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Extensive beef cattle production in Portugal

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ABSTRACT

Portugal, located in the Mediterranean region, one of the "Hot Spot" of the planet, has a huge variability in terms of topography, soils, climate, agriculture, traditions, resulting in a high diversity of animal genetic resources, represented by 15 native cattle breeds, most of them threatened. A significant percentage of extensive beef cattle production in Portugal is based on the use of animals, differing from north to south region, with good maternal aptitude, hardiness, a low growth performance and exceptional adaptation to the environment where they live, and especially to the local feed, naturally produced. In the north of the country and the Azores, dairy breeds predominate, while in the south beef breeds are most prevalent. Portugal is not self-sufficient in beef production, however it is possible to appreciate a market for beef produced by indigenous breeds from extensive and organic production systems. Beef from indigenous breeds is considered to be a high quality product, mainly because of the superior taste and structure of the meat resulting from the production system: slow growth rate and type of vegetation consumed. This product differentiation has allowed the enlargement of small niche markets and has led to an increase in the value of meat with a Protected Designation of Origin (PDO) or with organic beef. Since Portuguese agriculture cannot compete on quantity or production cost with other competitors, differentiation and quality seem to be the alternatives that may stimulate rural activities in Less Favoured Areas (LFAs) and create a regional added value able to contribute to sustainable development. Extensive animal production systems can be an important component of environmental

and landscape protection, as well as contribute to the decrease of the human, physical desertification of our rural areas and animal genetic resources.

1. INTRODUCTION

The total area of Portugal mainland is 8,878,952 ha with about 3,7 million ha of utilized agricultural area (UAA), of which 23% are occupied by temporary crops and nearly half by permanent grassland (meadows and pastures). Total farm (animal and vegetal), holdings just over 305,000 in 2009, decreased by 27% in ten years. However, the average UAA per holding increased from 9 hectares in 1999 to 12 hectares in 2009 (67.6 hectares in Alentejo and 5.8 in the North). In terms of structure, nearly 3.4% of the farms have more than 50 hectares, while small-sized farms, with less than 5 hectares, represent 75.6% of the total [1].

Consumers are demanding more sustainable and ethically sourced food, including production without negative impacts on animal welfare, the environment and the livelihood of poor producers. Silvopastoral and extensive systems address all of these concerns with the added benefit of increased production in the long term. Cattle, like all ruminants continue to play, a valuable role in sustainable agricultural systems. They are particularly useful in converting vast renewable resources from rangeland pasture and crop residues or other by-products into food edible for humans [2]. Some fears about meat consumption are linked with indiscriminate use of hormones, the use of several chemicals and prophylactic antibiotics. Intensive livestock production systems aim to improve the

genetic potential of the animals and of the feeds used. Nevertheless, such systems can, if the appropriate investment is not made, lead to serious problems of environmental pollution.

The small farmer, with limited economic resources and technology, has little possibility to compete on unit prices with large-scale producers. This has been one cause of the abandonment of land and the increasing danger of desertification of large rural areas. There is an increasing need to produce quality meat that, besides its organoleptic qualities, also gives health warranties. In Portugal, beef cattle production from local breeds can carry out these functions, and such production could be supported and given incentives.

2. CATTLE NUMBERS, MEAT PRODUCTION AND CONSUMPTION

In 2011, the Portuguese cattle herd reached 1,519 million heads, a slight increase (6.8%) from 2002. In this period the variation is a decrease in -19.1% in the dairy cattle herd and an increase of 19.2% in the suckler herd. The main production area is the Alentejo, with 38.9% of the cattle herd in 2011, followed by Entre-Douro-e-Minho (17.5%), the Azores (17.4%) and Ribatejo e Oeste (10.7%) [3]. In the north of the country and the Azores, dairy breeds predominate, while in the Alentejo beef breeds are most prevalent. Thus, in Beira Litoral, of the total cow herd, about 75.0% are dairy cows, in the Azores that proportion is 76.5% and in Entre Douro e Minho 68.8%. By contrast, in the Alentejo 94.3% are suckler cows, whereas in the Algarve this percentage is close to 100%, in Beira Interior 83.9% and in Trás-os-Montes 74.2%. Beef cattle production has major importance in the regions of Alentejo and the northern interior. The north of Portugal has a total of 57,000 beef cows (40.7% of the regional herd). The central region has 68,000 beef cows (57.6% of the regional herd), and the south has a population of 287,000 beef cows (94.4% of the regional herd).

