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Values of local breeds for niche productions and/or adaptation to specific environments

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INTRODUCTION

The evolution of livestock production during the 20th century in Europe was characterised by a specialization and an intensification of the productions. In this context, public policies supported, up to the seventies, the use of a small number of specialized breeds. In some cases, as in France, the purpose was to put all material and financial availabilities on a small number of breeding schemes in order to improve their efficiency [25]. Sometimes, such policies were simply due to a special view of what modernity shoud be [e.g., 27]. However, in the seventies, there were many claims for the preservation of the local breeds as a unique genetic resource: as examples, among others, one may refer to the work done in United Kingdom by the Rare Breeds Survival Trust or in France by the *Société d'Ethnozootechnie*, the *Institut Technique de l'Elevage Bovin* and the *Institut Technique du Porc*. The preservation of animal genetic resources has been included within public policies, at the regional, national and European levels. In France, several public initiatives have been taken: since 1975, an annual financial support is provided by the Ministry of Agriculture to the farmers' organisations in charge of a conservation programme; in 1983, the *Bureau des Ressources Génétiques (BRG)* was created in order to coordinate researchs and actions for genetic resources in crops, micro-organisms and animals; in 1999, a national cryobank was created in order to preserve frozen material for any population of livestock. Since the nineties, the Common Agricultural Policy (CAP) includes a financial support to breeders keeping reproducing females of rare breeds of domestic ruminants, pigs and equidae.

To apply any public policy requires simple criteria. For instance, the list of the endangered breeds to be supported by the European union was established by national experts on the basis of simple data such as the numbers of male and females reproducing animals. More elaborate rules could be used to decide what should be preserved. For that purpose, it has been proposed to analyse polymorphisms data through the Weitzman's (1992) approach, allowing to assess the global diversity of a set of breeds and the marginal diversity of a given breed [e.g., 30]. The marginal diversity of a given breed could be weighted by its risk of extinction, assessed on the basis of simple considerations about the breed history and status [30] or on the basis of the probability of allelic fixation within the breed [11]. Simianer [30] also proposed to include, as a all or non variate, some utility values of a given breed (e.g., adaptation trait) and Gandini and Villa [10] proposed an analytical approach of the cultural value of a breed.

The purpose of this paper is to show, on three French examples, how local breeds may have a considerable value for niche production and/or adaptation to a special environment. First, it will be shown how the characteristics of the *Bresse* poultry breed have been valorised through a production under *AOC* (Protected Designation of Origin). The second example will deal with an ultra-peripheric European area, the French West-Indies, and the adaptation of the local ruminants breeds to the humid tropical conditions. The last example will show the role of the cattle breeds *Abondance* and *Tarentaise* in both the use of mountain areas and the development of *AOC* products. How to consider such values in a public policy will be discussed next.

I. THE *AOC* PRODUCTION WITH THE *BRESSE* POULTRY BREED

The french production of chicken meat is differentiated into several categories : standard broiler (SB), label chicken (LB), certified chicken (CF), organic chicken, and *AOC* for the *Bresse* breed only. Chicken meat may be sold as a whole carcass (52%), as cuts (33%) or as processed products (15%) [source: *Institut Technique de l'Aviculture*]. In 1998-1999, the LB products represented 50% of the whole carcass market and 6% of the cuts, whereas the certified products represented 8 to 10% of these sales, and the organic even less. In terms of number of chickens, the LB production represented nearly 100 millions chickens raised all over France in 2002 [www.synalaf.fr], whereas the *Bresse AOC* represented 1,4 million chickens raised only in the *Bresse* geographical area defined by law. The LB was created as early as 1965, to promote product quality, by using a production system based upon a low rearing density and a food devoided of any animal by-products or additives. The LB and CF legal definitions do not require the reference to a particular breed, although the chickens used are generally characterized by a colored phenotype, which creates a clear distinction from the white plumage of standard broilers.

