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CONSERVATIONAL ISSUES IN LOCAL BREEDS – STATE OF THE ART

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ABSTRACT

Local pig breeds represent an important resource in the Mediterranean countries and a sustainable exploitation of them could greatly contribute to the income of the farmers. At present 34 local pig breeds are recognized and still raised in Mediterranean countries even if the level of information about them varies consistently. Some of these breeds are considered at risk even if for almost four-fifths the trend is positive (stable or increasing). Literature on these breeds constantly increases from the early 1990s' but there is a clear gap between the Iberian breed and the other genotypes. Genetics and quality of products are the two most important aspects investigated and within the former functional genetics became a priority in recent years. Selection in local pig breeds seems feasible, providing that goals are different from those used for the improved breeds, and the maintenance of genetic diversity continues to be a must for these populations. The research and new approaches developed until now contribute greatly to the knowledge about Mediterranean local pig breeds and it is important to set up future initiatives for the exploitation of the distinctive features of these genotypes. In the future actions to carry out will be to maintain genetic diversity and select characteristics to match consumer demands and farmers expectative. The use of the genomic selection could greatly help to reach these goals.

Key words: pigs / conservation / local breeds / risk status

1 INTRODUCTION – LOCAL BREEDS AND QUALITY OF PRODUCTS

A pioneer study (Giuffra *et al.*, 2000) recently confirmed by Groenen *et al.* (2012) established the existence of two main centres of pig domestication A study on wild boars (Larson *et al.*, 2005) showed that they have been domesticated in multiple centres, distinguishing two independent domestications of two European wild boar lineages. Investigating mitochondrial, Y-chromosome and autosomal polymorphisms Ramirez *et al.* (2009) demonstrated that Mediterranean and Slavic local pig breeds, even though clustering within the European group at mitochondrial level, are clearly differentiated from international breeds and more similar to wild boars when autosomal markers are considered. Such similarity is rather evident at morphological level, at least for some breeds, and it is also evident in terms of reproductive performances that in some cases (i.e. piglets born) strictly resemble those of wild boars.

This concept has been made explicit by Lauvergne (1982) claiming that traditional (or indigenous) breeds represent one of the four categories in which pig breeds are classified according to the degree of evolution. They are usually characterized, with few exceptions, by reduced population size, absence of specific selection programmes and are linked to specific environments and production systems (i.e. low input extensive systems). Such breeds are often supported by local strategies and in sometimes, in order to set up conservation strategies, resources from EU are employed to support farmers. According to Hiemstra (2010), the best conservation strategy is the one that makes breeds self-sustaining avoiding the use of external subsidies. Theoretically the self-sustainable

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condition of local breeds should be reached through the exploitation of typical food products characterized by an extra added value which in turn encompasses the breeding of a number of animals allowing sufficient genetic diversity. Nevertheless this condition is seldom attained in the local breeds and, as stated before, the intervention of public bodies is often considered essential by the farmers for maintaining the animals. It is thus necessary to find proper management and development programmes that include sustainable use of local breeds allowing at the same time the maintenance of genetic variability. In the following discussion we will provide an overview of the situation of local pig breeds in the Mediterranean countries giving a special emphasis to risk status classification of the breeds, nationally recorded data and the existing literature.

2 LOCAL PIG BREEDS IN MEDITERRANEAN COUNTRIES

Looking at the most important database on animal biodiversity (DAD-IS, 2013) it is possible to recognise 11 Mediterranean countries reporting information on local pig breeds, 8 of them with information on extinct breeds and 11 of them with info on breeds still alive. On the whole 93 breeds are recognised but only 34 are still alive (Table 1) even if with huge variation in population size. France, Italy and Spain are the countries with the highest share of local breeds, both extinct or alive (28 and 14 breeds, respectively). Actually the last two countries presented a slightly different situation in terms of numbers, with Spain presenting 7 different varieties of Iberian pig and Italy presenting 9 breeds not formally recognized by the National Swine Association.

