

INVENTORY AND CHARACTERIZATION OF TRADITIONAL MEDITERRANEAN PIG PRODUCTION SYSTEMS. ADVANTAGES AND CONSTRAINTS TOWARDS ITS DEVELOPMENT

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ABSTRACT

Traditional high-quality meat products from Mediterranean pigs are produced in extensive-type production systems using agro-sylvo-pastoral resources. These production systems depend on a number of native resources, geological, plants and animals. These farms have extensive areas of land, using local breeds, valorise the regional agro-forests and develop the practice of grazing, use less external inputs and less manpower. In this work different issues of traditional Mediterranean pig production systems are characterized and through a SWOT methodological approach (Strengths, Weaknesses, Opportunities, Threats), we discuss the main advantages and disadvantages from the point of view of sustainability and future of the traditional Mediterranean pig meat chain. Benefits: these products have a high gastronomic and economic value that the consumer values for its unique quality and environmental gains, cultural and ethical advantage; typical Mediterranean hams and sausages are recognized internationally; they present organoleptic qualities and unique dietary feature; there are protective mechanisms and quality control that allow defending the genuineness of the products (PDO, PGI). Constraints: it is common to find weaknesses at the farm management level and animal husbandry, and there are also serious threats related to natural resource management (degradation of the typical Mediterranean forest) and market competitiveness. The sustainability of Mediterranean traditional pig industry depends on the preservation of endogenous resources and the quality of management at the farm level, as well as the market transparency.

Key words: traditional / pig meat chain / quality / natural resources / management / market

1 INTRODUCTION

Traditional Mediterranean pig meat products have a huge importance in the group of traditional European products, many of them protected under European legislation – the products with protected designation of origin (PDO) or geographical protection (PGI). Under this protection, each product is produced in accordance with the rules laid down in the specification, which corresponds to a specific regional (traditional) production system and/or to local breed.

Overall, considering the European Mediterranean countries, the total number of processed products proposed or already registered (for all animal domestics spe-

cies) are 161, of which 122 (92.5%) are processed pork products: of these, the hams represent 27% (number 33), sausages 65% and fresh meat 8% (<http://ec.europa.eu/agriculture/quality/>). Many of these products originate from pigs raised under traditional production systems of the extensive type and agro-sylvo-pastoral, which are closely related with natural resources (geological, plants and animals) present in each location or region, in particular the climate, the rock formations, soil type, vegetation cover and type of forests and the animal resources.

With regard to animal genetic resources, the traditional Mediterranean pig meat chain is supported by about 37 autochthonous breeds, or even more, scattered throughout the Northern Mediterranean (DAD-IS, 2013;

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<http://dad.fao.org>): Portugal three pig breeds (3), Spain seven (7), France six (6) Italy, seventeen (17), Croatia (2), Slovenia (1) and Greece one (1). Many of these pig breeds are embraced sub-populations, or genetic varieties, representing an important repository of genetic resources alive not replicable in the world.

2 INTENSIVE VS. EXTENSIVE PRODUCTION SYSTEMS

Animal production systems encompass all factors (artificial, natural and handling) which are interrelated with each other, in order to obtain the final product – the carcass. In each production system, the diversity of natural inputs, technology and inherited know how determine the variability, the efficiency and quality of the final products. In terms of animal science the variability is studied through the development of the equation ($VP = VG + VE$), i.e. the phenotypic variance results from the sum of the genetic and environmental variances, the latter comprising the variability of natural resources, inputs, management and husbandry. Table 1 synthesises the main production criteria that distinguish the traditional production systems in three different regimes: intensive (SI), semi-intensive (SSI) and extensive (SE), depending on the type of buildings (indoors or outdoors), the type of access to grazing (no access to pasture, partial grazing or continuous access), the available areas per animal (stocking rate), the level of external inputs used (feed, production technologies, etc.) and the amount of manpower.

Contrary to intensive production systems, the extensive farms require larger areas and lower levels of stocking rate, use autochthonous breeds and less cross-breeding, demands for low levels of external inputs and

less technology and manpower. From the point of view of the use of natural resources, extensive farms valorise vegetables and agro-forestry surfaces, leading to products that are considered more natural and less “modified”. In between we have semi-intensives farms, which can be considered more or less extensive, depending on the area of land and resources available. Semi-intensives husbandries mix different aspects (resources and technologies) of SI and SE systems and they use largely outdoor production methods (free range) or semi-confined. These farms can be located in marginal areas or in small woods and forests (deciduous and coniferous), using shelters, fences, water supply and artificial shadows. The main reasons why pig producers opt for the semi-intensives systems are essentially two: i) as a result of the lack of available resources (land); ii) and due to a higher productivity compared to extensive farms.