As compared to LB, the *AOC* follows a quite different philosophy: a geographical district has to be defined, and characterized by specific features of the natural conditions and the production system, which can not be found in another geographical area. For the *Bresse*, the district was defined as early as 1936: it involved a specific area including a part of the Jura and most of the Ain and Saône-et-Loire administrative districts. The protection of the name *"Volaille de Bresse"* was decided by law N° 57-866 on August 1, 1957. The first conditions required are a defined geographical area, the Bresse region, and a defined chicken breed, the *Bresse* breed with white plumage, blue shanks, simple comb, red wattles, white earlobes and white skin. The breed definition was thus derived from the phenotypic standard of the *White Bresse* variety. The occurrence of blue shanks is determined by a single gene, ID, and the association of white plumage and blue shanks is rare among french poultry breeds [24]. Other conditions are included: a fixed set of growing conditions (density, open-air access, feed) has to be applied for at least 9 weeks, after a starting period of 5 weeks where the producer may still take some free choices. The finishing period has to take place in a specific housing system (called *épinette*) with a specific feed including milk, for at least 8 days for males, and 4 weeks for fattened pullets and capons. Specific regulations apply to slaughtering and processing of the carcass.

Since 1995, the selection procedure for the *Bresse* breed is also strictly regulated. The breeding goals are discussed yearly within an interprofessionnal committee (called *CIVB*) comprising the production chain (breeders, producers, distributors, ...) and a scientific institution. The selection procedure is based upon pedigree records and the founder lines are qualified by the French federation poultry and fish breeding companies (*SYSAAF*). The breeding centre, as well as the hatcheries distributing day-old chicks of the *Bresse* breed, have to be registered at the official sanitary control of regional veterinary services.

At the beginning of the *Bresse* AOC, founder animals were sampled from fancy breeders in the geographical area defined by the law. They had to follow the breed phenotypic standard, and they were submitted to veterinary treatments in order to eradicate the most common diseases. In a few years, a *Bresse* population with a "clean" sanitary status was obtained. It was subdivided into two *Bresse* sublines, one being selected on body weight, the other one on egg production. The selection intensity was mild, and the two sublines were crossed in order to produce the commercial chicken. This crossbreeding strategy is usual in poultry, except that it was done here within a single breed, the *Bresse* breed. In order to further improve robustness, a new sampling procedure took place with fancy breeders, always in the Bresse region. This immigration event led to the creation of a third *Bresse* sub-line, which is used now in a 4 way-cross to produce the commercial *Bresse* chick.

There is only one breeding centre, the *Centre de Sélection de la Volaille de Bresse* (*CSBV*) and three hatcheries, multiplying chicks from the lines selected at the *CSVB*. There are about 500 producers of the Bresse *AOC*, 2/3 are organised in collective production units (called *groupement de producteurs*) and 1/3 are independent producers. Chickens are identified by a producer-specific tag, to be attached to the leg before the shipment to the slaughter house. The total number of *Bresse* chicken produced yearly is about 1.35 millions, 950 000 are saled by 9 slaughter houses, and 350 000 are directly saled by producers. Processing of the carcass and criteria for disqualification are described by law. Carcasses are identified with a *Bresse* label before being shipped to the retailers. In 1986, a production commission was created, with 8 members representing producers, slaughter houses and professionnal cooks. Sales of *Bresse* poultry take place almost exclusively via small retailers and restaurants, and not via supermarkets.

As far as performance is concerned, the age at slaughter of *Bresse* chickens must be at least 112 days, up to 126 or even 147 days. For comparison, the strains used for LB production are slaughtered between 81 and 110 days of age, whereas standard broilers are slaughtered at around 39 days of age. The minimum live weight at the departure for the slaughter house is 1.5 kg for male *Bresse* chickens, whereas the average value reaches 1.9 kg for SB and 2.25 kg for LB. Higher weights are expected for female and capons, which are raised for a longer time. A minimum carcass weight is fixed by law for *Bresse* chickens: 1.2, 1.8, and 3.0 kg for males, females and capons, respectively. From the view point of economic profitability, slow-growing chickens are not as efficient as standard broilers regarding food conversion and stocking density. These extra-costs have to be accepted by the consumers, who are ready to pay more for a product of higher quality, which fits well the expectation. The reference product for prices is the whole chicken ready to be cooked (*PAC*). In 2002, the average price paid to the *Bresse* producers was 4.0 Euros per *PAC* kg, which provided a gross profit of 2.6 Euros per chicken saled [source: *CIVB*]. On the other hand, in the national wholesale market in Rungis (close to Paris), the average price was equal to 2.7 and 1.6 Euros per *PAC* kg for label and standard chicken, respectively [source: *OFIVAL*].