Table 1: *Mediterranean countries and local pig breeds*

Countries	No. of breeds still alive	No. of extinct breeds
Albania	2	1
Bosnia-Herzegovina	0	1
Croatia	2	3
France	7	21
Greece	1	1
Italy	6	22
Portugal	3	0
Serbia	3	3
Slovenia	1	0
Spain	8	6
Rep. of Macedonia	1	0

Information on these breeds is highly variable both in terms of population data and breed performance. If for the former the differences are mainly due to different depth of information in regard to census and inbreeding, for the latter very few data are reported for most of the breeds considered. This lack of information reflects, in some ways, the real situation whereas in some other cases scientific literature is largely available in the bibliographic databases and thus the lack is due to missing reports in the database.

2.1 RISK OF EXTINCTION STATUS OF MEDITERRANEAN PIGS

Four different categories are normally used to define the risk of dying out for livestock breeds: extinct, critical, endangered, and not at risk. It is also possible to distinguish the breeds on the basis of the presence or not of a conservation programme in two further sub-categories: critical-maintained and endangered-maintained. Following this classification Table 2 reports the situation for the 33 Mediterranean local pig breeds listed in the DAD-IS database (no information is available for one breed) and it is possible to observe that 18% of the breeds are not at risk with additional 45% in maintained status. Conservation programmes are set up in 70% of the breeds and in more than 80% of the breeds the population size is stable (44.8%) or increasing (41.4%). Actually the real situation is slightly different because the information dates back to 2001 for almost one third of the breeds and also the reliability of the data is unknown for 13 breeds out of 32 (41%).

It is noteworthy that the number of breeds considered in critical situation seems to be reduced from 2001 to date (Ollivier *et al.*, 2001) denoting that the average size of the populations was increased over time. Nevertheless the situation as presented here is not fully comfortable for the survival of the local pig breeds as it might be misrepresented by the lack of information in the database.

Table 2: *Risk of extinction of Mediterranean local pig breeds*

Risk status	No.	Percentage, %
Critical	4	12.1
Critical-maintained	1	3.0
Endangered	6	18.2
Endangered-maintained	15	45.4
Not at risk	6	18.2
Unknown	1	3.0

3 SCIENTIFIC LITERATURE ON MEDITERRANEAN LOCAL PIG BREEDS

Following the renewed interest for conservation of biodiversity, the first available data on local pig breeds in the Mediterranean area arrived at the end of the 1980's. The number of publications grew constantly over time. Figure 1 shows the number of scientific publications considering Mediterranean local pig breeds over the years with two distinct figures including (Fig. 1a) or not (Fig. 1b) the Iberian breed. The actual number of publications is likely underestimated because not all the journals are included in bibliographic databases.

The two peaks observed in 2000 and 2007 correspond to previous congresses on Mediterranean pigs (two proceedings were published in 2007), with the increasing trend even more clear when Iberian breed is included. Regardless of the breed involved, during the last five years (2008–2012) the most studied areas of research are genetics, with 83 published papers, followed by quality of products with 82 articles and, quite distant, nutrition (33) and performances (32); reproduction, health and other different aspects (i.e. housing, welfare, sustainability) represented the other 41 published papers during the reference period (Fig. 2). Focusing only on genetic aspects, using the same reference period as before, the studies investigating genetic diversity and inbreeding trends on local pig breeds are diminishing drastically (only 12 papers), whereas an increasing importance has been given to the studies involving functional genomics (representing two-thirds of the published research). In particular, leptin and leptin receptors received the major attention because of their effects on fatness and growth traits (Muñoz *et al.*, 2011), and fertility through placental efficiency (Gonzalez-Bulnes *et al.*, 2012).

