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Short communication

Sustainability and welfare of Podolian cattle

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Abstract

The aim of the present study was to evaluate the sustainability and welfare of extensively farmed Podolian cattle. A trained interviewer visited 50 farms and filled in a checklist which included four cards corresponding to the following animal categories: calves, replacements, feeders and adults. The analysis of the farming system showed that animals were able to express their main behavioural patterns. In addition, recorded animal-related variables indicated that Podolian cattle could benefit from high standards of welfare. Sustainability of the Podolian farming system in terms of human edible returns was evaluated for two production systems producing 10-month-old calves (10 month) and 18-month-old young bulls (18 month), respectively. Edible returns for humans were low when all animal intakes were considered for both production systems. However, if returns were computed using not only the amount of food used by the animals but also consumable by humans, yields were much higher for 18-month systems [103% crude protein (CP) and 37.1% gross energy (GE)] and so high that they could not be computed for 10-month systems. These results indicate either a low degree of competition (18-month system) or no competition (10-month system) between humans and Podolian cattle. Perceptions of sustainability and welfare of Podolian cattle may promote a favourable positioning of products in premium-price markets and help preserving this breed and the related traditional farming system.

Keywords: Sustainability; Animal welfare; Podolian cattle; Natural behaviour

1. Introduction

Farming intensification tends to increase productivity to reduce unit costs, which results in a marked estrangement from previous seminatural rearing conditions, in a dramatic decrease of animal welfare (Fraser et al., 2001) and in a lack of competitiveness of traditional livestock enterprises (Thompson, 1997).

Because animal welfare is not a purely scientific issue, no definitive definition is available. However, numerous authors propose to use the "five freedoms" (Farm Animal Welfare Council, 1993) as starting point for a definition. The fact that natural behaviour

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of farm animals is explicitly mentioned among them implies that the concept of animal welfare is not limited to the satisfaction of some basic physiological and behavioural basic needs, it also includes positive experiences and feelings (Verhoog, 2000). Obviously, the absence of fear and discomfort cannot be guaranteed in a natural environment, and many negative events, such as fear, hunger, disease, etc., can be experienced by animals. However, natural conditions can add important qualities to the life of animals, allowing the performance of natural behaviour, e.g., social interactions, appetitive and explorative behaviours, mating, mothering, etc. In principle, under human control, animals can be virtually protected from any environmental challenge and stress. However, a good life is not a life without challenges, and it can be assumed that strong positive emotions can arise during and after the process of successful coping.

Spedding (1995) indicated a number of distinct meanings (physical, biological, socioeconomic, etc.) for sustainability in animal production. An animal production system with high animal welfare standards may be considered more sustainable in the sense that it is more acceptable by the community (Spedding, 1995). However, there are two different approaches to sustainability (Thompson and Nardone, 1999). Sustainable animal production in terms of functional integrity is comprehensive of most issues of importance to society. The concept of functional integrity is well suited for extensive livestock farming, where domesticated animals, wildlife, forage, nonforage plants and manure display complex relationships and the capability to coexist as different components of a system. Conversely, resource sufficiency postulates that a farming practice is sustainable when supplies meet or exceed the needed resources, thus, quantitative considerations of the interactions between production system and resource use are prominent, and attention is focussed on increasing the efficiency at which resources are used. This approach may determine a further intensification of farming, although it also provides practical tools to calculate the level of sustainability.

According to Heitschmidt et al. (1996), grazing of indigenous rangeland is one of the most sustainable forms of agriculture. In fact, no other form of agriculture is less dependent on external finite resources (e.g., fossil fuel) and external potentially dangerous resources (e.g., fertilizers, pesticides, etc.). In particular, ruminants are able to convert vast renewable resources from grassland, pasture and by-products into food edible for humans: With ruminants, land that is too poor or too erodable to cultivate may become productive. However, questions have been arisen about the use of human edible foodstuffs in ruminant diets and the possible loss of nutrients for human consumption.