The successful development of the *AOC* started from conservation of *Bresse* chickens by fancy breeders. The number of white *Bresse* chickens increased and became stable, at a level where the breed is not endangered any more. Initially, the *Bresse* breed had also a black and a grey varieties, which numbers have decreased. Recently, the *CSVB* decided to launch a new programme on each of these varieties, the first sampling of *Bresse Grise* yielded a number of 35 chickens only.

Besides this favorable effect of the AOC on the preservation of the *White Bresse*, it must be noticed that any chicken that would be hatched from *White Bresse* parents, but raised outside the official Bresse region, can not be called a *Bresse* chicken. A new name was chosen: chickens related to the *Bresse* breed but not raised in the Bresse region are now called either Gauloise or *Bresse Gauloise*. This tends to complicate the definition of breeds.

The strict regulations defining the *Bresse AOC* are protecting a production system and a breed in a given region. However, they could limit its extension and adaptability to new constraints. Consequently, the *CSVB* may now use other varieties of the *Bresse* breed, as well as other traditional breeds, to propose to the consumers a larger choice of quality chickens, based upon the revival of old traditional breeds. The set up of genealogical selection based on sampling of chickens from fancy breeders, using strict sanitary conditions, is now a proven method that can be applied to other breeds.

II. THE LOCAL RUMINANT BREEDS FROM THE FRENCH WEST-INDIES AND THEIR ADAPTATION TO HUMID TROPICAL CONDITIONS

Guadeloupe and Martinique are two French overseas departments located in the Caribbean and included in the Ultra Periferic Regions of Europe. Their particularity is to belong to the economical context of EU, but in a hot humid tropical climate, with agricultural systems inherited from historical and sociological background. Since none of the major domestic species (cattle, sheep, goat, poultry, pigs) existed in these islands until their discovery by Europeans, the current local populations are of rather recent origin, after the 16th century. They are representative of the populations of ruminants present in the Caribbean and Latin America [21]. Dealing with ruminants, mainly three local breeds can be cited: *Créole* cattle and *Créole* goat from Guadeloupe, and *Martinik* hair sheep. Table 1 presents some statistics on the structure of the local herds of these species in the two islands. Due to historical reasons, the main small ruminant species are goats in Guadeloupe and sheep in Martinique. The three local breeds represent between 70% and 95% of the breeding females of the different species. In Martinique, the Brahman cattle breed have been introduced during the 20th century and progressively have replaced the local population which may be currently considered as endangered .

Table 1. Statistics on herd structure and local animal populations in the French West Indies (Source: Agricultural Census and personal estimations)

Department	Species	Total No of animals	No of adult females	Part (%) of the local breed	No of herds/flocks	No of females per herd/flock
Guadeloupe	Cattle	65003	25438	70 %	8484	3.0
	Goats	33880	14714	90 %	2957	5.0
Martinique	Sheep	15925	8520	95 %	1828	4.7

Historical, biological and genetic data show that the French West-Indies breeds are fixed admixtures of various breeds introduced during the colonisation period, mainly during the 17th and 18th centuries. In cattle, first introductions of Iberian and French taurine animals were followed by introgression of West African cattle, mainly humped cattle. The characteristic of the *Créole* cattle breed is the original combination of genetic markers specific of either origin [22]. African origins, related to the commercial routes during the period of slavery, is also evident in small ruminants, exemplified by the phenotype of *Martinik* hair sheep [15], or by the genetic markers studied in the *Créole* goat [23]. The combination of the natural selection in a constrained environment, and the common use of the flocks, during four centuries, have shaped up these mixtures into original genetic resources.

