marshes and alkaline wet grasslands occur (Figure 1): three sites were grazed by Hungarian Greys (traditional breed) and three by crossbred beef cattle (Charolais × Limousin F1). The soil pH ranged between 4.41 and 4.71 in the marshes and 5.20 and 5.99 in the wet alkaline grasslands, soil salt content was 0.04% in all sites and the humus content ranged between 2.61% and 2.69% in the marshes and 2.47% and 2.48% in the wet alkaline grasslands. The areas grazed by the traditional breed and the crossbred cattle were situated 10 km apart.

The grazing season lasted from mid-April to mid-October. In 2015, the grazing intensity in the study sites was 0.35 livestock units (LU)/ha and all the study sites were grazed by Hungarian Greys. From 2016 onwards, the pastures were utilized as follows: (a) the three sites grazed by the traditional breed were grazed by 540 Hungarian Grey cattle and 480 calves, corresponding to a grazing intensity of 0.61 LU/ha; (b) the three sites grazed by crossbred beef cattle were grazed by 550 cows and 500 calves, corresponding to a grazing intensity of 0.68 LU/ha. Note that the weight of a Hungarian Grey (bull: 900 kg, cow: 600 kg) is approximately 10% lower than the weight of the crossbred cattle (bull: 1,000 kg, cow: 700 kg).

Vegetation of the study sites was sampled in May 2015, 2016 and 2017. In the six study sites (three sites grazed by the traditional breed and three sites grazed by the crossbred cattle) we designated two sample areas (one in marshes and one in alkaline wet grasslands). Within each sample area, we designated five 2 m × 2 m-sized permanent plots, where we visually estimated and recorded the percentage cover of all vascular plant species. We analysed a total of 60 plots. Nomenclature follows the work of Király (2009).

2.4 | Data analysis

We calculated the cover-weighted averages of the relative ecological indicator scores for moisture (referred hereafter as "moisture indicator value") at the plot level. For the calculations, we used the classification system of Borhidi (1995), which is similar to Ellenberg's ecological indicator score system, but adapted to the Hungarian conditions. We also expressed the relative naturalness of the vegetation of each plot, based on the Social Behaviour Type system of Borhidi (1995). The system classifies plant species in an ordinal scale, ranging from low (e.g. ruderal competitors are given a score of −2) to high naturalness value (e.g. habitat specialist species are given a score of +6). We expressed the cover-weighted mean Social Behaviour Type score for each plot (referred as "naturalness value" hereafter).

Following the system of Barcsák, Baskay, and Prieger (1978) we categorized weeds as conditional and absolute weeds. The categorisation is based on the nutritive value, palatability and toxicity of the plant species. Absolute weeds are detrimental for animal husbandry (e.g. prickly or toxic species), while conditional weeds decrease forage quality only in case they are present with a high abundance. Absolute weeds include prickly (e.g. *Cirsium vulgare*, *Carduus acanthoides*) and toxic species (e.g. *Ranunculus repens*, *Artemisia santonicum*). Conditional weeds include both forbs (e.g. *Capsella* *bursa-pastoris*, *Chenopodium album*) and graminoids (e.g. *Carex praecox*, *Bromus arvensis*). We also calculated the cover of legumes and rushes + sedges, as these groups are important to evaluate the forage quality. For the list of detected plant species and their assignment to the above-described categories, please see Appendix S1.

We analysed the effects of cattle breed (traditional breed/crossbred beef cattle, fixed factor), habitat type (marsh/grassland, fixed factor) and year (2015, 2016 and 2017, fixed factor) and their interactions on the vegetation characteristics (dependent variables) using generalised linear mixed models (Zuur, Ieno, Walker, Saveiliev, & Smith, 2009) in SPSS 22 (IBM Corp., Armonk, NY). Site was included as random factor. Dependent variables were the following: variables related to the conservation value of grasslands (species richness, Shannon diversity, naturalness value and moisture indicator value), and variables related to forage quality (cover of rushes and sedges, leguminous plant cover, absolute weed cover, conditional weed cover). Sample area was included as random factor.

