Which Orientation for Strategies and Policies for Local Animal Breeds? The Role of ICT and Novel Technologies

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Abstract. Local breeds are endowed with numerous advantages in terms of adaptability to specific conditions and the sustainable utilization of resources. Nonetheless, their role is neglected when their multiple societal, economic and environmental contributions are not properly acknowledged and interest is focused only on productivity issues. This paper explores the role of local breeds and the development of effective conservation strategies and relevant policy measures. The paper focuses on the reasons behind the underestimation of the values with which local breeds are endowed and discusses how economic development, policies and market competition have rendered many of these breeds in danger of extinction. The development of a new paradigm of conservation strategies, which could also be extended to breeding programs, is presented here, which incorporates ICT, new technologies and innovations. It is concluded that using proper measures and achieving synergies between actors and measures, local breeds can be protected in order to continue supporting multifunctional production systems and local short value chains.

Keywords: Rural development, Agricultural policies, Livestock farming systems, Innovation, Animal breeding

1 Introduction

Genetic diversity is an issue of particular importance at the country level but also at European level. In 1992, it was reported that 28% of livestock breeds had already disappeared or had become threatened or rare during the last 100 years (World Conservation Monitoring Centre, 1992). After then, the recognition of the problem is reflected in scientific and political discussions. In the context of the Interlaken Declaration in 2007, the main objective was the development of a World Plan of Action on Genetic Resources of Farm Animals (conservation, sustainable use and development of genetic resources of farm animals for food and agriculture, global

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food security, improvement of human nutrition and rural development). This Declaration calls for registration, monitoring, characterization, sustainable use, development and conservation of the genetic resources of farm animals. The European Association for Animal Production (EAAP) has developed a genetic material bank of animal breeds, by encouraging, *inter alia*, the use of breeds that contribute to the protection of genetic diversity.

This loss of genetic material entails the loss of traditional farming and jeopardizes the viability of local production systems (Rege and Gibson, 2003) where the prevalence of local/autochthonous breeds plays an important role in sustainable land management. Lacking local breeds, farmers do not always have access to animals well-adapted to the local climate conditions, which are often very harsh. This situation highly burdens the production costs and the operation of local short value chains and also imposes severe threats on local ecosystems: genetic diversity is threatened by massive imports of foreign breeds which are reared either as purebreds or to improve the milk and meat productivity of farms.

The declining populations of local breeds are mainly due to information deficiencies to the general public as well as to a lack of training of farmers. When it comes to consumers, they are usually unaware of the environmental benefits of supporting genetic diversity or of the good quality characteristics of products from autochthonous breeds. Farmers, on the other hand, are not always trained to understand the indirect benefits of rearing autochthonous breeds and insist on imported breeds of higher yields, which nonetheless incur significantly more costs (feeding, illness treatment etc.), thus being detrimental to the profitability of farms.

The purpose of this paper is to discuss and propose potential measures and remedies to protect local animal breeds from their declining trends. Firstly, the paper endeavors a discussion of the reasons behind this reduction and seeks to find whether this trend is justified or whether there are factors, which are disregarded, thus leading to this situation. Based on this, the paper proposes assessment methodologies for these factors. Then, potential policies and strategies to support the protection of these 'valuable' resources are discussed, especially based on the use of modern technologies, ICT and novel socioeconomic approaches.

2 Local Breeds: "Victims" of the Development Process?

The adverse situation that many local animal breeds face nowadays is mainly due to the under-estimation of their real values. This is directly related to the economic development process, the agricultural policies in force for decades but also to market competitive conditions.

The economic growth process in the agricultural sector of most European Union (EU) countries, including Greece, was characterized by a transition from extensive labor-intensive to modern capital-intensive systems. New modern farms started to emerge some decades ago, which adopted novel technologies and developed an entrepreneurial organization model. Farms stopped to pursue subsistence and geared towards strategies to reduce production costs, including the achievement of economies of scale. The average farm size increased and this was accompanied by

specialization in the production of one or a few livestock products, signaling the end of the era of 'economies of scope'. In order to improve their economic performance, livestock farms were in need of animals which would be pertinent to a holistic management approach, so as to facilitate workers to include a new lifestyle, with less work on the farm and more free time to enjoy other non-rural activities. At the local level, the economic development pattern led to specialization in non-farming activities as a result of rural diversification procedures. Under these circumstances, livestock systems were geared to market requirements, where the demand for products of animal origin has been ever-increasing. The increased productivity of the improved breeds was thus a particularly desirable feature for farmers, who further increased the import of such animals into their livestock farms. For all these reasons, traditional local breeds were gradually substituted by others, fewer in number, of foreign origin and of lower resilience.