Despite some favourable consequences, due to the regularity of the climate and the high level of rainfall permitting high biomass production, the hot humid climate of the West-Indies induices strong direct and indirect constraints to livestock production. The ambient temperature (around 26°C) and humidity (higher than 75 % all around the year) have a direct incidence on thermoregulatory reactions of the animals. In cattle, especially during the hot and humid season, purebred *Créole* animals perform better in controlling their homeothermy than crossbred animals having a sire from a European taurine breed [22]. Indirect influences include first nutritional constraints, as the variation in rainfall leads to a clear seasonal pattern of forage availability. Moreover, the biological characteristics of the tropical forages give them a low nutritional value, particularly due to their rapid ageing. In such conditions, the *Créole* cattle seems to have developed specific adaptation to the use of roughage in a hot climate [4].

Indirect influence can also be observed in the prevalence and impact of parasites, with a high incidence of strongyles particularly on small ruminants, and of ticks and related diseases on all species. Experimental results show to what extent the local breeds are resistant to these diseases. The *Créole* goat was found to be highly resistant against internal parasites [18], the biological basis of which being currently under investigation. The *Créole* cattle was found to be resistant against the tropical bont tick *Amblyomma variegatum* and its related diseases, dermatophilosis and cowdriosis [22].

In these harsh environmental conditions, the productivity of the local breeds appears relatively good. The overall productivity of purebred *Créole* goats is higher than other genotypes referenced in the region. This result is due to the good reproduction and suckling abilities of *Créole* goats: deseasonality, high prolificacy, and low mortality rate [1]. The longevity of *Créole* goat and cattle is also very high: 25 % of the cows wean more than 8 calves, and produce 1550 kg of weaned calves in their life [20]. Postweaning growth of the *Créole* cattle is also high, in comparison to the known results with zebu breeds in the Latin America [22].

A recent interest is also paid to genotype by environment interactions in these local breeds. In particular, an interaction has been found in *Créole* cattle for the liveweight at 15 month, in intensive or pasture management: the genetic correlation between the liveweight measured in both management system is low (0.20) and not significant [22], showing that ambient conditions are to be taken into account in the selection process for the tropical region.

Due to their adaptation and their productivity in the tropical climate, the local ruminant breeds have remained for years the basis of the meat production in the French West-Indies. They are associated to traditional familial farming systems using low technology. They are also used in crossbreeding schemes, according to the objectives and breeding practices of the farmers, in a wide variety of farming systems. In the same time as the increase in the technicity and the specialisation of the breeders, the use of crossbreeding has already affected the structure of the cattle herd of Guadeloupe, with an increasing percent of crossbred animals, and higher rate of imported blood [22]. The same trend appears, to a lower extent in goat, with the use of specialised meat breeds, but with lower reproductive potential. However, in all cases, the local breeds of *Créole* cattle and goat appear a determinant component of the production systems, purebred or crossbred, for the adaptation traits they hold [12, 22]. The studies also have shown a genetic variability in these breeds for the major components of productivity that could be used for selection within these breeds [17, 19, 22]. The case of the Martinik hair sheep is particular, as it is appreciated by the consumers as a quality product, which gives a regional commercial niche to this breed. A selection programme for the *Martinik* sheep is implemented for more than 10 years [15].

III. THE USE OF HIGH ALTITUDE PASTURES BY THE *ABONDANCE* AND *TARENTAISE* CATTLE BREEDS AND THE *AOC* CHEESE PRODUCTION IN THE NORTHERN ALPS

The French Northern Alps are world-wide known for their landscapes and for their large possibilities for tourism and sport during both the summer and winter seasons. Agriculture also plays a role in the economy of this region. Dairy cattle production is the main agricultural activity and the majority of the milk is processed for cheese production. Permanent grassland represents 78% of the agricultural area in the Northern Alps, i.e. about twice the average proportion in France. The main characteristics of the farming system is the complementary use of valley pastures, close to the farms, and of high altitude pastures (1400-2400 m) called *alpages*. As shown on Figure 2, the use of high altitude pastures, during summer, allows to make from the valley pastures large forage reserves for the winter period which is particularly long in this region. In order to benefit from this forage stock when the milk production of the cows is highest, the farmers try to group the calvings during the three or four months after summering.