To visualize the differences in the vegetation composition of the two studied habitats grazed by the cattle breeds in the three study years we used detrended correspondence analysis (DCA; CANOCO 5; ter Braak & Šmilauer, 2012). We used the averaged percentage cover scores of the species occurring in a certain sample area.

3 | RESULTS

3.1 | Vegetation composition

During the study we found a total of 129 plant species in the pastures, 61 in Year 1 (2015), 95 in Year 2 (2016), and 92 in Year 3 (2017). A total of 83 species were recorded in the marshes, and 98 species were found in the alkaline wet grasslands. In the areas grazed by the traditional beef cattle, 101 species were found, and in the areas grazed by the crossbred beef cattle, 104 species were recorded. Note that grazing intensity was 0.35 LU/ha in Year 1 and the livestock numbers were increased after that year to 0.61 LU/ha (in the three sites grazed by the traditional breed) and 0.68 LU/ha (in the three sites grazed by the crossbred cattle). The DCA ordination showed separations in the species composition according to the habitat type and cattle breed (Figure 2). The vegetation composition of the marshes was more similar in areas grazed by different cattle breeds; the distinction was much sharper in the case of the grasslands.

3.2 | Conservation values

The vegetation characteristics related to conservation values did not differ among the sites grazed by the two cattle breeds, but there was a significant interaction between the cattle breed and the habitat type in the case of two dependent variables (Table 1). The species richness and Shannon diversity were marginally significantly higher (p = 0.055) in the pastures grazed by the traditional breed compared to the ones grazed by the crossbred beef cattle in both habitat types (Figure 3a,b). The highest number of species and highest Shannon diversity were found in alkaline wet grasslands grazed by the traditional breed, and the lowest in marshes grazed by the crossbred beef cattle (Figure 3a,b). The naturalness and moisture indicator values of the vegetation were not affected by the cattle breed (Figure 3c,d). The moisture indicator value decreased with increasing grazing intensity in the marshes grazed by the crossbred beef cattle, and increased slightly in the case of traditional beef cattle grazing.

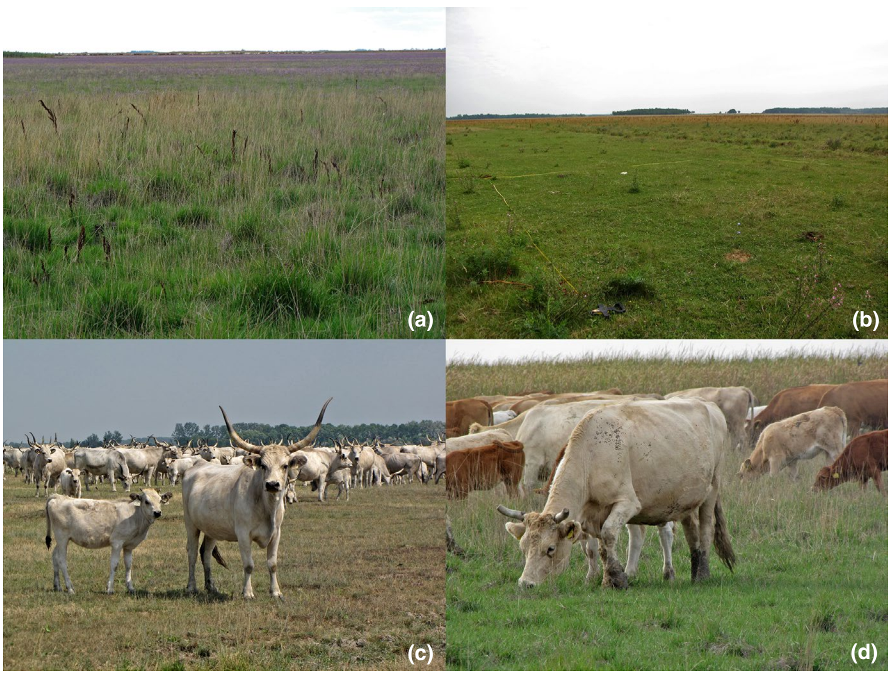

FIGURE 1 Photos about the studied habitat types and grazing beef cattle breeds. (a) Alkaline marshes; (b) grasslands; (c) traditional beef cattle (Hungarian Grey); (d) crossbreed beef cattle (Charolais × Limousin). Photos by Nóra Kovácsné Koncz [Colour figure can be viewed at wileyonlinelibrary.com]