Both the last cited papers involved the Iberian pig breed and actually the scientific literature on Iberian pig is, by far, the most important let it be in terms of number of published articles or different aspects: genetics, quality of products, health, breed performances, sustainable management and many others. For the other breeds the situation is diversified and incomparable. It is clear that the abundance of the scientific literature is correlated to the economic importance of the topic (in this case the Iberian ham) but the phenomenon is interconnected and, in a certain way, more scientific information means more market options for the products. It is thus necessary to expand the profile of the research to all local breeds and better information may in turn produce greater market options. This expansion could be reached by strengthening the already existing collaborations but also procuring new opportunities sharing information among countries and exploiting synergies.

4 CONSERVATION THROUGH UTILISATION

As stated in the introduction the conservation of a breed obligatory passes through its utilisation and after the period of genetic recovery, it is necessary to set up a sustainable system in which the breed represents a pivotal role.

Anyway, in many cases, the activities for conservation will need to continue even when the sustainable use is fully in action; this is due to the small population size of most local breeds and to the impossibility to expand them without losing their specific characteristics. In fact local breeds are often linked to a specific niche both in terms of territories and markets. The breaking of the link between a specific area and the breed could lead to the loss of the added value which is obtained by rearing the genotype in the specific geographical area. According to Gandini and Oldenbroek (2007) the *in situ* sustainable

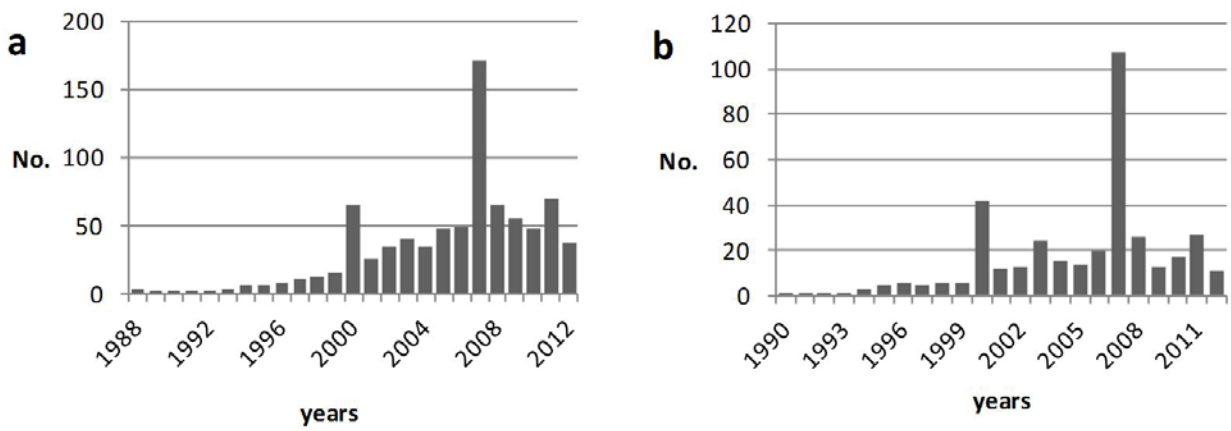

Figure 1: *Number of publications on Mediterranean local pigs over the years considering (a) or not (b) the Iberian pig breed*

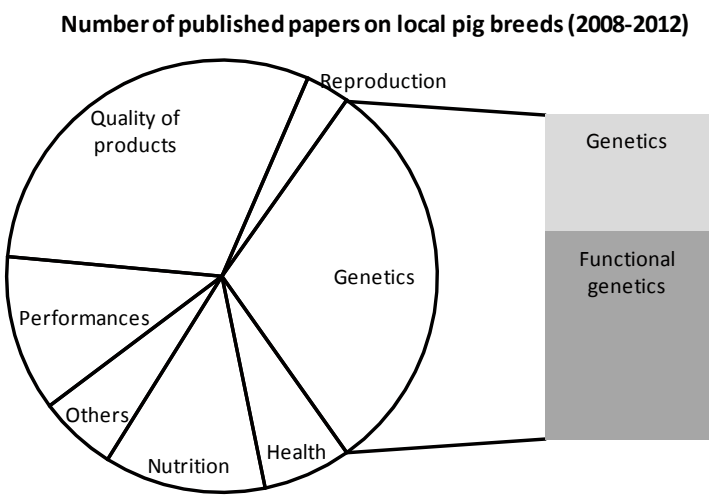

Figure 2: *Number of published papers (2008–2012) in different research areas involving local pig breeds*