The current mixed production system with competing industrialised and traditional farms is threatening the latter, as demonstrated by the decreasing trend observed for the number of heads of Podolian cattle (−50% in 10 years; AIA, 2003). The aim of the present study was to evaluate the possibility of extensively farmed Podolian beef cattle to perform their natural behaviour and interact with an environment similar to their natural habitat in relation to animal welfare. In addition, the sustainability (measured as degree of competition with human nutrition) of the traditional farming system, which is still in use for this breed in some internal areas of southern Italy, was also assessed.

2. Material and methods

2.1. Farming system and welfare assessment

In the province of Potenza (southern Italy), 10,869 Podolian heads are bred in 241 farms. Fifty of them were selected from the recordings of the provincial breeder association (APA di Potenza, via dell'Edilizia, 85100, Potenza, Italy). In particular, 25 farms producing 10-month-old calves and other 25 finishing the animals to an age of 18 months were randomly chosen. The sample was representative of the province according to number of heads and location. The main figures of the selected farms are given in Table 1.

A trained interviewer visited the farms and filled in a checklist which included four cards, each one corresponding an animal category: calves (from birth to weaning), replacements (from weaning to first calving or first mating), feeders (from weaning to slaughter) and adults (from first calving or first mating

Table 1
Main traits of Podolian farming system (mean±σ)

	Production system	
	10 months	18 months
Calves		
Age of separation (months)	8.9±2.8	9.3±2.9
Losses from predation (%)	10.1±5.1	8.2±5.3
Slaughter age (months)	10.5±3.6	18.2±4.3
Adults		
Heads (*n*)	73±70	57±25.9
Age at first calving (months)	33.0±5.8	33.1±4.4
Calving interval (months)	12.9±1.7	14.8±2.1
Age at culling (years)	13.4±1.7	14.7±1.9

to culling). For each animal category the following aspects were monitored:

Housing
- main characteristics of the barn, if present, including type of floor
- pasture availability
- space allowance

Management
- general aspects
  age at slaughter (this aspect only for beef cattle)
  age at separation from mothers (this aspect only for calves)
- feeding regimen
  diet
  body condition score
- stockmanship
  ability to identify individual animals
  problems encountered in milking (this aspect only for cows)
- animal-related parameters
  cleanliness
  disease incidence
  longevity

Parameters were either obtained from farm recordings (pharmacological treatments, disease incidence and longevity) or the farmers (age of calves at separation from mothers, diet) or directly measured (space allowance, body condition score and cleanliness). Body condition scores were given according to the method of Edmonson et al. (1989). Cleanliness was measured using a five-point scale ranging from 0 (very clean) to 2 (very dirty) for five anatomical regions of the hind quarter. Scores were subsequently totalled to obtain a single value for each animal (Krebs et al., 2001). Body condition and cleanliness were evaluated twice, in December and June, and always in clear days. A preliminary card concerning general information on the farm (location, land owned, conduction, etc.) was also included. Data gathered from the checklists were used to describe the Podolian farming system and calculate returns on human edible input on the basis of animal food, energy and protein consumption.

2.2. Sustainability

Podolian cows are seasonal by nature and mate in spring, when the number of hours of day light increases, thus calving at the end of the next winter, when more food is available at pasture. Therefore, most of calves used in this experiment were born between February and April. Cows and bulls grazed natural pasture throughout the experimental year. However, from August to February, they also received mixed hay obtained from natural pasture. Calves were dam reared, thus suckling and feeding on pasture at the same time for 10 months. However, calculations were performed as if young animals depended exclusively on mothers for the first 3 months of life and only on pasture for the subsequent 7 months. Subsequently, calves were either slaughtered immediately or fed a finishing diet in loose house conditions for 8 months before slaughter.

For a period of 1 year, calculation of human edible returns were performed using gross energy (GE) and crude protein (CP) animal intakes and productions.