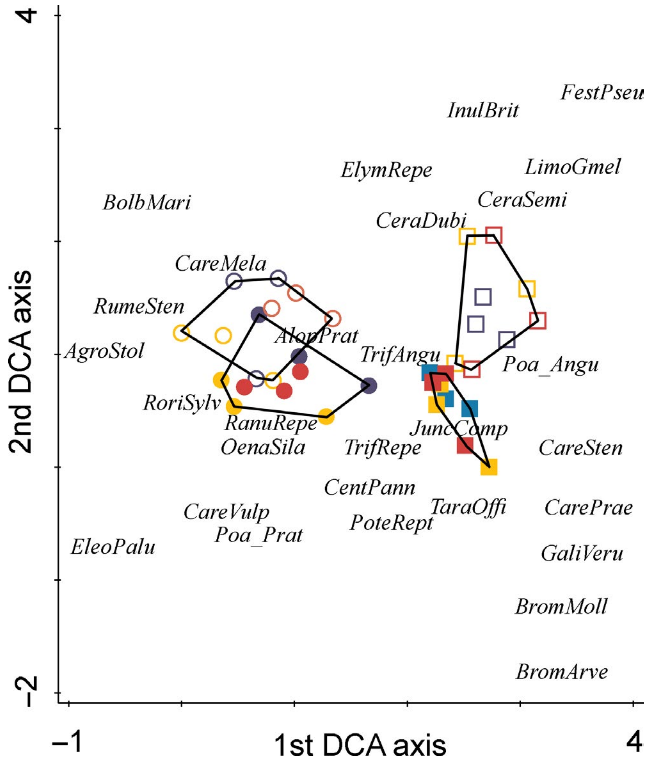

FIGURE 2 Detrended correspondence analysis (DCA) ordination of the plant species composition of the studied plots. Circles: marshes, squares: grasslands; full symbols: areas grazed by traditional cattle breed, empty symbols: areas grazed by crossbred beef cattle; blue symbols: data from 2015, yellow symbols: data from 2016, red symbols: data from 2017. Species names are abbreviated using the first four letters of their genus and species names. Eigenvalues were 0.498 and 0.181 for the first two axes. Cumulative variation explained by the first two axes was 20.42% and 27.86%, respectively [Colour figure can be viewed at wileyonlinelibrary.com]

3.3 | Forage quality

The majority of the vegetation characteristics related to forage quality were not different among the sites grazed by the two cattle breeds (Figure 3d–g). The cattle breed influenced only the cover of absolute weeds (Table 1). In the areas grazed by the traditional cattle breed, the cover of absolute weeds was higher than in the areas grazed by the crossbred beef cattle (Table 1, Figure 3f). In marshes and grasslands grazed by the traditional breed, the percentage cover scores of the rushes and sedges and conditional weeds decreased with an increase in livestock number from Year 1 to 3. The cover of legumes increased from the first to the third year of the study. In Year 3, the largest cover of legumes was found in the alkaline wet grasslands grazed by the traditional breed, and the lowest in the marshes grazed by the crossbred beef (Figure 3e).

4 | DISCUSSION

In the studied lowland marshes and wet alkaline grasslands, we found that the effect of cattle breed on the habitat conservation values and forage quality is dependent on the habitat type. Our results confirm the recent findings of Pauler et al. (2019) who highlighted that matching the proper cattle breed to certain vegetation types is highly important for the maintenance of the habitat's conservation values.

