



PROSPECTS FOR TRADITIONAL LIVESTOCK BREEDING OF POLISH RED CATTLE WITH THE AGREEMENT OF BIODIVERSITY PROTECTION*

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Key words: welfare, native cattle, grazing, meat quality, Polish Red cattle, biodiversity protection.

Abstract

Meat from conservation breeding programs receives higher scores for juiciness, texture and aroma. Polish Red cattle kept on low-input farms where livestock are raised extensively (pastured in summer and fed farm-made fodder in winter) and highly appropriate for breeding due to moderate productivity and the high quality of milk and meat. In the past, Polish native cattle breeds were extensively grazed to preserve bird habitats in the same ecosystem. The demand for beef from “grass-fed” cattle is on the rise because consumers have a growing interest in animal health and well-being, environmental sustainability, and meat products with a modified nutritional profile and lower fat content. Two-thirds of the energy supplied by feed is required to maintain body functions of cattle. Energy expenditure increases in response to both low and high temperatures that differ from the thermal optimum of each species. Cattle are sensitive to both heat and winter stress, and the maintenance of thermal homeostasis requires additional energy when animals are exposed to suboptimal temperatures. Based on the knowledge, the aim of this review is understanding that to ensure high levels of animal welfare, the grazing of traditional native cattle breeds should be planned by calculating nutrient yields in pasture grass and basal diets, not only for cows, but also for other free-ranging herbivores.

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* The research was financed from the statutory funds of Department of Biodiversity Protection, Institute of Animal Reproduction and Food Research of Polish Academy of Sciences, Olsztyn, Poland.

Characteristics and history of Polish Red cattle

Italy and France are leaders in the conservation of native cattle breeds. The conservation of local livestock breeds in those countries is highly promoted by the Food and Agriculture Organization of the United Nations with the aim of upholding agricultural traditions and the local culture.

Polish Red, Polish Red-and-White, White-Backed, and Polish Black-and-White cattle represent only a small percentage of Polish native cattle breeds that increase biodiversity (LITWIŃCZUK et al. 2012). Polish Red cattle originated from small wild brachycephalic (short-horned) cattle in Central Europe and Scandinavia. These animals have red to dark red coloring, and they were introduced to Polish territory at the beginning of the 16th century. Between the two world wars, Polish Red cattle accounted for 25% of the domestic cattle population. Before World War II, the Polish Red had the status of an international breed, and by the mid-20th century, it was found in nearly all Polish regions. The breed accounted for 22% of the entire Polish cattle population in the 1950s and for 18% in the 1960s (2 million head). In 1973, Polish Red was reared exclusively in three districts in southern Poland as part of a regionalization scheme. A conservation breeding program for Polish Red cattle was introduced in Nowy Sącz Voivodeship at the end of 1975 to maintain this valuable breed. The regionalization scheme and the conservation breeding program were abandoned in 1982, and Polish Red cattle were replaced by more productive breeds and animals crossbred with foreign breeds, mainly the Angler (*Bydło. Ochrona ras...* 2023).

Historical and current grazing conditions of Polish Red cattle

Until the 1970s, grazing played an important role in Polish Red cattle breeding, but uncontrolled bark chewing and trampling caused significant damage to tree stands. However, grazing improved light access and the supply of animal manure, which led to changes in the structure of the local biocenosis. Cattle grazing led to the formation of thermophilic oak forests which emerged as one of the most floristically rich forest communities in Poland (LIBBERT 1933) and became protected as a priority habitat under the Natura 2000 program (JAKUBOWSKA-GARBARA 2004). Widespread cattle and pig grazing in forests induced permanent changes in the structure of plant communities because excessive foraging on the undergrowth and overgrowth eliminated hornbeam and lime trees from the stand.

Undergrowth density was reduced to 5–10% of the original value, which enabled light-loving or even xerothermic species to develop in the undergrowth layer. Sparse oak crowns were easily penetrated by light and rain, which promoted the growth of lush and diverse vegetation on the forest floor. However, the absence of livestock and anthropogenic pressure led to rapid changes in the phytocenosis. Oak forests emerged as a result of planned forest management activities (JAKUBOWSKA-GARBARA 1991), as well as the pressure exerted by foraging deer. Light oak disappeared from Białowieża Forest due to changes in the abundance and hierarchy of herbivores feeding on hornbeam trees (KWIATKOWSKA 1994). However, herbivores populations were controlled not only by natural predators, but also, at least periodically, by humans, which suggests that herbivores pressure was a natural as well as an anthropogenic factor. The impact of large herbivores on woodlands led to the formation of “pasture forests” in Europe already before the development of agriculture (BORKOWSKI 2011).