2.3. Estimation of input

GE and CP intakes were computed using the actual values for the feeds offered in the barn and estimations for forages grazed on pasture (Table 2). Estimations were based on predicted dry matter intakes of animals and the composition of the natural pasture of the area. The vegetation was mainly herbaceous and contained grass (*Lolium* spp., *Dactylis glomerata*, *Bromus* spp, etc.), legumes (*Medicago* spp., *Vicia* spp., *Trifolium* spp., etc.) and forbs

Table 2
Mean individual food, net energy, gross energy and crude protein intakes for each animal category

	Cows (pasture+hay)		Replacements (pasture+hay)	Feeder calves (pasture+hay)	Young bulls (finishing diet)
	Lactating	Dry			
Net energy (Mcal/day)	1.65	0.93	0.78	0.66	1.15
Gross energy (Mcal/day)	76.54	43.74	30.62	19.78	39.29
Crude protein (g/day)	1416	711	685	548	880
Food intake (kg of DM/day)	17.5	10	7	4.5	8

(*Cicoria* spp., *Achillea* spp., etc.). Shrubs (*Crataegus oxycantha*, *Genista* spp., *Juniperus communis*) and trees (*Fagus sylvatica*, *Fraxinus ornus*, etc.) were also present. The diet of Podolian cattle is predominantly based on herbaceous plants, particularly legumes, although they also ingest shrubs and tree leaves whenever the herbage availability decreases (Braghieri et al., 2003).

Calculations were performed using the following general formula: ingestion of CP (kg/day)×period of ingestion (*n* of days) or GE (Mcal/day)×period of ingestion (*n* of days).

To meet maintenance (500 kg of live weight) and milk production (5 kg/day) needs, in 5 months of lactation, cows ingested:

1.416 kg of CP/day×150 days=212.4 kg of CP;
76.54 Mcal of GE (corresponding to 9.7 UFL)/day×150 days=11,481 Mcal of GE;

whereas in the remaining 7 months, nonlactating animals consumed:

0.711 kg of CP/day×215 days=152.865 kg of CP;
43.74 Mcal of GE (corresponding to 5.5 UFL)/day×215 days=9403 Mcal of GE.

For calves, it was assumed that maternal milk was the only feeding source for the first 3 months after parturition. Subsequently (90 to 300 days of age), animals with a mean daily weight gain of 0.6 kg and a final weight of 220 kg at 10 months of age ingested:

0.548 kg of CP/day×210 days=115.08 kg of CP;
19.68 Mcal of GE (corresponding to 3.6 UFC)/day×210 days=4133.15 Mcal of GE.

In 50% of the farms, calves were slaughtered at 10 months (300 days), whereas in the others, they were finished with hay and concentrate to an age of about 18 months (540 days, mean daily weight gain of 1.08 kg). Mean protein and energy consumptions in the finishing period (from 300 to 540 days) were the following:

0.88 kg of CP/day×240 days=211.2 kg of CP;
39.29 Mcal of CE (corresponding to 6.3 UFC)/day×240 days=9430 Mcal.

These animals received both hay from natural pasture (about 8 kg) and about 3 kg of cereal grains (barley and oats). The latter corresponding to:

0.33 kg of CP/day×240 days=79.2 kg of CP;
11.48 Mcal of GE (corresponding to 2.76 UFC)/day×240 days=2755.6 Mcal of GE.

The mean percentage of cow replacements was 10. Therefore, consumptions were the following:

(0.685 kg of CP/day×990 days)×0.10=67.815 kg of CP;
(30.62 Mcal of GE×990)×0.10=3030.9 Mcal of GE.

Where 990 days=1080 days (first calving at 36 months of age)−90 days (days of milk feeding).

2.4. Estimation of output

Calculations of CP outputs were based on the following general formula: amount of product (kg of milk or meat)×proportion of protein in the product; whereas for GE, the following general formula was used: [(amount of product expressed as kilogram of milk or meat×proportion of protein in the product× conversion factor)+(amount of product expressed as kilogram of milk or meat×proportion of fat in the product×conversion factor)+(amount of product expressed as kilogram of milk×proportion of lactose in the product×conversion factor)]. For conversion of milk and meat fat into Mcal, the factors 9.202 and 9.3918 were used, respectively, whereas for conversion of protein and lactose into Mcal, the factors 5.64 and 3.95 were used, respectively, as suggested by Mc Donald et al. (1998).