4.1 | Conservation value

The traditional breed maintained a marginally significantly higher species number and Shannon diversity in both habitat types than the crossbred beef cattle, which supported our hypothesis. This corresponds to the findings of Pauler et al. (2019) who found that the robust Galloway cattle maintains a more species-rich vegetation compared to the production-oriented breeds. Furthermore, we found that the species richness was the highest in wet alkaline grasslands grazed by the traditional beef cattle, and the lowest in the marshes grazed by crossbred cattle. The moderate trampling by the lighter traditional beef cattle likely increased the diversity of the vegetation by increasing the availability of open microsites proper for plant establishment. Since being a heavy breed, the crossbred beef cattle can have a considerable trampling effect resulting in a high proportion of bare soil surface and a considerable decrease of the vegetation (Pauler et al., 2019). Trampling effects on the vegetation were found to be larger on wet soil compared to dry soil (Proffitt, Bendotti, Howell, & Eastham, 1993) which highlights the vulnerability of marshes towards grazing by heavy breads.

In our study, the species richness and the Shannon diversity were positively linked to a moderate increase in the number of animals. Possible causes of the positive correlation between diversity and grazing intensity include (a) decreased competition caused by the continuous removal of biomass, (b) increased propagule input by the dispersal of seeds on the fur and hooves of the animals and by manure; and (c) improved establishment conditions caused by the increased nutrient input and the increased availability of open microsites (Deák et al., 2017; Ma et al., 2016; Smit & Putman, 2011).

The habitat naturalness value was not affected by the cattle breed. It was influenced by the habitat type and the intensity of grazing only. Naturalness values decreased with increasing grazing intensity, which calls attention to the importance of setting and designing proper management intensities in rangelands. Even though in our case increasing grazing intensity did not lead to the severe degradation of grasslands, several studies identified overgrazing as a major cause of habitat degradation (Deák et al., 2017; Gaitán et al., 2018; Tóth et al., 2018).

An important finding of our study is that the grazing of crossbred cattle leads to decreasing moisture indicator values in marsh habitats. This is probably caused by the trampling effect of the larger-sized crossbred beef cattle, which is higher on wet soil compared to dry soil (Warren, Nevill, Blackburn, & Garza, 1986). On the one hand, trampling can increase the area of open soil surfaces, which

TABLE 1 The effect of cattle breed, habitat type, year and their interactions (fixed factors) on the vegetation characteristics of the studied habitats (generalised linear mixed models). Significant effects are marked by boldface.

Vegetation characteristics	Cattle breed		Habitat type		Year		Cattle breed × Habitat type		Cattle breed × Year		Habitat type × Year	
	F	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*	*F*	*p*
Species richness	3.73	0.055	13.82	**<0.001**	6.51	**0.002**	4.29	**0.040**	1.08	0.342	0.58	0.563
Shannon diversity	3.72	0.055	29.77	**<0.001**	12.30	**<0.001**	9.49	**0.002**	2.17	0.117	0.94	0.393
Naturalness value	1.19	0.275	53.76	**<0.001**	13.22	**<0.001**	3.38	0.068	0.79	0.455	1.42	0.244
Moisture indicator value	0.37	0.546	616.98	**<0.001**	3.164	**0.045**	0.14	0.706	3.39	**0.036**	0.78	0.458
Cover of rushes and sedges	0.39	0.530	27.84	**<0.001**	5.34	**0.006**	2.79	0.097	6.94	**0.001**	5.68	**0.004**
Cover of legumes	1.50	0.223	2.07	0.152	1.03	0.359	0.42	0.517	14.74	**<0.001**	0.54	0.582
Cover of absolute weeds	4.44	**0.037**	15.94	**<0.001**	2.56	0.080	1.07	0.303	1.60	0.206	2.84	0.061
Cover of conditional weeds	1.43	0.233	34.15	**<0.001**	0.17	0.842	0.62	0.431	5.14	**0.007**	0.05	0.949

Note: Significant effects are marked by boldface.

due to the increased rate of evaporation can lead to the marshes drying out. On the other hand, in the created open vegetation structure several mesophilous species can occur (Deák, Valkó, Tóthmérész, et al., 2014c), also leading to decreased moisture indicator values. In the face of climate change, the interaction of grazing- and climate-induced drought will act as an important threat for the conservation values of rangelands (Gaitán et al., 2018; Webb et al., 2017). An option for mitigating the negative effects of climate change could be to apply grazing of traditional cattle breeds in the sensitive marsh areas.