Figure 1. Calendar management of herds and grazing periods in the Northern Alps.
Locations where animals are kept for a given period are underlined. G = grazing, H = hay harvest.

Location	N	D	J	F	M	A	M	J	Jy	A	S	O
High altitude pastures	Snow on high mountain								G			
Valley pastures							G		H			G
Cowshed	←Main part of calvings→											

From the fivties, due to a decreasing number of people wanting to summer with animals, there was a decrease in the use of high altitudes pastures. This phenomenon led to a reduction in the grazing presure and in the amount of the manure, which had unfavourable ecological consequences [33]: development of lowly appetizing grasses and of brushes, increase of the acidity of the soil and reduction in its richness. The development of brushes had an unfavourable impact on tourism, because the landscape became less and less open and, from place to place, the risk of avalanche increased.

In the same time, the population size of the two local cattle breeds, *Abondance* and *Tarentaise*, decreased dramaticaly [33]: from the early seventies to the early nineties, the reduction in the number of cows was -32% and -58% for *Abondance* and *Tarentaise*, respectively, which was higher than for the whole French dairy cattle population (-25%). In the recent years, the population size has decreased with a smaller rate (*Tarentaise*) or has little increased (*Abondance*). In 2000, there were 57 700 *Abondance* cows and 13 500 *Tarentaise* cows, mainly kept in mountain or high mountain areas [source: Agricultural Census].

Facing these regressive evolutions, from the early eighties, the farmers developed a new dynamics for the mountain agriculture. First of all, the conditions of life and work during summering were improved [31]: construction of tracks for the access to high altitude pastures, restoration of chalets, grazing management on high altitude pastures, and setting up milking machines and cheese processing equipments. This action involved a collective organisation of farmers and was supported by local and regional public policies. Secondly, because the price of the usual dairy products decreased, the farmers developed the production of cheeses under *AOC*, which was supported at the national level by the management of the milk references within the milk quotas system [7]. From 1980 to 2000, the production of the main two *AOC* cheeses from Northern Alps, namely the *Reblochon* and *Beaufort*, was multiplied by 3.4 and 2.2, respectively (source: INAO). Such *AOC* productions, which are under the close control of farmers within small cooperative factories, led to a substantially higher milk price paid to farmers: from +20 to +40% in comparison with the milk for non-*AOC* cheeses in the same region, and from +35 to +60% in comparison with the average price in France [7, 26, 31].

The local *Abondance* and *Tarentaise* breeds play a central role in this new dynamic in the French Northern Alps. These two breeds show some adaptation and functionnal traits of interest for the mountain farming system and the use of high altitude pastures. Table 2 shows the traits which have been assessed by comparisons with other dairy breeds on the basis of experiments or field observations. Some of the adaptation traits are partly due to the small adult weight of the cows (from 450 to 550 kg). The cows of these breeds reproduce well and regularly, which is very valuable because the farming system strongly depends on the calendar of calving (see Figure 1).

Table 2. Adaptation and functionnal traits in the *Abondance* and *Tarentaise* cattle breeds assessed by experiments or field data.
o = moderate, + = rather high, + + = high, x = trait not measured on the breed.

Trait	*Abondance*	*Tarentaise*	Reference
Easily of walking and low impact of long walking on dairy production	x	+ +	[9]
Resistance to heat	+ +	+	[8]
Grazing activity on high altitude pastures under harsh climatic or topographic conditions	+ +	+ +	[2]
Ability to intake and valorize rough dry forages	+ +	+	[14]
Fertility and longevity	+	+	[5]
Resistance to mastitis (based on somatic cell counts) independantly from the milk yield	+ +	o	[29]

Dealing with the production of AOC cheeses, the average milk production is moderate: about 5,000 and 4,000 kg per cow and per lactation, for the *Abondance* and *Tarentaise* breeds, respectively [source: on farm milk recording, 2002]. This milk has favourable properties for cheese processing: (*i*) higher protein over fat ratio (between 0.85 and 0.90) than specialised dairy breeds, (*ii*) intermediate frequency of the B allele of the κ-casein [13], this allele being favourable to both the quickness of milk clotting and the cheese yield, and (*iii*) other good chemical characteristics involved in milk clotting [16].