utilisation should consider six options: economic performance of the breeds, activities to increase the market value of the products, infrastructures and technical assistance, genetic improvement, optimisation of production systems and developing incentives. For the first key point we can assume that breed performances are well known for most of the local genotypes but information is limited for the economic evaluation and this represents a crucial lacking point for the survival of the genotypes. Addressing the second option, in the present situation (at least for some populations), the market value of products is adequate to counterbalance higher production costs due to lower performances (sometime with the support of financial resources from public bodies). However it is likely that this difference in profitability will decrease more and more in the future and we need to recover part of this difference through reducing production costs and most importantly improving performances. Such issue should be faced with attention because local pig breeds exploit harsh environments scarcely used by other types of farming activities. Indeed the overall value of this type of farming overrules the ordinary income statement and developing incentives can help the sustainability of the farms even if, as stated by Gandini and Oldenbroek (2007), they cannot provide a general economic support. In terms of conservation another key factor is the possibility to select these breeds for specific traits but the question is disputable. Namely, two different types of problems could arise when selecting local pig breeds: inbreeding increase and/or resemblance with the improved breeds. In fact, if on one hand the selection leads to an increase in inbreeding on the other side the selection can also carry local breeds to resemble the improved ones losing thereby their favourable and unique characteristics. The theory for maintenance of genetic variation within the breeds has been developed in recent years (Meuwissen, 2007) and different software packages are available both for computing genetic diversity (Boichard, 2002; Gutierrez and Goyache, 2005; Stránden and Vuori, 2006; Groeneveld *et al.*, 2009) and to allocate optimal contribution of males and females in the selection programmes (Meuwissen, 2002; Berg *et al.*, 2006). This last approach, from the theoretical point of view, has been applied in Iberian pig by Fabuel *et al.* (2004) using microsatellite markers and more recently by Engelsma *et al.* (2011) in Holstein Friesian cattle using a 50k SNPs chip. The results showed that it should be possible to select while maintaining genetic diversity using molecular information. However, the last authors pointed out that the use of pedigree information in small populations continues to be highly efficient. Selection is thus feasible providing that the goals in local pig breeds are different from those classically used in modern genotypes. Local breeds possess unique features linked to the quality of their products and only these traits deserve to be included in selection programmes. The genomic information might help to locate these traits considering that nowadays thousands of markers over the whole genome are available also for swine. The use of the genomic selection methods enables an effective selection, targeting specific regions of the genome along with the maintenance of genetic variation (Roughsedge *et al.*, 2008) but if not precisely controlled, might lead to higher risk of inbreeding. Obviously, when working with population of limited size and, to a certain extent, limited economic importance, the question of traits recording remains open. The classical methods of selection using pedigree data require the recording of phenotypic traits and the accuracy of the estimation is strictly dependent on the number of data and this is even more true using the methods of genomic selection. In fact these methods require a training set of data and the power of the analysis is a function of the size of this training population; reduced size means reduced reliabilities. Another interesting approach for recovery and management of endangered population comes from Fernández *et al.* (2012) proposing different strategies and sources of information (i.e. morphological traits) for genetic management. The results obtained showed that the use of every possible source of information, carefully balancing the needs for selection and maintenance of genetic diversity provides reasonable solutions.