In 5 months of lactation, cows produced an average of 5 kg of milk at 3.5% protein/day:

5 kg/day×0.035×150 days=26.25 kg CP.

In addition, if calves were slaughtered at 10 months of age and 220 kg of body weight (55% carcass yield, 77.5% meat yield and 25% protein), the output was:

220 kg×0.55×0.775=93.77 kg of meat and 93.77×0.25=23.44 kg CP,

whereas when 480-kg young bulls were produced at 18 months of age (58% carcass yield, 79.5% meat yield and 25% protein), the output increased to:

480 kg×0.58×0.795=221.33 kg of meat and 221.33×0.25=55.33 kg CP.

The GE produced by lactating animals (150 days lactation, 5 kg milk/day, 4.4% fat, 3.5% protein and 4.5% lactose) was:

fat: kg/day×0.044×150 days×9.202 Mcal/kg of fat=303.65 Mcal/lactation;
protein: 5 kg/day×0.035×150 days×5.64 Mcal/kg of CP=148.04 Mcal/lactation;
lactose: 5 kg/day×0.045×150 days×3.95 Mcal/kg=133.31 Mcal/lactation;
total: 303.65+148.04+133.31=585 Mcal/lactation.

Calves produced:

fat (4.85% of carcass): 220 kg×0.55×0.0485=5.87 kg of fat and 5.87 kg×9.3918 Mcal/kg=55.11 Mcal;
protein: 220 kg×0.55×0.775×0.25×5.6404 Mcal/kg of CP=132.22 Mcal;
total: 55.11+132.22=187.33 Mcal.

The outputs of young bulls were the following:

fat (4.8% of carcass): 480 kg×0.58×0.048=13.36 kg of fat and 13.36 kg×9.3918 Mcal/kg=125.5 Mcal;
protein: 480 kg×0.58×0.795×0.25×5.6404 Mcal/kg of CP=312.1 Mcal;
total: 125.5+312.1=437.6 Mcal.

3. Results

3.1. Farming system

The main traits of the two farming systems used for Podolian cattle are depicted in Table 1. Cows were usually not assisted at calving (30% assisted vs. 70% not assisted). After parturition, calves were left with their mothers (97%) for 9.1±2.9 months either at pasture (41%) or in provisional sheds (12.2%) or in loose barns (46.3%). All calves had outdoor space availability, therefore, their cleanliness was high in 68% of the farms, and disease incidence (mainly diarrhoea) was low (percentage of affected calves lower than 5%) in 44% of the farms or none (46% of the farms). A high cost of calf rearing at pasture was represented by a high percentage (9%) of young animals killed by predators (wolves and feral dogs), whereas the mortality due to other reasons was neglectable (below 1%).

Fifty percent of the calves were not finished and slaughtered after separation from mothers at about 10 months of age. The remaining animals were finished either on pasture with shelter (20%) or on pasture without shelter (20%) or in strawed loose barns without outdoor paddock (30%) or in tie stalls (10%) or with different combinations of these previously reported systems (20%), where they all received mixed hay from natural pasture and concentrate. Space allowance for the animals kept in loose housing was characterised by a wide range of variation both among the farms and during the finishing period (higher at the beginning and lower at the end). However, it was always above 3.5 m^2/head. These finishing animals were slaughtered at 18 months of age.

Conversely, most of replacers were kept on pasture (61%) as compared with tie stalls (0%), pasture with nocturnal shelter (19%) and strawed loose barns with outdoor paddock (10%). Only this latter group received mixed hay and concentrate, whereas the others fed directly on pasture.

For adult animals, none of the farms used tie stalls, whereas more common were systems based on pasture with no shelter (66%) and pasture with nocturnal shelter (32%). Only in 38% of farms that feeding supplementation was offered to animals. Therefore, in December, animals tended to be lean (mean BCS below 2.5 in 22% of farms).