3 EXTENSIVE PRODUCTION SYSTEMS AND AGRO-SYLVO-PASTORAL

Extensive production systems, so-called sustainable, are developed in close relation with the biotic and abiotic factors, having as their primary specificity, the ability of the local breeds to adapt to different climates and rural ecosystems and the ability of these pigs to utilize the different agro-forest resources and transform them into high quality food products. Agro-sylvo-pastoral pig systems exist in the *Mediterranean evergreen oak forest* dominated by the evergreen sclerophyllous *Quercus* species (European Environment Agency, 2006). The evergreen oak woodland constitutes the main natural forest formation of the meso Mediterranean vegetation belt. A characteristic physiognomy of evergreen oak woodlands in the Iberian peninsula are savannah like formations,

Table 1: Main criteria for intensive, extensive and semi-intensive production system

	Husbandry	Feed supply	Stoking rate	Technology [Genotypes]	Manpower
Intensive	Indoor	Concentrate meals	Welfare legislation pig/m ²	+++ [exotic breed]	+++
	Outdoor	Concentrate meals	15–20 ♀/ha; <120 pigs/ha	++ [exotic breed]	+++
Semi-intensive	Closed with access to outdoors	Concentrate meals (-) other by-products	6–15 ♀/ha; 10–60 pigs/ha	+– [cross breed]	+–
Extensive	Closed with access to pasture	Agro-forestry (forest fruits + grass)	Depending on the availability of pasture and fruit	– [local Breed]	–
	Grazing with acorn intake in <i>montanhaeira</i>	Acorn and holm-oak formation (<i>Q. suber</i> <i>Q. rotundifolia</i>)	<2 pigs/ha	– [local breed]	–

known as *Montado* in Portugal and *Dehesa* in Spain, in which crops, pasture land or arborescent matorral are shaded by a fairly closed to very open canopy of native evergreen oaks (*Q. Suber* and *Q. Rothundipholia*). Extensive (agro-sylvo-pastoral) production systems also can be found in a wide diversity of thermophilic deciduous forests that are scattered in the Mediterranean (*Quercus ssp.*, *Quercus cerris* dominated forest, *Pyrenean oak forest*, *Chestnut forest*, *Celtis australis* forest and others: northern Iberian Peninsula (Asturias, Galicia), Pyrenees (France), Corsica and Italy, where the forests are cooler and wetter).

3.1 THE EXTENSIVE PIG PRODUCTION SYSTEM IN THE MONTADO OR DEHESA (PORTUGAL AND SPAIN)

Traditionally two farrowing seasons are distinguished in this production system (spring-summer and fall-winter). Farrowing usually take place mainly in two types of facilities, the traditional piggeries or in individual outdoor hut ("camping"). Piglets born between April to September go to *montanha* the following year, where they begin the finishing period in the oak groves with the minimum of 100 kg live weight (LW) and with variable age, depending of growth rate in the previous period (Tirapicos *et al.*, 2007). As a first step, after weaning and during one a year Alentejano pigs graze grass and stubble, and they are supplemented with a cereal mixtures. In this period their growth rate ranges between 200 to 400 g per day. In October pigs reach 100 LW kg and begin to be fed with acorns. From here, and throughout the period of *montanha*, animals will be finished only with acorns and pastured grass. Grass has a facilitator effect on digestion, provides large amounts of water to the animals allowing them to eat large amounts of acorn. The intake of acorn can reach 10 kg per day during *montanha* period (2 months minimum) where the animal density is less than 2 pigs per ha, depending on the number of trees per hectare (Rodríguez-Estevez *et al.*, 2009). Then, the pigs will attain more than 160 kg of LW at 14–18 months of age. These animals go to slaughter and their meat is processed into high quality typical hams and sausages. The excellent organoleptic qualities of the final products are due to the large amounts of lipids (mainly monounsaturated fatty acids $\pm 60\%$), in the intra-muscular tissues. In certain farms due to lack of acorn, the animals can be supplemented in the pasture with a concentrated meals, this system is known as *recebo* (in Spain) and *mixed montanha* (Portugal). Piglets usually born between December to March do not go to pasture, because they are indented to supply the market with weaned piglets to

roast and fresh meat market with LW less than 120 kg. In Spain, the production system is similar, but in many cases, it uses the terminal crosses with Duroc breed with the aim of achieving better growth performances, higher yields and leaner carcasses (Perez Serrano, 2008).