Conservative cattle breeding in Poland

The Polish Red is the oldest Polish cattle breed with a single body color, and it is characterized by adaptability to unfavorable environmental conditions, resistance to diseases (such as mastitis, leukemia, and hoof disorders), very high fertility, calving ease, and extraordinary longevity. Polish Red cattle can be raised under unsupportive environmental conditions, and they are able to effectively utilize low-quality roughage. The popularity of traditional breeds has increased, especially on smaller farms, and Polish breeders are entitled to subsidies. The Polish Red presently accounts for 1% of the domestic cattle population and only 0.29% of the registered population. According to the annual monitoring data of the Agricultural Advisory Center, approximately 3500 head of Polish Red cattle were reared in 320 herds as part of the breed protection program in 2021 (Table 1).

Table 1
Breeding history of the Red Polish Cow in Poland based on number of individuals according to reports of „Statistic Poland”

Year	Number of individuals
1960	2 000 000
1999	150
2010	2091
2015	2388
2021	3500

Polish Red and White-Backed cattle are dual-purpose breeds that have long been used for milk production. In comparison with other cattle breeds, the Polish Red and White-Backed are characterized by moderate productivity and very high milk and meat quality. Upon the breeders' request, the National Research Institute of Animal Production (NRIAP) introduced breed assessment programs based on meat production traits for Polish Red cattle in 2017 (Polish Red Cattle Conservation Program, NRIAP, 2022) and for White-Backed cattle in 2019 (Polish White-Backed Cattle Conservation Program, NRIAP 2022).

The average milk yield of Polish Red cattle is 3,786 kg (4.26% fat content and 3.39% protein content). The superior performance of Polish Red cows can be attributed to their genetic ancestry which contributes to the breed's high conservation value. This valuable genetic resource must be protected because it plays an important biological role in agriculture and organic farming, and contributes to the preservation of landscapes, local traditions and culture. Cattle are registered for the needs of the genetic resource conservation program coordinated by the National Research Institute of Animal Production in Poland (NRIAP) in accordance with the applicable animal welfare regulations. According to recommendations, White-Backed, Polish Red, Polish Red-and-White, and Polish Black-and-White cattle should be kept in a pasture system in summer and indoors outside the grazing season (Polish Red Cattle Conservation Program, NRIAP, 2022).

The role of large herbivores in habitat restoration

In the 20th century, many livestock species were deprived of their natural habitats, which led to a dramatic decline or even the extinction of some animal populations (GOLONKA and JAWORSKI 2002). The establishment of nature conservation areas would protect endangered species, increase their population, and, in some cases, facilitate the reinstatement of these populations in the original habitats. Native cattle and horse breeds can be grazed extensively to protect indigenous avifauna. Before Polish Red cattle and Konik Polski horses were used to protect ornithofauna habitats through grazing, the Polish Society for the Protection of Birds had advocated for extensive wetland grazing to restore valuable bird habitats at the turn of the 19th and 20th centuries (KALSKI 2019). In recent years, a seasonal grazing program involving Polish Red cattle and Konik Polski horses was launched by the Polish Society for the Protection of Birds in the Narew River Valley (more than 290 ha) to restore local avi-

fauna habitats. During the program, Konik Polski horses from Popielno and Polish Red Cattle were grazed between June and October/November (*Ptaki. Podsumowanie... 2023*).

A greater increase in the breeding populations of *Charadriiformes*, including corncrake (*Crex crex*), spotted crane (*Porzana porzana*), northern lapwing (*Vanellus vanellus*), black-tailed godwit (*Limosa limosa*), ruff (*Calidris pugnax*), and common redshank (*Tringa tetanus*), was observed in grazed meadows than in the remaining areas. Grazing and trampling effects improved vegetation structure and foraging conditions for wading birds in wetland habitats (*Ptaki. Podsumowanie... 2023*). The animals were reunited with their herds at the end of the program. The grazing scheme could not be prolonged due to periodic flooding of meadows in the Narew River Valley. Konik Polski horses and Polish Red cattle had to be returned to their respective farms to undergo obligatory veterinary preventive care and other maintenance procedures, such as hoof correction. In Poland, only Konik Polski horses can be kept in semi-open breeding systems in natural reserves. However, the above applies only to individuals born in the wild.