In 2010, 402,297 cattle (93,159 t) were slaughtered for meat. In 2011 there was an increase in the number of slaughtered animals (to 414,857), as well as a rise in the amount of meat consumed (96,004 t). The average carcass weight was 231.4 and 231.6 kg respectively. The geographical distribution of slaughtering indicates that 36.3% took place in the region of Entre-Douro e Minho, 3.8% in Trás-os-Montes e Alto Douro, 11.0% in Beira Litoral, 3.0% in Beira Interior, 26.9% in Ribatejo e Oeste, 4.8%, in Alentejo, 13.1%, 1% in

Algarve, 13.1% in Azores and 1.2% in Madeira. The combined kill in the northern interior (Trás-os-Montes e Alto Douro), central interior (Beira Interior) and Alentejo accounts for just 19.6% of the national total of animals slaughtered [3].

This situation indicates that a significant proportion of the production was slaughtered outside the production area and usually is carried out close to the major centers of consumption, primarily on the Portuguese coast and north of the Tejo River.

The trend in Portugal was of increasing consumption of beef, from 137,000 t in 1988 to 174,000 t in 1995, 195,000 t in 2006 and 192,000 t in 2010 [3, 4].

The beef consumption per capita are higher in Portugal (18.4 kg vs 16.9 kg beef/person/year, in 2006 and 2012 respectively compared with the EU average (\approx 11-12 kg in the same years), and self-sufficiency in beef has decreased from 54.4% in 2006 to 52.0% in 2012 [3, 5].

3. EXTENSIVE SYSTEM

In extensive systems, production is mainly monitored by man and not modified by him. These are systems where cattle have the freedom to roam outdoors, and where the cattle have some autonomy over diet selection (through grazing), water consumption and access to shelter [6]. There are also fewer behavioral restrictions on the livestock allowing such systems to have high animal welfare standards. The extensive livestock production systems are more “natural” and it is accepted that they tend have advantages over intensive systems in terms of ecological sustainability. Extensive livestock production is one way of giving life and quality to rural landscapes, avoiding rural desertification [7]. Feed diversity is an important characteristic of these livestock production systems and should be maintained, based in the use of local feed production. The complementarity of the natural feed resources should also be maintained, such as the use of crop residues from cereal growing [8]. The advantages of silvopastoral systems for increasing biodiversity, improving animal welfare, providing good working conditions and allowing a profitable farming business are such that these systems are sustainable [9]. Table 1 briefly compares extensive systems with intensive production systems.

In Portugal, the extensive production refers mainly to systems using indigenous breeds where the feeding of the animals is based on natural resources and affected by soil and weather conditions. There are two principal

extensive beef cattle production systems in Portugal. One is located in the north and the centre and the other one in the south of Portugal (Table 2).

The weather in Portugal is generally classified as Mediterranean. However, in the north and in the centre, there is a significant Atlantic Ocean influence, especially near the coast. In contrast, in the south (Alentejo) there is a Continental influence.

The Interior North (Trás-os-Montes e Alto Douro and Beira Interior) is a mountainous region with altitude above 700 meters. Here the Atlantic influence disappears and gives way to a mountain ecology, with irregular temperatures, rainfall and atmospheric humidity throughout the year.

The soils are very heterogeneous, but normally have a high agricultural capacity in the valleys and in some of the summits and slopes (favorable for permanent meadows and pastures). The soils are poorer on most of the summits and slopes of the mountains. Land exploration can be divided into two categories. In the valley, lands are private and are divided into small farms (landowners); in the hills, lands are communal (common grazing) [11].