3.2 EXTENSIVE PIG PRODUCTION SYSTEM IN WET FORESTS OF HARDWOOD (*QUERCUS* SPP., *CASTANEA* SPP. AND OTHERS)

In the north of the Iberian Peninsula, Galicia, Asturias, the Pyrenees and south-central Italy production systems based on local breeds are of great tradition. In these regions, excluding the Italian ones, the weather is cooler and more humid than in other regions, soils are more fertile, and the vegetation is thicker and forests are more luxuriant.

Argentería Gutiérrez *et al.* (2012) proposes to the Asturian's forest the introduction of Asturcelta breed under a production model quite similar to the extensive system practiced in the Iberian pig in the oak forest: fattening/finishing pigs based on grazing grass, wild plants and fruits (acorns, chestnuts and hazelnuts) in autumn-winter season. In this system the goal is to obtain pigs of more than 1 year old and over 160 kg LW for traditional dry cured sausages and high-quality hams. In his work, Argentería Gutiérrez *et al.* (2012) draws attention to the annual variability of fruits cropped in forests, suggesting that in some years it will be necessary to complement local food with concentrates (*recebo* pigs). Another solution pointed out by the same author is fattening the Asturcelta breed in outdoor parks with concentrated feedstuffs, in order to have two categories of animals: pigs with 120 kg LW at 8 months of age for fresh meat, and pigs with 160 kg LW. In France, Pyrenees and Corsica native pigs (Gascon, Basque and Nustrale Corsican) have also played an important role in the panorama of traditional Mediterranean products (Lenoir, 2007; Secondi *et al.*, 2007). These pig breeds are produced by small and medium-sized farms taking advantage of the natural resources available (extensive production schemes): meadows, woods and marginal areas. During the productive cycle the majority of the autochthonous pigs spend their lives outdoors, have a slow growth rate and they are slaughtered with 150 kg LW at more than 1 year old. In Italy, extensive or semi-extensive pig production systems based on native breeds is an activity with great tradition and that has become more and more professional due to the diversification of the typical pig meat chain. The objectives are to produce late pigs (more than 1 year old) growing at a slow rate and presenting variable slaughter weights, depending on the region, available resources

and management decisions at farm level (Bonanzinga *et al.*, 2012). Further information on the indigenous pig production in Italy can be found in Proceedings of the 7th International Symposium of the Mediterranean Pig. In the North of Portugal an additional example of sustainable production systems can be found in Bísaro pig, whose production system shows some diversity (Santos Silva, 2012). In the case of this breed there is a great tradition for the consumption of roast piglets. Seventy per cent of the weaned piglets are slaughtered at young age weighting 8–12 kg. Only 30% are fattened and processed into traditional products. Typically, Bísaro pig have two growing phases. The first one of moderate growth up to 70–75 kg LW is followed by a finishing phase with variable diets depending on the availability of food resources on each farm (flour, fruits, vegetables, nuts and acorns). In the last period of the finishing Bísaro pig the rate of growth depends on feeding management and the possibility that the animals have access to pasture. The animals can be slaughtered from 120 to 180 kg LW, depending on tradition of each region. This breed was almost extinct, having been preserved in very small family farms (1–2 sows per farm) where the animals were self-sufficient. Today there are approximately 1800 registered Bísaro sows in the breed herd book, which are raised in intensive outdoors system or semi-extensive in farms with 30 sows on average.

4 THE COMPLEMENTARY TRADITIONAL FARM OR HOUSEHOLD PRODUCTION SYSTEM

In the rural and mountain regions of North of the Iberian Peninsula in Spain, Pyrenees in France and Italy, there are also small family farm with poly-cultural systems (agriculture and livestock). In these farms the pig is considered an economic supplement for self-consumption and for processing artisanal products, sold directly to consumers and/or in small fairs where they can be sold at very higher prices. This production system does not make systematic use of forest food resources because there are none or is scarce, but utilize more the products and by-products of local agriculture: cereals, tubers, vegetables, grass and a variety of seasonal fruits on a small scale. However if there is access to small woods or forests, the pigs can be used to reap some vegetation and wild fruits (*Quercus* spp., *Castanea* spp., and coniferous forest) contributing to the control of combustible material. In other cases, farmers cut the weeds in the field and directly use it for animal bedding; afterwards the manure is used as a fertilizer (Santos Silva, 2012). In the finishing period pigs are fed with agricultural by-products, cereal