Energy expenditure during cattle grazing

Generally, in seasonal grazing cattle milk yield is lower than in indoor breeding. The stress associated with herding cattle, changes of the diet and weather conditions cause periodic drops in the milk yield of these animals. Whereas energy expenditure during grazing increases in response to both very high and very low temperatures which fall outside the optimal thermal range of a given species. Cattle are sensitive to both heat and winter stress, and in addition to meeting basic physiological needs, the energy derived from feed has to accommodate the animals' thermal needs in unfavorable climatic conditions. On winter rangelands at northern latitudes, forage intake is often limited by low temperature and poor-quality pastures (ARNOLD 1985). The diets of grazing beef cattle are supplemented with protein to increase the intake of dormant forages for their nutritional needs and improve productivity (BODINE et al. 2001). In winter, protein supplementation strategies are introduced on the assumption that all animals consume a daily target quantity and that deviations from the targeted intake negatively impact their health and performance (BOWMAN and SOWELL 1997, WYFFELS et al. 2020). In winter, prolonged exposure to low temperatures and cold winds in northern grazing environments increases the resting metabolic rate and the overall energy expenditure to

maintain homeothermy (KEREN and OLSON 2006). Changes in energy requirements can affect the intake of dietary supplements during winter months. Short-term behavioral responses showed by thermal stress may be critical to the energy balance of domestic animals under extreme weather conditions (SENFTE and RITTENHOUSER 1985). Moreover according to THORNOTON et al. (2021), anthropogenic climate change has major impacts on domesticated livestock, including increased heat stress in animals in both intensive and extensive livestock systems.

The influence of grazing on meat quality and palatability

Low-input livestock production systems, also known as extensive or traditional farming systems, promote animal welfare, sustainable development, and the production of safe foods with health promoting properties (MARINO et al. 2011, RAZMINOWICZ et al. 2006). However, the nutritional profile of meat produced in pasture-based feeding systems in countries with a long growing season, such as Brazil, Argentina, Uruguay, Australia, and New Zealand, is not directly equivalent to the nutritional profile of beef marketed as “grass-fed” in the US. Differences in pasture type and availability, cattle breed and age can influence the nutritional composition, quality, palatability, and digestibility of meat (LUCIANO et al. 2011, MIR et al. 2006). The fatty acid profile of beef is most effectively modified through diet. Forage such as grass, clover, and haylage is a rich source of α -linolenic acid (18: 3n-3), whereas cereal-based concentrates and maize silage are abundant in linoleic acid (18: 2n-6). The meat of cattle fed fodder from permanent grasslands was characterized by a more desirable ratio of n-6/n-3 fatty acids than the meat of cattle fed concentrates (NUERNBERG et al. 2005). In Poland, breeders of native cattle are entitled to subsidies under agricultural and environmental programs (FLOREK et al. 2017).

The influence of green fodder on the fatty acid profile of beef should not be generalized because the content and proportions of fatty acids in meat appear to be affected by both breed and type of grass (VAN ELSWYK and MCNEILL 2014). For example, the saturated fatty acid (SFA) profile of beef from two US cattle breeds, Angus and Simmental, differed in animals fed annual and perennial grasses. When the results were adjusted for differences in intramuscular fat content, Angus cattle grazed on annual pastures (rye grass, red clover, lotus) deposited more stearic acid in the polar lipid fraction of intramuscular fat than Simmental cattle grazed on annual pastures (ITOH et al. 1999). The fatty acid profile of individual muscles also differed in grass-fed or grain-finished cattle (LORENZENL et al. 2007). Car-

cass fat content was also found to affect the fatty acid composition of beef. Regardless of diet, the meat of “lean” breeds (such as double-muscled breeds) is more abundant in polyunsaturated fatty acids (PUFAs) than the meat of other breeds (DESMET et al. 2004) because PUFAs are accumulated mainly in muscle membrane phospholipids.