Apart from economic growth, the policy framework favored a productivist model through the provision of subsidies, which has contributed substantially to the devaluation of animal genetic resources. EU price policies, especially in livestock production, encouraged high milk yields, thus leading to an increase of dairy breeds at the expense of dual-purpose local breeds. At the same time, high subsidies to crops altered the competitive relationships between crop and livestock production substantially: the former became more profitable thus several livestock farmers abandoned livestock production. In addition, the alternative cost of grazing increased due to the increased profitability of crops and the cultivation of fodder plants was substituted by other highly subsidized crops, burdening the production costs of livestock farms and further reducing its competitiveness in relation to agriculture. The farms that ceased to operate as a result of these issues were mainly those that reared local breeds. Policies also encouraged increased productivity at the national level also for political reasons, related to the consolidation of national sovereignty and the treatment of market uncertainty, non-cyclical market fluctuations and unexpected extreme conditions. Surprisingly, in livestock farming, productivity growth was pursued in many countries through the introduction of improved genetic material from abroad, ultimately increasing the reliance on imported genetic material and partly counter-balancing the advantages of self-sufficiency in domestic markets.

Market conditions combined with the characteristics of modern livestock farming intensified threats to local animal breeds. Companies marketing the genetic material of breeding animals often supported intensive production systems that require improved genetic material at the expense of genetic diversity. In this context, private consultants in rural areas, without the operation of a central Extension service in many countries, often favored the expansion of improved breeds, without reassuring first that they are adapted to local conditions or are suitable for semi-extensive traditional production systems. So, although these breeds were inappropriate in numerous contexts they displaced local ones in several cases. In addition, this trend limited the focus of breeding programs on only a small number of primary traits, with a direct and observable effect on farm economic performance (dairy production, prolificacy), thus increasing the demand for breeds with such characteristics and shifting interest from local breeds with desirable secondary traits (e.g. durability).

3 Values of Autochthonous Breeds: How Can They Inform Targeted Protection Strategies?

The values of animal breeds, particularly of local ones, can be divided in two broad categories, use values and non-use values (Turner et al., 2000, Bateman et al., 2003, Roosen et al., 2003, Ragkos 2008a). Use values derive from characteristics, which directly or indirectly affect the economic performance of farms. According to relevant literature, local breeds are better adapted to local conditions (Legarra et al., 2007), exhibit higher resistance to disease (Mpizelis, 2013), adaptability (Ragkos and Lagka, 2014) and have relatively low requirements for purchased inputs (mainly feedstuff) (Roustemis, 2012, Ragkos et al., 2014). Also, the quality characteristics of the products of these breeds are very satisfactory (high fat and protein content) (Vafeiadakis, 2013), but these are not always remunerated to their true potential because in many cases the pricing policy of food companies is based only on quantity (Roustemis, 2012). With these characteristics, local breeds are suitable for traditional farms that formulate multifunctional production systems in many European settings (OECD, 2001, Lankoski and Ollikainen, 2003, Rege and Gibson, 2003, Ragkos and Lagka, 2014). These systems play multiple roles beyond production of market goods (social, economic environmental, developmental) thus contributing to sustainability (Ripoll-Bosch et al., 2013).

The non-use values of genetic material, on the other hand, are neither reflected in the economic performance of farms nor in the market prices of products and are generally not linked to tangible benefits (bequest value, existence value, philanthropic value, quasi-option value). The sum of use and non-use values is referred to as the "Total economic value" (TEV) of local breeds (Pearce and Turner, 1990, Pearce, 2001), which reflects their overall contribution to the economy, environment and society and points towards the need to protect them.

The estimation of the TEV is necessary for the design and implementation of integrated protection programs for local breeds, but also for any genetic improvement program. Indeed, when society recognizes and values genetic diversity, an important argument is provided in favor of funding improvement programs. On the contrary, if society is not interested in the protection of genetic resources there is no justification for 'sacrificing' funds for genetic improvement. In addition, through a valuation process, all values of genetic diversity can be recognized and be used in the design of integrated protection policies, the selection of the most important genetic resources and the efficient allocation of scarce financial resources. The valuation process is also necessary for the definition of proper policy measures, especially in order to determine the "optimum" level of financial compensation for those who rear them - a model close to Payments for Ecosystem Services (Villanueva et al., 2015, Caro-Borrero et al., 2015).