grains, potatoes, vegetables and fresh fruits at the same time as grazing. This diet gives to the meat particular nutritional and organoleptic features, although they are little studied or poorly characterized. In this production system, energy and protein intakes vary widely throughout the year, which is reflected in the high variability of the performances and final quality of the products. The small size of the farms and the nature of the raw materials used in the traditional diet limited the increase of herd size. As alternatives to improve the system, intensive outdoor, camping or semi-confined housing with the incorporation of technology and external input (eg., cereals and food concentrates) have been developed according to the different physiological stage of the animals. Some of these farms, trying to find solutions to decrease production costs, seek to integrate other cheaper raw materials from local agro-food industries: by-products of industries of dairy products, fruit, vegetable and bread-baking. However, this requires technological care at the level of food quality and formulation, logistics, storage and distribution of the diet.

5 CHARACTERISTICS AND BENEFITS OF THE TRADITIONAL MEDITERRANEAN PRODUCTS

Sustainable pig production systems in Mediterranean region show marked differences in relation to technologies and final products arising from intensive systems. Regarding management practices, sustainable production systems depend on the balance of natural resources, and in terms of markets, depend on the maintenance of the characteristics of the final products as well as the defense of its genuineness. In contrast the intensive farms focus their efforts on market competitiveness: improved productivity (piglet's weaned/sow/year, conversion rates, % lean meat) in order to decrease production costs, mainly from raw materials and energy.

For example, we can see in table 2, differences in carcass traits and meat quality, obtained from local breeds vs. industrial pigs at similar weight. As it can be seen, local breeds have the advantage for processing (technological quality) and organoleptic attributes. In general terms, traditional pig has lower percentage of lean meat, lower loss of meat juice (drip loss) and more intramuscular fat and different lipid profile being more rich in unsaturated fatty acids (in particular mono-unsaturated - oleic acid).

With regard to the comparison of the final products (Table 3) – industrial hams, Serrano ham, Teruel ham and Iberian ham (PDO) (from left to right: intensive → extensive), an increase in subcutaneous fat in ham, more intra-muscular fat, an increase of the curing time and,

Table 2: Carcass and meat quality traits according to different breeds: exotic vs. local

	Industrial (Carrión, 2009)		Mediterranean (Santos e Silva, 2000)		
	Lean	Industrial carcass	Exotic	Alentejano	Bísaro
Carcass weight, kg	78–81	86	84.3	75.8	81.2
Lean meat, %	>59	57–59	55.8	45.3	48.8
pH 24h	5.5	5.6	5.4	5.5	5.6
Drip loss, %	4.0	3.0	3.6	2.3	1.5
Intramuscular fat, %	1.0	1.5	0.84	4.0	2.6

more important, an increase in the price per kilogram of cured ham.

6 SWOT ANALYSIS

Based on a SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) the main advantages and problems that remain in the traditional Mediterranean pig meat chain were summed up.

6.1 ADVANTAGES OF THE TRADITIONAL MEDITERRANEAN SYSTEMS

Strengths are mainly related to the specific features of the production systems that are linked to market opportunities:

1. One of the highlighted strengths is the fact that traditional production systems as well as final products have high economic value in the market because consumer values for its *sui generis* features and qualities including environmental and social value, ethical and cultural impact;
2. As an opportunity, the Mediterranean region is

recognized for the high quality of its food, including hams and charcuterie. In addition, there is a good network of information and international trade (organizations, networks of services, food fairs, internet) and mechanisms for protection and control of the quality that allows the stakeholders to defend the genuineness of the products (PDO and PGI). However, it is necessary to put them into practice.