The above examples indicate that that meat quality is determined by numerous factors; therefore, the extent to which the transition from a standard diet to year-round grazing will affect the quality and nutritional value of Polish Red beef is difficult to predict. Research has shown that nutrition and genetics have no influence on the protein content or amino acid profile of beef (SCOLLAN et al. 2006). A comparison of the protein content of meat from grass/forage-fed and grain-finished cattle revealed no significant or practical differences (protein content ranged from 20% to 23%) (DUCKETT et al. 2009, 2013, LEHESKA et al. 2008). Meat aroma and palatability may be associated with individual preferences or cultural norms. For example, American consumers enjoy the flavor of beef from traditionally fed cattle, whereas consumers in other countries prefer beef from grass-grazed cattle (SCOLLAN et al. 2006, SITZ et al. 2005). Meat flavor is influenced by forage type and maturity, cattle breed, fat content, and marbling score, which is why the flavor of beef from grass/forage-fed and grain-finished cattle is difficult to compare (VAN ELSWYK and MCNEILL 2014). It should also be noted that the content of macro- and microelements is similar in the meat of Polish Red, Simmental, and Polish Holstein-Friesian cattle (DOMARADZKI et al. 2016).

Grazing by ruminants in different countries

In many US regions, beef cattle that had been raised under intensive farming systems are increasingly often grazed in pastures. Cattle are usually grazed in summer when fodder crops are more nutritious and palatable. Seasonal grazing strategies are also implemented to improve animal welfare and performance as well as for economic reasons. Consumers are becoming increasingly aware that grazing promotes animal health and well-being, contributes to environmental sustainability, and that the meat of pasture-grazed cattle is leaner and more abundant in health-promoting fatty acids (VAN ELSWYK and MCNEILL 2014). Feed is the most significant cost in livestock farming, and supplemental feeding accounts for 65% of the annual costs in cow-calf production (ARTHUR et al. 2004, VAN DER WESTHUIZEN et al. 2004, MEYER et al. 2008). Two-thirds of the energy derived from feed is utilized for physiological processes (FERRELL and

JENKINS 1984, 1988) and is an important consideration in cattle production (ARTHUR et al. 2001, NKRUMAH et al. 2006, CROWLEY et al. 2010). Feed constitutes the largest production input, which is why the selection of breeds characterized by lower feed intake and high productivity could substantially improve profitability (MEYER et al. 2008).

Livestock grazing influences landscape composition and plays a significant role in most European countries. In the Netherlands, the importance of grazing, including in forests, is widely recognized as a factor that contributes to animal welfare. Livestock grazing promotes habitat biodiversity and leads to changes in the size and composition of plant communities (LINDENMAYER et al. 2018). High-quality fodder from pastures is also a rich source of macro- and microelements, protein, energy, and vitamins (BARSZCZEWSKI et al. 2015). In the Netherlands, the number of grazed animals has decreased due to a rise in the cattle population. For example, 92% of the animals are grazed in herds with 40 head, but only 42% are grazed in herds of 160 or more animals. Average herd size continues to increase, which implies that fewer animals will be grazed (VAN DEN POL-VAN DASSELAAR et al. 2015). In recent years, the uncontrolled increase in the population of large herbivores in the Oostvaardersplassen nature reserve in the Netherlands has stirred considerable controversy. Oostvaardersplassen spans an area of around 56 square kilometers, and it is an experiment in rewilding. Due to uncontrolled reproduction and overcrowding, nearly 3300 deer, horses, and cattle died of starvation in the winter of 2017–2018 (Givetash 2018, Barkham 2018).

Conventional grazing requires access to areas with high ecological and landscape value, including forests. Forest grazing is prohibited in many countries, but its popularity is on the rise in Europe, despite the critical opinions of forest rangers who have argued that grazing cattle disrupt hunters, damage seedlings, the soil environment, and tree stands (VARGA et al. 2015). In Poland, rotational grazing is the most popular grazing strategy. The pasture is divided into paddocks, and cattle are moved to different portions of the pasture. Paddocks should have a similar size, and they should be enclosed by trenches, roads, or forests. Pastures should be rotated and effectively managed to maximize productivity. All four Polish native cattle breeds (Polish Red, White-Backed, Polish Black-and-White, and Polish Red-and-White) are kept on low-input farms where livestock are pastured in summer and fed farm-made fodder (silage and grass) in winter (LITWIŃCZUK et al. 2014). Beef from such production systems has higher nutritional value (CABRERA and SAADOUN 2014). The mineral content of beef is influenced by cattle breed, age, diet, production system, and meat processing (CABRERA and SAADOUN 2014, DOMARADZKI et al. 2016).