Mean farm unit size in the north and centre is approximately 3 ha and is commonly divided into small dispersed parcels of land. In the south (Alentejo), farms are around 300 ha and less fragmented. Given this land structure, the numbers of cattle per farm varies from between 1.6 and 3.5 head in the north and centre and between 55 and 80 animals in the south (average values).

In the north, the farm is divided into several plots of land, some of them used for two crops in the year, mostly for subsistence vegetables and green forages. The remaining plots are used as permanent or temporary pastures. The units have only a small number of cows (2-5), kept by the family semi-intensively. Grazing takes place in daytime and, at night, feeding on cows-shed is based on hay or green forages. Breeding takes place throughout the year. The natural mating is the method of breeding, where the bull is kept in a servile center, which is the private property of on farmer. The productive life of cows varies from 10 to 14 years, during which they produce 9 to 12 calves [11]. In the south the animals are kept throughout the year. Feeding is based on natural pastures and cereal straw. Occasionally, for a short period and when a severe feed deficiency occurs, cereal grains are fed. The breeding season varies according to seasonal local feed availability. The method of breeding is pasture mating where the bull is allowed to run with the herd

throughout the breeding season. Heifers are mated at the next breeding after they are mature enough. The productive life of cows varies from 8 to 10 years, during which they produce 5 to 7 calves. The weaned calves are fattened on the origin farm or are sold at 6 to 8 months of age to be fattened in other regions [11].

On the small farms in the north and centre, farmers rarely fatten the cattle. Calves are sold at 4 to 8 months of age and classified as “Veal” [12] to avoid feed competition between calves and their mothers and the need for extra housing for the young animals. The sales of calves are an indispensable source of income for the maintenance of the family economy. In the south (Alentejo), the farm size allows an extensive livestock production system which involves rearing the calves to finishing at 18 to 24 months. In these two types of farm enterprises the supplementary feeding (concentrate) of the animals is null.

3.1. Portuguese local breeds

In the north there are very small herds of suckler cows of native breeds (in north litoral region one can find Minhota breed, in the interior north the Barrosã, Cachena, Maronesa breeds occur and, in the northeast, the Mirandesa breed is found). In the center the Arouquesa, Marinhosa and Jarmelist breeds occur and in the south large herds of native breeds (Alentejana, Brava and Mertolega), rare breeds (Algarvia and Garvonesa) and crossbred with exotic beef breeds occur. Finally the Ramo Grande can be found in the Azores islands. These breeds are used as line mothers for pure or crossbreeding (Figure 1).

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The total number of adult females registered in the herd book for all the fifteen breeds is 76,664 cows varying between a minimum of 6 in Algarvia and a maximum of 17,396 in Mertolenga breed (Table 3).

The adult female live weight reaches 600-700 kg in the Alentejana, Marinhoa and Minhota breeds, 500 kg in the Mirandesa breed and lower live weight in the other breeds. There are also differences in birth live weight between them. The first calving occurs between 24-36 months and the calving interval is superior to 13 months (Table 4).

In the south, there are two calving seasons: the traditional summer season (from August until October) and the winter season (from January to March). In the north and centre of Portugal, calving

takes place throughout the year. Summer is a less favourable season in terms of the expression of milk production capacities and consequently for the weaning weight of the calf. Often it is necessary to supplementary feed the cows with straw, hay and, in critical situations, with cereal grain. In the winter calving season the higher milk production of the mother can be better exploited. The cow benefits from the greater quantity and quality of pastures, increasing milk production and consequently calf daily liveweight gain [28]).

In the traditional systems of north and central Portugal, calves are slaughtered after weaning. In the south, steers are slaughtered between 18 and 24 months of age. Steers born in winter, because they reach a heavier liveweight at weaning, as a result of higher milk consumption, are killed at 18 months. In the first 6 months after weaning, the steers are fed generally with a low quality feed, directly from the pasture or stored feed. The next 6-month period is the most productive period in the year, since it corresponds to spring, when there is peak grass production with a high digestibility.

At the end of this second period, steers are submitted to a finishing phase. In the summer-born animals slaughtered at 24 months of age, compensatory growth is used. However, there are some disadvantages, such as the possibility of limited bone development in the calves [28]. The advantage is that feed costs are lower, because the animal ingests the maximum possible quantity of low-cost energy (pasture), and the minimum of high-cost energy (processed feed).