6.2 PROBLEMS IN THE TRADITIONAL MEDITERRANEAN PIG MEAT CHAINS

From the point of view of the constraints it is common to find weaknesses in farm management and there are also serious threats related to the management of natural resources and market competition:

1. As weaknesses we have:
 - Large number of pig farms of very small dimensions;
 - Many buildings and animal facilities are rudimentary, poorly dimensioned and show problems at the level of productivity, animal welfare and food safety;

Table 3: Main differences between different types of dry-cured hams (Adapted from Carrión, 2009)

	Industrial	Semi-industrial	Mediterranean	
	Dry-cured ham (standard)	Jamon Serrano (TSG)	High Grade Jamon Serrano PDO Teruel	Jamon Ibérico PDO
	(–)	Extensification of production systems →		
				(+)
Weight, kg	–	>9.5	>11.5	–
Fat coverage, mm	–	>8	>20	>30
Intramuscular fat, %	1.5–2.5	2.5–3	>3	>4
Total drying period, days	160	>210	365	480
Price ratio	1	× 1.5	× 2	× 10

PDO–protected designation of origin; TSG–Traditional speciality guaranteed

- Low number of animals with recognized genotypes (autochthonous, herd book);
 - Poor training of producers.
2. With respect to Threats:
- The consumption of added-value products depends on the behaviour of the global economy (economic crisis);
 - The intensive or industrial production systems have been competing to format final products substitutes for the traditional Mediterranean pig meat chain, in particular, to imitate typical products and sell them at lower prices;
 - Threat of loss of natural resources related to the health extensive production systems: the report of the European Environment Agency (2006) showed an accelerated loss of typical Mediterranean forest and at the same time an advance of mono-cultural exotic forest (fast-growing species). These facts have occurred mainly in Portugal (who already had lost 18% of their native forest, Spain 12% and France 15%). Forest degradation is a very common phenomenon, due to a complex historical interplay of harsh environmental conditions (drought, aridity, soils prone to erosion) and anthropogenic influences (fire, grazing, and intensive forest exploitation). It is assumed that this regression of the autochthonous Mediterranean forest has been caused not only by the pressure of the timber sector, but also caused by agricultural abandonment or intensification of agricultural production, or even by the deficit sustainable environmental management, which have given rise to serious soil erosion processes, significant loss of biodiversity, degradation of ecosystems and the natural landscape.

From a strategic view of the traditional Mediterranean pig production systems, it is necessary to improve the weaknesses of farm management practices (buildings and animal facilities and husbandry) and combat major threats: avoid the regression of Mediterranean forest and original products counterfeiting, and at the same time, take advantage of the market opportunities.

6.3 FACILITIES FOR PIGS IN TRADITIONAL MEDITERRANEAN PIG HERDS

The main problems are detected in the management of farms and animal husbandry. Normally, the facilities and technologies are poorly adapted to the physiological needs of the swine's, due to the physical environment and climate specific to different regions, such as the temperature, direct sunlight, excessive heat and cold, high

temperature range, rainfall, humidity and lack plans for preventing climate disasters.

This brings us to the importance of building projects and adequate accommodation for animals. The quality of buildings and accommodation for animals has an extreme importance on the effectiveness and quality of pig production: more than 50% of animal's lifetime takes place within the grounds where they rest, feed, walk, *etc.* These facts influence the environment, animal welfare and animal performances making this issue a key point of the efficient management, quality and food safety. This topic is often overlooked and it should deserve more attention with regard to build future innovative research projects in this area. There are examples of types of accommodation and buildings used in traditional Mediterranean pig production. These accommodations are very different and must be adapted (location, dimensions and materials) to the needs of the animals, according to physiological, geographical and environmental conditions of each region/local:

- Buildings of traditional architecture (stone, masonry and other materials);
- Individual outdoors huts for sows (maternity and shelters);
- Shelter tunnels in grazing areas for overnight stay and rest;
- Tunnels of fattening and finishing pig in the forest;
- Innovative facilities built with eco-materials.

7 CONCLUSIONS

Sustainable pig production in Mediterranean area have a grounded common basis: the use of extensive systems and agro-sylvo-pastoral schemes assorted throughout the territory, depending on local breeds and the diversity of forestry resources. One of the great advantages that can be claimed by these production systems is the performance of their aesthetic function and its environmental and ethic advantages. These production systems allow the animals to live much of their lives in freedom, developing the natural behaviour and contribute to the preservation and enhancement of regional ecosystems. Production systems, authenticity and the high quality of the Mediterranean pig chain must be recognized and distinguished by the consumer, by means of certification and control mechanisms available in legislation, in order to avoid illegal economic profits and to defend the specificity of each product. This authenticity should be reflected in the final price. Finally, the purity of the Mediterranean autochthonous pig breeds should be ensured by good strategies of breeding and selection certified

by each herd book. Preservation of natural ecosystems should be ensured by privates in symbiosis with global and regional public policies.

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