In Poland, ruminants are grazed between May and mid-October (around 160–170 days), and the grazing season ends shortly before the first ground frost (TWARDY and BARSZCZEWSKI 2015, BARSZCZEWSKI et al. 2015). Forest grazing is generally forbidden in Poland, but the forest division in Strzałowo (north-eastern Poland) authorized supervised grazing of Konik Polski horses in oak forests to restore ecosystem biodiversity (BOREK 2015). However, the project was not prolonged.

In Scandinavian countries, clear cuts in boreal forests play an important role in livestock grazing (TOFASTRUD et al. 2019), but the availability of *Picea* and *Abies*, *Larix*, and *Pinus* species (GAUTHIER et al. 2015), as well as flora has been greatly reduced (KELMAN WIEDER et al. 2006). Tofastrud et al. (2019, 2020) determined the number of beef cattle grazing in boreal forests of Norway. The grazing season lasted 80–120 days, from late May to early September. Northern Scandinavian forests are valuable grazing areas for adult cattle and calves, but livestock compete for food with moose, which decreases the availability of feeding resources for wild animals. Moreover, changes in forage composition also decrease foraging activities (TOFASTRUD et al. 2019, 2020). Although forests offer a good alternative to livestock pastures, in many cases, they can be used only as supplementary pastures (10–20% of total grazing; VARGA et al. 2020). Forest grazing is not always recommended. In comparison with pasture forage, forest forage is low in protein and energy, thus it does not provide sufficient nourishment for livestock (MERCKER 2019). Low-energy diets can lead to metabolic diseases (KOWALSKI 2010), and a negative energy balance is associated with ketosis in cattle (LITTLEDIKE et al. 1981). According to CANTÓN et al. (2021), the low energy content of winter diets can also contribute to hypomagnesaemia.

Ten to forty acres of forest or one acre of improved pasture are typically required to provide the same number of grazing days. Around one hundred plant species growing in forests can have toxic effects for livestock (MERCKER and SMITH 2019). Forest grazing can decrease cattle productivity due to the adverse effects of poisonous herbs and reduced availability of forage during the grazing season (TOFASTRUD et al. 2019). According to HAN et al. (2021), forest grazing contributes to the extinction of rare plant species.

Attempts have been made to introduce Polish Red cattle to the natural habitat of Konik Polski horses and wildlife herbivores (*Naukowy zbadaja...* 2023). At present, the conservation herd of Konik Polski horses consists of twenty-one mares of reproductive age, four stallions, and their annual offspring. The herd is grazed on an area of approximately 1,620 ha, including 57 ha of forest meadows. This area is also inhabited by wild

ruminants such as red deer, fallow deer, and roe deer. According to annual hunting data, more than 100 cervids were identified in Popielno in March of 2021 (Table 2).

Table 2

Number of ruminants living on the Popielno Peninsula according to annual counting
(March 2021)

Species	Number of individuals
Konik Polski (<i>Equus caballus</i>)	32
– stallions	4
– mares	21
– foals	7
Red deer (<i>Cervus elaphus</i>)	57
– bulls	15
– hinds	32
– calves	10
Fallow deer (<i>Dama dama</i>)	12
– bulls	4
– hinds	5
– calves	3
Roe deer (<i>Capreolus capreolus</i>)	32
– bucks	12
– does	14
– calves	6

In recent years, local meadows were considerably damaged by wild boars (damaged turf and strong weed infestation), which reduced the availability of forage for large herbivores, including cattle. Plans had been made to clear 100 ha of forests, establish meadows, and replace forest trees with oaks, but these efforts require time and effective management to ensure a good feed base. Despite the disadvantages of forest grazing, native cattle breeds have well adapted to pasture grazing without human involvement. Pasture grazing can raise environmental awareness and attract tourists, but it can also compromise long-term biotope stability, especially in habitats with rare and protected-plant species (CHODKIEWICZ 2020). The demand for healthy beef products has increased in recent years. Research has demonstrated that grass-fed beef delivers health benefits due to its desirable fatty acid profile and antioxidant content (DALEY et al. 2010). However, poorly managed forest grazing areas can compromise the health of ecosystems by contributing to erosion, reducing vegetation cover, decreasing organic matter content, soil moisture and compaction (MERCER and SMITH 2019).

Conclusion

Polish Red cattle are characterized by high adaptability to unsupportive environments, high disease resistance, high fertility, extraordinary longevity, and high meat quality. In countries with a temperate climate (such as Poland), this breed should not be pasture-grazed throughout the year because low temperatures compromise the animals' health and welfare.

Accepted for print 28.07.2023

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