Cows showed a high degree of cleanliness (mean scores below 3) both in June (61% of farms; the remaining 39% had a medium degree of cleanliness, with scores ranging between 3.1 and 5) and in December (49% of farms; another 49% showed a medium degree of cleanliness, whereas for the remaining 2%, cleanliness was poor, with scores exceeding 5). In particular, animals tended to be dirtier in December, when rainfalls are more abundant, only in farms provided with either provisional or nocturnal shelter.

Artificial insemination was occasionally used and only in 9% of farms, whereas one or two bulls were permanently kept in all the herds.

In 59% of farms, where milk was usually collected, a traditional milking method is used: only two teats are hand milked by the stockman, while two others are left to the suckling calf. In none of them, stockmen had problems in collecting and milking the animals which were individually known by name. In the remaining 41% of farms, where each animal was also individually known by the stockman, milk was not collected and left to the calves. Calf suckling, hand milking, body cleanliness and a low mean milk production (5 kg of milk milked per day in 5 months of lactation) determined the absence of mastitis in the 80% of farms, whereas its prevalence was low in the remaining 20%.

3.2. Sustainability

Estimations of energy and protein inputs and outputs are shown in Table 3. The total amount of GE and CP used by the system were 37478.1 Mcal and 759.35 kg, respectively, if young bulls were slaughtered at 18 months of age, whereas the inputs were reduced to 28048.1 Mcal and 548.15 kg of CP in a system producing 10-month-old calves.

Table 3
Estimation of inputs and outputs as crude protein (CP) and gross energy (GE)

Animal category	Input		Output	
	CP (kg)	GE (Mcal)	CP (kg)	GE (Mcal)
(1) Cow	365.26	20,884	26.25	585.00
(2) Calf	115.08	4133.1	23.44	187.33
(3) Young bull	326.28	13,563.1	55.33	437.60
(4) Replacement	67.81	3030.9	–	–
Total=1+2+4[a]	548.15	28,048.1	49.69	772.33
Total=1+3+4[b]	759.35	37,478.1	81.58	1022.60

[a] For system producing 10-month-old calves.
[b] For systems producing 18-month-old young bulls.

GE and CP obtained by the 10-month producing system were 772.33 Mcal and 49.69 kg, respectively, whereas farms producing 18-month-old young bulls yielded 81.58 kg CP and 1022.6 Mcal GE.

4. Discussion

Webster (1994) observed that, under natural conditions, dams begin to leave their calves in group at about 2 weeks of age while they graze nearby, whereas, according to Phillips (1993), cow–calf pairs remain together until the calf is gradually weaned at approximately 6–8 months. In this study, young Podolian calves were dam reared until the age of natural weaning. In particular, the social bond of cow and calf is life long for female offspring, whereas for most males, it lasts until they leave the herd (either 10 or 18 months). According to Broom (1991) and Le Neindre, (1993), for calves, the main welfare problems associated with intensive farming are isolation from mothers, isolation from other conspecifics, reduced space allowance, barren environment and diet based on reconstituted milk. Unlike in most intensive cattle farming system where artificial rearing is performed, in the Podolian farming system calves were not separated from the cows, thus, they could benefit from maternal milk and undergo a balanced and gradual growth.

A relevant welfare problem due to keeping calves in free-range conditions was represented by the losses from predation. However, this aspect makes Podolian cattle an integrated component of the ecological system. In addition, the survival of individual animals is affected by natural selection more than in other

Table 4
Estimation[a] of humane edible returns as crude protein (CP) and gross energy (GE)

Farming system	CP (%)	GE (%)
10-month-old calves	9	2.75
18-month-old young bulls	11	2.73

[a] Calculated as the ratio output/input and expressed as percentage (%).

farming systems, thus allowing antipredatory behaviours to be preserved into the population (Koene and Gremmen, 2000).

Many farms finishing the animals to an age of 18 months kept the subjects on pasture (40%). However, in some cases, tie stalls were used. This housing system has detrimental effects on the welfare of cattle (Haley et al., 2000), thus, the substitution with systems allowing a higher degree of comfort should be encouraged. For example, in loose barns, cattle have more opportunities to satisfy some basic behavioural needs (e.g., locomotion, social interaction, etc.) in comparison with tie stalls (Wierenga, 1987).