We can assume that indigenous breeds are the strategic reserve of beef cattle production in Portugal. Replacement of indigenous breeds could result in the loss of products and services preferred by local people, and the conservation of local breeds must therefore be considered within the broader context of sustaining rural communities and their existing economic foundations. Moreover, such losses now may limit future development options, based on animal products and services from specific breeds, that otherwise could have added considerable economic value as consumer demands become more varied [29]. These breeds play, therefore, a key role in ecological and social equilibrium, and are the basis of local high-quality products [30]. The effective management of farm animal genetic resources is primordial to ensure global and sustainable food

security [31]. Studies reveal that in the lighter breeds, calves are weaned with a greater liveweight per 100 kg of maternal liveweight [32]. Results indicate that smaller females with good fertility rate, enough capacity to produce milk and low maintenance energy requirements present some advantages over heavier breeds when managed in extensive production systems. Good performance results (30 kg calf per 100 kg liveweight at weaning) can be achieved. Small cows can be maintained at higher numbers per unit area, and produce more offspring per unit area than larger breeds [33].

3.2. Organic Farming and Protected Denomination of Origin of Portuguese Indigenous Beef Cattle

Organic animal husbandry is defined as a system of livestock production that promotes the use of organic and biodegradable inputs from the ecosystem in terms of animal nutrition, animal health, animal housing and breeding [34]. It deliberately avoids the use of synthetic inputs such as drugs, feed additives and genetically engineered breeding inputs. The recent focus on and concerns over food quality, animal welfare, traceability, human health and environmental quality have led to the emergence of and growing interest in organic livestock farming, which is gradually spreading across the world [35].

In Portugal mainland, the total number of cattle in organic husbandry is 65.291 heads and 537 producers. 67.7% of the animals and more than 50% of farmers are located in Alentejo (Table 5).

Despite some weaknesses and threats, the strengths and opportunities are considerable for this system of livestock production [36].

The EEC regulation n° 2081/92 [38] defines the Protected Designation of Origin (PDO) as the name of a region, place or, exceptionally, a country, which is used to designate an agricultural product originating from that region, locality or country whose quality and characteristics arise essentially or exclusively from geographical provenance, including natural and human factors, and whose production and processing occur in a geographically restricted area. The PDO can provide farmers with a higher income, rewarding higher quality output and provide consumers with high-quality products of guaranteed origin and processing.

Portuguese meats with protected designation of origin (PDO) are certified by European Union legislation and are expected to present unique quality and organoleptic characteristics, especially associated with specific properties of its lipid fraction revealed in various studies [39,40,41,42,43,44]. Meat from autochthonous cattle breeds, reared in traditional production systems, has been progressively reintroduced in human diets as a result of its high intrinsic quality [45] and of public perception of BSE and chemical residues safety issues [10].

So far, nine PDOs related to Portuguese indigenous beef breeds are registered in the UE, Barrosã, Cachena, Mirandesa, Maronesa, Arouquesa, Marinhoa, Alentejana, Bovina Preta and Mertolenga (Table 6).

It is generally accepted for some animal products that the floristic composition of vegetation has an effect, at the least residual, on the quality of the final products derived from it, and/or that breeding influences meat characteristics at the tissue level and chemical composition. This, associated with the traditional and balanced extensive production systems, as well as the identification of the typical characteristics of the different meat products from indigenous breeds, is the basis for the certification of such products.

The PDO sector needs to be well organized in each region. The agents involved in PDOs are the Breed Societies, PDO Management Groups and private organizations for quality control. There has been a consolidation of PDO meat production, resulting in the reinforcement of the PDO Managing Groups in the national meat market.

Differentiation and quality products seem to be the only alternative able to stimulate rural activities in Less Favoured Areas and create a regional added value that promotes sustainable development [46]. The success of this strategy depends upon creating quality management systems, financial incentives, setting up an aggressive marketing strategy able to give an image of channels in order to reach international markets.