For all these reasons, at the request of both the farmers and cheesemakers, the use of the local breeds has been included within the rules to produce the *AOC* cheeses from the Northern Alps. Only *Abondance* or *Tarentaise* cows are allowed to produce milk for the *Beaufort AOC*. For the other *AOC* cheeses from this region, only *Abondance*, *Tarentaise* and *Montbéliarde* cows are allowed, this latter breed originating from a middle-mountain area and having a milk composition close to that of the alpine breeds. Due to their ability to use high altitude pastures and due to their typical traits, the local breeds strongly contribute to give a favourable image of the *AOC* cheeses. Conversely, such a link with the production of high quality cheeses is a very good opportunity for the valorisation of these breeds and, as a consequence, is expected to contribute to their preservation or their development.

DISCUSSION AND CONCLUSIONS

The examples presented in this paper show the connections between the natural constraints, the value of the local breeds and their valorisation through both the farming system and quality products. The efficiency of these systems and their dynamics does not depend only on the traits of the breeds but also on the organisation of farmers and producers. Other examples of farming systems involving the adaptation abilities of local breeds and valorising them through products with quality signs, such *AOC* or *Label Rouge*, may be given [e.g. 32, 6]. This requires clear genetic strategies, on farm recording based, putting emphasis in the selection goal on adaptation, functionnal and maternal traits.

In harsh environments, such as tropical or mountain regions, a particular attention should be given to local adaptation. The ability of the local breeds to produce in such conditions, due to their rusticity and their productivity in relation to the environment should be fully evaluated. This is all the more true in ruminants species, for which a large variety of management systems can be observed. More generally, the local breeds may bear a special cultural value as their history follows the history of the human population.

Niche productions are appealing because they may combine dynamic breed conservation and economic profitability at a local scale. When a niche production becomes a success, the production tends to grow, whith a potential risk of decrease in the specificity and/or the quality of the product. The *AOC* system offers a regulatory set up which limits the risk of both standardizing of the product and loosing the breeds' specific abilities [e.g. 3]. However, the *AOC* system is really effective if the producing and processing rules are strict and if they are applied, as examplified by the case of *AOC* cheeses [26, 32]. Yet, the market share for niche production remains limited, and the number of niches may not be indefinitively extensible, so that the marketing may become a critical issue in the success of a new project.

Looking at preservation priotities only through genetic variability based on markers would be reductory. For instance, based on the single basis of molecular information, the breeds of the new world would probably appears as poor contributors to the global diversity, as they combine different genes from their ancestors. Their originality consists in combining, in probably unique genotypes, traits inherited from their different ancestors, and shaped by the environmental and management conditions in which they have been raised.

How to include the economic and/or adaptation value of local breeds in decision tools? On one hand, the various approaches of the diversity provides quantitative information. On the other hand, the adaptative, economic or cultural value of a given breed is mainly of qualitative nature. How to weight both information in order to build a global priority index is not so obvious. One solution would be to separately assess the originality of a given breed from a strictly genetic point of view and its value for the use in special environments, for special quality products, etc. Public policies could provide financial incentives together with a check-list of technical criteria in order to facilitate the launching of niche valorisation programmes for local breeds. The check-list could include molecular data together with performance linked to environmental constraints and/or economical objectives. Such programmes would be expected to reach a stage of self-supported state while emerging projects would still be supported.

In conclusion, it should be outlined that animal genetic resources are not only "gene bags". Local breeds may have considerable value *per se*: adaptation traits, quality of products, traditional use and interest for tourism, etc. Moreover, as a *Vérité de La Palice*, the domestic animal populations are kept by breeders: the motivation of the breeders and their dynamism are also essential for the presevration of any breed. Public policies should play a stimulating role for these breeders and provide them with technical and regulatory supports.

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