4.2 | Forage quality

There were no major differences between the forage quality of the vegetation on the pastures grazed by the two types of cattle breed. The only exception was the cover of absolute weeds, which was higher in the pastures grazed by the traditional breed. Even this phenomenon is unfavourable from the agricultural viewpoint, we should note that the most abundant absolute weeds were *Ranunculus repens*, *Oenanthe silaifolia* (both typical species of alkaline marshes and wet grasslands) and *Cirsium brachycephalum*, which is a species of high conservation value, listed in Annex 2 of the Habitats Directive of the Natura 2000 system (Council Directive 92/43/EEC). In these quantities (below 6%, see Appendix S2 and S3) these species do not reduce the forage quality. The percentage cover of the conditional weeds did not change due to the grazing of the two different cattle breeds. However, we found that after the slight increase in the grazing intensity of traditional cattle breed, the cover of conditional weeds decreased significantly. This was probably due to the decreased cover of *Carex stenophylla* and *Carex praecox*, which can be explained by the low selectivity of the Hungarian Grey cattle. At the same time, the cover of *Bromus arvensis* and *Bromus mollis* was increased, which are also considered as conditional weeds. Even though these species are valuable forage in springtime, later on, they get dry, and they are not palatable anymore. Their high cover is unfavourable from the conservation point of view (Molnár, 2017).

We found that the percentage cover of rushes and sedges, which are the least valuable forage components of the vegetation, was not different in the pastures grazed by the different cattle breeds. Rushes and sedges were suppressed by the increasing number of livestock in both habitat types. This decrease was due to the decreasing cover values of *Bolboschoenus maritimus*, *Carex praecox*, *Eleocharis palustris* and *Eleocharis uniglumis*. The decrease in the cover of rushes and sedges was larger in the areas grazed by the traditional breed, compared to areas grazed by the crossbred beef cattle. The likely reason is that the grazing of Hungarian Grey cattle is characterized by low selectivity (Török et al. 2016). In the pastures with traditional beef cattle grazing, there was a significant increase in the cover of the legumes (*Trifolium angulatum*, *Trifolium repens*), but in the areas grazed by the crossbred beef cattle there was no significant change. These findings suggest that the two cattle breeds have slightly different forage selectivity, and the traditional breeds maintain higher quality forage if we consider the decreasing cover of rushes and sedges and increasing cover of legumes.

5 | CONCLUSIONS

Traditional breeds are valued as part of the traditional pastoralism, for their genetic resources and for their positive effects from the conservation viewpoint. Crossbred beef cattle are