The design of genetic improvement programs itself requires such an assessment. By recognizing the heterogeneous preferences of potential consumers of genetic material, which are volatile over time especially in relation to functional traits, it is possible to identify the role of actors involved and to improve the overall operation of the breeding system. The systematic recording of these preferences allows critical questions to be addressed in the design of breeding goals: what are the characteristics

of the animal, the producer, the farm and the territory (natural, economic, social) and what are the marketing and information channels which influence the producer's decision to "consume" a particular animal. This is the first step towards designing better-oriented genetic improvement programs, which meet the needs of livestock farmers.

4 Evaluation Methodologies for Genetic Diversity

The methods conventionally used for the valuation of genetic diversity presuppose competitive market conditions, the application of market valuation techniques (for example, profit functions (Legarra et al., 2007) and linear programming (Theodoridis 2008)) allows for the evaluation of traits with use values such as milk production and prolificacy and for the examination of competitiveness based on purely economic criteria. However, such conditions are not always met for transactions made by farmers when purchasing animals for their farms. The demand for local breeds (from the point of view of producers who are "consumers" of genetic material) and for their products (from the perspective of consumers who buy dairy products and meat) is distorted. Asymmetric information (Rousseau and Vranken, 2013), the distance between buyers and sellers, and the importance of local breeds only for specific territories are the main causes of market failures (Ragkos and Abas 2015, Ingersent and Rayner, 1999). In this context, the market fails to attach monetary values to characteristics with indirect contribution to economic performance, such as resistance to disease and adaptability to grazing, which are of particular importance to extensive systems. Regarding the consumption of products of animal origin, these methods do not allow the evaluation of their non-use values as described above (Arrow et al., 1993), leading to a potential underestimation of their true value by consumers.

Given these problems, the estimation of the TEV of local breeds and of their products requires the application of non-market methods, especially of stated preference techniques (Arrow et al., 1993, Haab and McConnell, 2002, Roosen et al., 2003, Bateman et al., 2003, Ragkos, 2008b). The main characteristic of these methods is the formation of a hypothetical market and the elicitation of the Willingness to Pay (WTP) or of the Willingness to Accept Compensation (WTA) of the hypothetical consumers (in the case of genetic diversity, the market can comprise livestock farmers, who are potential "consumers" of genetic material). The Choice Experiment (CE) method (Adamowicz et al., 1998, Hensher et al., 2005) is quite pertinent to the particularities of such a valuation task. The outcomes of CEs can effectively provide orientation to protection and conservation policies for local breeds. Indeed, identifying the values of particular traits of local breeds will provide additional arguments for the protection of breeds, which exhibit these traits, because their overall economic value will justify the mobilization of more funds. Moreover, higher WTP for products from local breeds is an important argument for their protection as it demonstrates that an expansion of their rearing would entail positive market outcomes.

5 Novel Approaches and New Technologies for the Protection and Promotion of Local Breeds

The loss of animal genetic diversity indicates that protection and conservation policies have not been successful. A key argument towards a new paradigm of such policies and strategies is the recognition of the multifunctional nature (OECD, 2001, Lankoski and Ollikainen, 2003) of traditional livestock systems. Indeed, goods and services with non-market values are emerging from the operation of these systems, in addition to their market outputs. These include the formation of the agricultural landscape that often identifies the countryside and local history, tradition and intangible cultural heritage (www.unesco.org/). Also, these systems are a major source of income in marginal and less-favored areas and play an important role in rural development. Traditional livestock systems and the protection of local breeds also entail environmental benefits for local grazinglands. In any case, rearing breeds which are adapted to specific local conditions is an integral part of sustainable livestock systems.

In this framework, the overall objective of protection and conservation strategies should be to save, protect and valorize existing populations of local breeds by employing interdisciplinary approaches and novel tools addressing all aspects of these multifunctional systems. These goals have been pursued through public genetic improvement programs, but also through private initiatives by Cooperatives, businesses and non-government organizations. Whatever their form, the success of these actions is highly dependent on the mobilization of all actors through multi-actor approaches. Wider stakeholder involvement is key to successful conservation programs, as they should be designed with a bottom-up approach, which should address the real problems of all actors.

The genetic improvement process, which will enhance the overall state of the local breeds populations, will need to utilize modern tools, methodologies and technologies in order to achieve rapid, sound and sustainable results. Considering that ICT continuously penetrate rural and urban societies, they are some of the basic tools to be incorporated in effective strategies of the sort. In what follows, some of these tools are briefly presented.