Firm defence of the product characteristics, in its origin, and production techniques, on guarantees to avoid product adulteration and to promote demand are essential. The message that the meat quality

results from the animals' genotypes, from the environment and from the production system should be conveyed to potential consumers.

4. Conclusion

The local breeds are an important alternative in LFAs, contributing to additional farm income, to rural development and the preservation of traditional landscapes. Portugal has nine PDO beef products and fifteen native cattle breeds, some of which are particular threatened. In terms of productive levels, these breeds cannot compete with imported breeds, and if they are not preserving, they may disappear. For the preservation of these breeds it is necessary to add value to the retail price of the products in order to compensate the farmers for the low productivity of the extensive systems.

The indigenous breeds require protection, and the ageing of the rural population continues to result in abandonment of the rural areas, and in some cases a great risk of desertification exists, mainly in the interior areas of the country. The extensive animal production systems are characterized by the use of low capital inputs but with production costs only potentially competitive. However the improvement of the indigenous breeds can contribute to the stabilization of the rural population and help to increase the interest of young people in agricultural activities. The assurance of product quality and typicity related with indigenous breeds will be essential characteristics for the intended added value, specific preference and demand for the product by the consumer and protection of the environmental quality associated with "extensive production systems".

It is necessary to support the improvement of the indigenous breeds in order to:

- a) the conservation of the animal genetic resources represented by the local breeds,
- b) diversify agricultural activities to ensure better use of the natural resources,
- c) increase farming income to prevent abandonment of rural areas with low population density,
- d) promote production systems with low stocking rates that conserve the environment, and

e) maintain the characteristics of the indigenous breeds and their pasture management systems in order to obtain high and guaranteed quality, able to command an added retail value.

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Table 1. Some differential characteristics of the Portuguese extensive and intensive production systems [10].

Production Systems	Extensive	Intensive
Genetic Resources	Indigenous breeds	Mainly crossbred imported x indigenous
Feed	Local Resources Indigenous flora	Mainly imported concentrate
Feed	Quality variable with annual cycle Produced to local capacity of land	High energy and protein More expensive
Produce quantity and quality	Limited supply Specific characteristics	Mass supply Standardise product
Demand	Niche market Tending to expand	Wide market Declining
Animal welfare	Aims to optimise use of locally available forage resources Low stocking density	Aims to maximise income High stocking density
Animal - Biological adaptation	Well adapted, but less productive	Higher sensitivity to production diseases Higher production capacity
Location	Regional	General
Influence on environment	Positive	Potentially adverse
Labour	Limited requirement	High manpower requirement
Conservation of genetic resources	Possible	Unlikely

Table 2. Characteristics of the portuguese extensive production systems (adapted from: [10]).

Characteristics	north/centre	south
Weather		
Mediterranean	With Continental and Atlantic influence	With Continental influence
Average annual temperature	≤ 15°C	>15°C
Average annual rainfall	> 700mm Gerês, Serra d'Ossa (≈ 3,000mm)	< 700mm Barrancos (400mm)
Frost	High Lameiros* (70 days)	Low to medium depending on proximity to Atlantic Ocean
Soils		
Granite and Schistose soils with sandy soils, Low pH Low levels of exchangeable bases	Steep Medium fertility & productivity Medium hydraulic erosion Low organic matter	Essentially flat Low fertility and productivity High hydraulic erosion (esp. under cereal monoculture) Very low organic matter
Production systems		
Average farm size	Small farms: ≈ 3 ha	Large farms: ≈ 300 ha
Average size of the herd (animals)	3	75
Farmer characteristics	Diversified and family type	Entrepreneurial
Aptitude of indigenous breeds	Meat/traction	Meat
Pasture	Natural irrigation + Dry land	Dry land
High digestibility and high forage production	April, may, June & July	March, April & May
High digestibility and low forage production	March & October	October & November
Period of null or low forage growth	August, September, November December, January & February	June, July, August, September December, January & February
Supplementary feeds	Hay, cereal, straw, turnip, ferrejos**, potatoes & fruit	Cereal straw, hay, cereal grain & restolhos***

Calving	All year round	Two periods (Summer & Winter) 18-24 months
Slaughter age	5-9 months	

* Lameiros - permanent pastures of natural grassland in the slopes of mountains with run-off irrigation and overflow.