In the Podolian farming system, most animals are allowed to graze on pasture. Free-ranging herbivores have the opportunity to taste a heterogeneous assemblage of different foods. Choices are much more limited in confinement: animals can only select among plant parts (leaves, stems, cobs, kernels, etc.), and few plants species are included in the ration. In addition, when feeds are chopped and mixed, as in unifeed rations of most intensive cattle farms, diet components become increasingly difficult for animals to be separated. Grazing on natural pasture allows selection among a diverse array of herbaceous and arboreal plants based on nutrient requirements and individual preferences, as influenced by physical characteristics, accessibility and palatability (Provenza et al., 1998). Therefore, also for feeding and similarly to wild herbivores, Podolian cattle could express their natural behaviour and select a balanced diet in response to their changing needs and physiological status.

Artificial insemination was only occasionally performed, thus, animals were allowed to express their proper mating behaviour through the progressive development of typical precoital activities involved in courtship behaviour (greeting, interchange of sexual stimuli and oestrus display) and female reception of male (Chenoweth, 1982). The possibility to express the own proper natural behaviour is considered to be essential to animal welfare (Kiley-Worthington, 1989).

Although Podolian cattle are considered semiwild animals, stockmen did not usually have problems in performing hand milking, even if it was rather complex: each subject had to be isolated from the herd, her own calf allowed in close contact and hind legs tied up before hand milking could start. Stockmen were also able to recognise each individual animal. Both results indicated a good quality of the human–animal relationship.

Calf suckling, hand milking, body cleanliness and a low mean milk production determined a very low incidence of mastitis compared with standard dairy farms.

It is difficult to determine how, if at all, cleanliness is related to the welfare of the animals. However, given a chance, animals choose to keep their bodies free from dung. In our study, free-ranging animals showed high levels of cleanliness.

Estimates of returns in humanly edible food were obtained as the ratio output/input and expressed as percentage (Table 4). Age at slaughter (10- vs. 18-month-old animals) did not dramatically change humanly edible returns. However, these results were obtained using all energy and protein intakes. Conversely, in many cases, the feeds used in animal production are not humanly consumable, and to determine the real efficiency of the system, only humanly consumable energy and protein input should be used for efficiency comparisons. There is a wide range of strategies in which various proportions of noncompetitive feed resources, grains and other concentrates can be used for ruminants. A common error is to assign a single efficiency to all types of beef production. In the present study, when younger animals were produced, all the food consumed by cows was humanly inedible, therefore, the ratio output/input was so high to be not estimable, thus indicating no

Table 5
Input, output and returns in relation to human animal competition in 18-month systems

	Crude protein	Gross energy
Input	79.2 kg	2755.6 Mcal
Output	81.58 kg	1022.6 Mcal
Returns	103%	37.1%

competition between humans and Podolian cattle, as also confirmed by the fact that the animals grazed natural pasture that could not be used for grain production (e.g., wheat) due to the difficult accessibility to highland pastures, which are often mixed to bushes and trees.

Conversely, if the second production strategy was used (18-month-old animals; Table 5), protein and energy returns were similar to those observed in various beef production systems used in United States (Oltjen and Beckett, 1996).

In addition, little cultural energy input was required for calves-producing systems (some labor at calving and transport to the slaughter house but no machinery, fertilizer, pesticides, seed and irrigation were needed), whereas only further 877 Kcal input/Kcal of output was necessary to produce dry land barley and/or oats for young-bull-producing farms (Cook et al., 1980).

5. Conclusion

Perceptions of sustainability and welfare of Podolian cattle may promote a favourable positioning of products in premium-price markets and help preserving this breed and the related traditional farming system. Further studies are needed to evaluate the economic and social features of the Podolian farming system. In fact, economic reasons, along with quality of labor and, possibly, other reasons associated with village life and services, may account for the decrease in the Podolian cattle population.

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