- Introduction of holistic farm management in farms rearing local breeds, especially in nucleus farms. This approach is rather a philosophy, which will allow farmers to make the best of the animals they rear and adopt innovation, without, however, altering their predominantly traditional production practices.
- An integrated reproduction strategy in farms. This includes the use of ICT tools for data recording, which will assist controlled mating and choice of animals, combined with Artificial Insemination and other modern technologies such as embryo transfer.
- Integrated databases with population statistics and historical, socioeconomic and on-site measurement data, including productivity and quality characteristics. These data should be complemented with genotyping results, using cutting-edge genomic approaches. Such databases could inform current and future conservation and improvement efforts.

- Multimedia campaigns for the general public, in order to get them closer to the benefits that local breeds may bring to society. The internet and social media constitute low cost alternatives to contribute towards this way.
- Information and training are necessary also for farmers. More and more ICT techniques are included in curricula for farmer education and they are useful also for this purpose. E-learning and the use of multimedia are important for providing aware farmers detailed information about the benefits of local breeds.
- Such methods are also important for establishing meaningful networks of farmers rearing such breeds. There are examples of Organizations supporting local breeds at the local level (there are actually more than ten in Greece) many of which work on the genetic improvement of specific breeds. There also regional or even national Organizations (e.g. the CORAM (http://www.races-montagnes.com/) in France) and efforts are currently in force to support even supra-national organizations (such as the European Shepherds Network - ESN). E-networking provides an ideal means of constant communication among them, in order to shape concrete linkages, also considering that these organizations usually operate with minimum funding and other means. E-networking can also be induced at the vertical level establishing food value chains (e.g. farmers - dairies - other SMEs - retailers - special interest tourism businesses (restaurants, visitable dairies etc.) - consumers etc.).
- The implementation of these strategies could be further enforced by a branding scheme and/or the certification of products (e.g. Protected Designation of Origin). This way, local breeds will favor the local short value chains, thus promoting sustainability and providing significant opportunities for innovation and development. All these could be contextualized by ICT applications such as e-commerce and e-sales platforms.

The strategies whose principles were described above can also be imprinted in policy measures. The new Rural Development Program of Greece (RDP) 2014-2020 is an example of the sort, as it clearly favors endangered animal breeds (M10.1 and 10.2). The protection of local breeds and genetic diversity is also in accordance with other RDP measures (M01 concerning cooperation for training, M03 about quality certification, M07 about cultural identities, M14 about animal welfare, M16.4 about short supply chains etc) but also with various local, regional, national and supra-national policies concerning animal welfare, dairy products, public health etc, which have emerged through times in various EU settings. Strategies of this sort are also in line with Europe 2020 strategy for SMART growth: smart (investments in education and innovation), sustainable (a low-carbon economy) and inclusive (emphasis on job creation and poverty reduction in rural areas).

6 Conclusions

This paper proposes an interdisciplinary strategy to encourage collaboration and networking based on a holistic approach, which will embed the necessity of protection of local breeds among all relevant actors. Overall, the approach described in the previous sections is expected to valorize systems rearing local breeds and add

value to their products, signaling a territorial development process with wider economic, social (aversion of depopulation, protection of cultural heritage) and environmental (restoration of degraded rangelands, production of high quality food) implications. The benefits of such an approach will affect actors in the whole value chain. Farmers will have direct access to animals with beneficial characteristics; stakeholders in the value chain (dairy producers, retailers, other manufacturers etc) will benefit from increased and efficient primary production and better communication and networking with other actors; consumers will benefit from the availability of local, safe and potentially certified dairy products but also from the protection of genetic biodiversity, which entails environmental benefits.

Interesting conclusions can be drawn regarding the future prospects of systems rearing local breeds. Relevant programs must incorporate the sustainability of the production systems to which the genetic material is addressed. Indeed, rearing local breeds can be environmentally, economically and socially sustainable and this should be addressed by every conservation initiative. Thus, a bottom-up approach is proposed, favored by a common forum for communication and exchange of views between actors. Bearing these in mind, a conservation strategy, more even than a 'mainstream' breeding program, should include

1. the identification of the willingness of farmers and other stakeholders to participate, e.g. by performing SWOT and stakeholder analyses,
2. economic values for animal traits by combining market and non-market valuation
3. cost-benefit analyses to demonstrate the feasibility of the program
4. identification of priorities and directions

The proposed interdisciplinary approach will generate additional opportunities and indirect benefits for primary sector entrepreneurs and local agri-businesses (job creation and income) and for actors related to the primary and secondary sector in general.

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