** ferrejos - barley or wheat cut as green forage.

*** restolhos - cereal crop residues.

Table 3. The fifteen Portuguese indigenous cattle breeds, localization, census and extinction status.

Native Breeds	Region	Females \geq 2 Years (31/12/2013) [13]	Cows in the Herd Book* [14]	Producers [15]	Risk status ([16])
Barrosã	North	9,201	6,710	2,045	In risk
Cachena	North	6,298	4,821	471	Very threatened
Maronesa	North	5,465	5,081	1,281	Threatened
Minhota	North	9,338	5,828	2,057	In risk
Mirandesa	North	5,585	4,852	508	Threatened
Arouquesa	Centre	5,315	4,533	2,508	Threatened
Marinhosa	Centre	1,539	1,269	588	Very threatened
Jarmelista	Centre	139	155	17	Rare (particular threatened)
Alentejana	South	26,371	14,980	177	Not threatened
Algarvia	South	2	6		Rare (particular threatened)
Brava de Lide	South	13,704	7,800	106	Not threatened
Garvonesa	South	576	440	8	Rare (particular threatened)
Mertolenga	South	31,324	17,396	218	Not threatened
Preta	South	4,560	2,793	56	Threatened
Ramo Grande	Azores	1,356	1,255**	278	-

*Data from Relatórios Anuais 2013_DGAV_PRODOR_Subacção 2.2.3.2/ Data base from Herd-Book

**Data from DRADR – Direção Regional de Agricultura e Desenvolvimento Rural.

Table 4. Reproductive and productive parameters in Portuguese indigenous cattle breeds.

Indigenous Breeds	First calving (months)	Calving interval (days or months)	Female adult weight (kg)	Male / female birth weight (kg)	Weaning age (months)
Alentejana	36.5±7,4 [15]	442±137 days [15]	600-700 [15]	33/30 [17]	6-7 [15]
Arouquesa	24-36 [15]	> 14 months [15]	300/350(b)	28.0/25.4 [18]	6-8 [15]
Barrosã	24-36 [19]	444.7±108,8 days [15]	350/400[17]	24.7±3.51/ 27.4±4.51 [18]	6-7 [15]
Preta	48 [15]; 32,6 [27]	494 days [15]	400-600 [15]	-	6.8 [27]
Brava de Lide	-	-	280 [15]	-	-
Cachena	-	12-15 months [15]	-	23.7±2.24/20.2±2.83 [18]	-
Garvonesa	-	-	-	37 [15]	7-8 [15]
Jarmelista	29 [15]	446.2±86.5 days [15]	450-600 [15]	34.1±3.82/34.0±4.95 [15]	-
Marinhova	36 [20]	504 days [15]	600-700 [15]	46.62±4.25) [15]	4 [15]
Maronesa	28 [21]	411±54.8 days [15]	300/400 [15]	31.3/ 28.3 [21]	7-8 [15]
Mertolenga	36 [22]	13.2 months [23]	380 [15]	26.1/24.3 [15]	6-8 [15]
Minhota	26.3 [24]	404.4±45.6 days [24]	560.4 ±4,09 [24]	43.5±1.38/42.9±1.29 [24]	-
Mirandesa	32.9 [25]	423.0±117.5 days [26]	500 [25]	34.4±3.36/31.0±3.70 [26]	5-7 [15]
Ramo Grande	24-30[15]	-	-	-	-

Table 5. Cattle organic production in Portugal mainland in 2011 [37].

Continente	Cattle (n°)	Farms (n°)
Entre-Douro e Minho	1,608	36
Trás-os-Montes	1,304	41
Beira Litoral	85	4
Beira Interior	12,655	170
Ribatejo e Oeste	5,406	12
Alentejo	44,139	273
Algarve	94	1
Total	65,291	537

Figure 1. Geographic origin of Portuguese indigenous beef breeds.