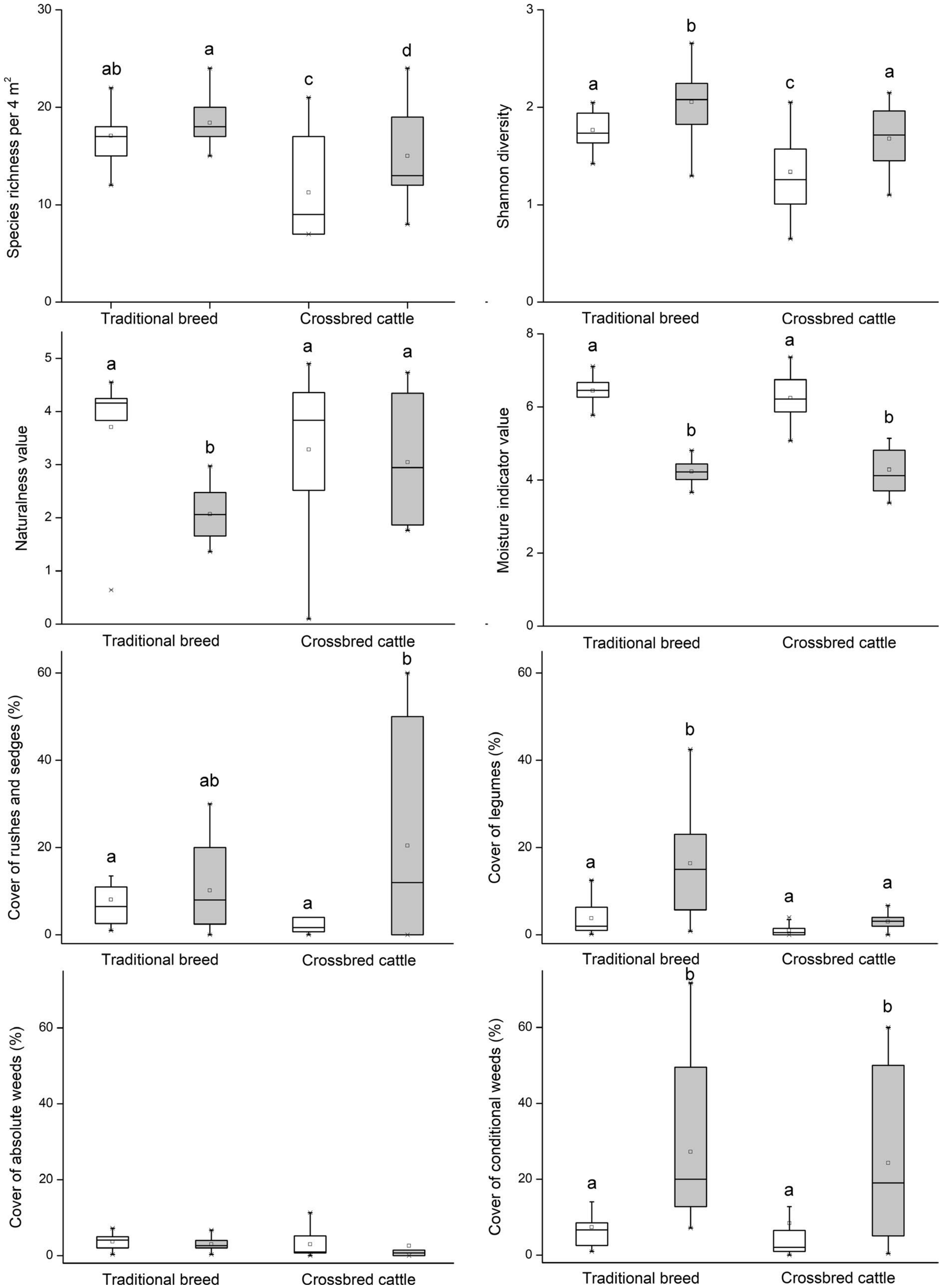

FIGURE 3 Variables related to the conservation values (species richness, Shannon diversity, naturalness value, moisture indicator value) and forage quality (cover of rushes and sedges, legumes, absolute weeds and conditional weeds) in pastures grazed by the traditional breed and the crossbred beef cattle in Year 3. White boxes: marshes, grey boxes: alkaline wet grasslands. The boxes show the interquartile range, the lower whiskers show the minimum, the upper whiskers show the maximum and the inner lines display the median values. Letters denote significant differences between groups (LSD test, $p < 0.05$)

valued for their better meat quality. Our findings revealed that traditional breeds should be prioritized in the management of wet alkaline grasslands and marshes. However, crossbred beef cattle might be a substitute but only in cases where traditional breeds are not available for the management of alkaline wet grasslands, in order to offer a good compromise for harmonising the needs of the agricultural and nature conservation sectors. In marshes, however, we recommend to prioritize the traditional breeds as they maintain higher diversity compared to the crossbred beef cattle.

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AUTHOR CONTRIBUTIONS

NKK, OV and BB conceived of the research idea; NKK, OV, BD, AK, KT, RK, SR, and TM collected data; BD and OV performed statistical analyses; NKK and OV, with contributions from BD and BT, wrote the paper; all authors discussed the results and commented on the manuscript.

DATA AVAILABILITY STATEMENT

Data used in this study are given in Appendix S3.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

Appendix S1. Assignment of the recorded plant species to the functional groups, as well as their moisture and naturalness values

Appendix S2. Vegetation characteristics in the studied grasslands and marshes grazed by the two cattle breeds in the three study years

Appendix S3. Mean percentage cover scores of the vascular plant species recorded in the marsh and grassland pastures grazed by the two cattle breeds in the three study years

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