5 OPPORTUNITIES AND THREATS

The conservation of genetic diversity of local pig breeds has a multidimensional context that cannot be simplified with limited information. Genetic studies help to shed a light on the topic but it embraces various aspects including economic, social and technical issues (Collado *et al.*, 2010). In general the most important opportunities will come from: a) presence of niche markets; b) diffusion of organic farming; c) use of abandoned lands and woodlands; d) reservoir of specific traits; e) recovery of traditions; f) importance of eating good food (questionable). On the other hand the major threats can be summarised as follows: a) human health hazards (high levels of saturated fats); b) substitution with improved breeds; c) uncontrolled crossbreeding; d) products of bad quality. From the genetic point of view the biggest opportunity for maintenance of genetic diversity will come from the use of the new methods of selection integrating pedigree and genomics data, succeeding thus in disengaging from national subsidies. The major genetic threat will be the crossbreeding with improved breeds in order to mimic the performances of the latter; i.e. losing specific features and traits of the local breeds even if crossbreeding would be controlled.

6 EU PROJECTS INVOLVING LOCAL PIG BREEDS

Finally a brief survey on CORDIS database showed that were very few EU projects dedicated to local pig breeds and their sustainable management. It was possible to trace back only 11 projects involving local pig breeds and most of them were dedicated to genetic diversity where local pig breeds were often used as outgroup populations. Starting from the early 1990's, PigMap but especially PigBioDiv1 and 2 included local pig populations. In recent years Sabre and Q-Porkchains projects worked on pigs but the former was fully dedicated to cutting edge genomics whereas the latter included only the Iberian breed among the Mediterranean local pig breeds. Nevertheless the financial contribution to these project has been high (more than 30 million of Euros) and in many cases the results were important in terms of future research. An overview of the situation of pig genetic resources, even if limited to 4 countries (France, Germany, Italy and Spain), has been also given by the RESGEN12 project. The final results have been published by Ollivier *et al.* (2001) giving special emphasis on local breeds and providing a basis for the conservation of Europe's pig genetic resources.

In a recent mini-review on pig genetic diversity, the same author (Ollivier, 2009) reaffirmed the genetic uniqueness of the European local pig breeds; all the projects cited in the review provide useful information for conservation purposes though the author raised the question as to marker neutrality due to *gene hitchhiking*. Most of the markers employed until now seem to be linked to quantitative traits and the results could be misled by this phenomenon. Thus we agree with Ollivier (2009) that measuring genetic diversity in farm animals remains a challenge. Nevertheless new technologies open wide possibilities and it would be very fascinating to use all Mediterranean local pig breeds in a study on selection signatures, as was done by Wilkinson *et al.* (2013) in some European pig breeds. Traces of selection were found in genomic regions including genes related to coat colour and ear morphology as well as in regions harbouring growth and fat deposition traits; and all these traits represent specific features of the local pig breeds. It is unquestionable that the results obtained in the abovementioned research are a good starting point to set up future initiatives of research considering local pig breeds as a focal point when sustainable management will be the key factor. Another important aspect to point out for future research is the possibility to exploit the specific features of local pig breeds in order to study important genetic effects for pig production (i.e. fat depot, growth, fertility, adaptability to harsh environments, *etc.*). Such future initiatives should embrace the various aspects linked to conservational issues of local breeds and more specifically genetics, performances, quality of products and food markets. Finally, as stated by Collado *et al.* (2010), conservation of local breeds is a complex problem and it might also be desirable for pig local breeds to set up a decision-making tool to identify and select strategies and policies for the development and conservation of local genotypes.

7 CONCLUSIONS

Conservation of local pig breeds is vitally dependent on the exploitation of the specific quality of the derived products. This great potential has been almost fully exploited in the Iberian pigs employing a sustainable management system which includes aspects related to woodlands, pastures, farming, food processing and food markets. On the contrary most of the other local Mediterranean pig populations, after a first phase of great interest, continue to be undervalued. It is thus necessary to exploit the unique features of these local genotypes trying, at the same time to preserve their genetic diversity. Such actions could be addressed by employing the new opportunities coming from the genomics though it

would be necessary not to forget that our animals are a part of broader context which involves the entire society. This is the only way out for the future of the Mediterranean local pig breeds.

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