Breeds in danger of extintion and biodiversity

A. Blasco

Instituto de Ciencia y Tecnología Animal. Universidad Politécnica de Valencia, P.O. Box 22012. Valencia 46071. Spain
Department of Dairy Science, University of Wisconsin, Madison, USA

ABSTRACT - Some arguments currently used to support breed conservation are examined. The central point is that we cannot conserve all breeds because we do not have financial resources enough to keep everything (mainly in developing countries) and in many cases we do not have special reasons to conserve breeds. A breed is a human product and it should not be confused with specie. A breed can be generated or transformed. We can create synthetic breeds with the best characteristics of several breeds. Selection is not exhausting genetic variability (there are several experiments showing that), and genetic variability within breeds is large. We need reasons to keep breeds in danger in extinction. A breed is a tool, and we can decide to keep it when it is useful because it is specially adapted to some environments (although in this case it should not be in danger of extinction), it can be useful in crossbreeding to shorten the way of obtaining response to selection, or it has some extreme values for traits that may be useful in the future (in this case we have to define clearly which traits and how we expect the future to be). We can add cultural reasons when we have money enough to spend in culture.

Keywords: Biodiversity, Endangered Breeds, Conservation programs

Introduction

Keeping breeds in danger of extinction is one of the classical tasks of animal breeders. There is a general idea about that breeds should be kept in order to conserve the planet genetic biodiversity, to keep genes that can be useful in the future, or for cultural reasons. There would not be a problem of keeping all possible breeds if we had a large amount of facilities that were not competing with other priorities. However to keep a breed which is not clearly and immediately profitable is expensive and takes funds from other activities that are also important, particularly in developing countries, like feeding people at a reasonable cost. We must admit that we cannot afford to maintain all breeds that live in our planet. However, the extinction of many of them is not a great loss. In this paper we will critically examine the arguments for keeping breeds, some of them not related to any scientific or technical consideration but to ideology or to ways of seeing our role in the World.

Main reasons for keeping breeds in danger of extinction

It is common in the literature to find lists of reasons for conserving endangered breeds (see, for example, Ruane, 1999, or Gandini & Oldenbroek, 2007). Without any intention of being exhaustive, here we can find a list of the main reasons usually referred for keeping breeds in danger of extinction. They can be grouped in three different types of arguments, one type is genetic, another type blends productive and ideological reasons and a third type is cultural:

1. Loosing breeds we lose genetic diversity. This argument includes several items:
   a Genetic variability is a good thing that should be preserved
   b Genetic variation between breeds is much higher than within breeds
   c Selection leads to the end of genetic variability
   d We should keep genes that are not useful now but may be useful in the future, and that are kept in unselected breeds.

Breeds that are not useful in intensive industrial systems can be used in local productions in poor areas, using local products for feeding, housing etc. This argument contains also several items:
   a Local breeds are usually better adapted to local environment, mainly when local products are used for feeding, housing, etc.

b Local breeds often produce better quality products

c Intensive industrial systems have several environmental inconveniences that should be avoided (excess of gas or manure, for example).

d Intensive industrial systems produce a poor animal welfare.

e Sustainable systems (excluding sustainable intensive industrial systems) not only are more environmentally friendly or have a better welfare, but also permit an independence of farmers from big multinational companies.

Breeds are part of the heritage of people. This statement has some implicit arguments:

a Some groups of people (nations, tribes, or merely locals having some sense of identity) use to have in the past some special eating habits, live in particular houses, wear some distinctive clothes, etc., and all of this, including some breeds that were peculiar of these people, composes what we consider to be a heritage that should be preserved.

b By maintaining a herd of these peculiar animals, we keep this heritage.

Let us now examine with some detail these arguments. But we have an important preliminary question should be, therefore, what is a breed?

What is a breed?

Is a breed the product of an agreement?

There is no consensus about the definition of what a breed is. Rodero and Herrera (2000) compare the common elements of 16 definitions of breed and the only common requirement to all of them is the genetic homogeneity, which applies essentially to external traits. Hall (2004) also compares several proposals for breed definition and prefers the simplest one, given by Lerner and Donald (1966): "a breed is whatever a government says it is". Woolliams and Toro (2007) also collect some definitions, including Keith Hammond's statement that "a breed is a breed if enough people say

it is". We can say that *a breed is a group of animals with some common external characteristics defined by some people who consider this group of animals to be a breed*. A breed requires some people deciding which the external characteristics of the breed are, and they normally attribute some average performances to the breed (in most cases without any proper evaluation of them). These animals should be kept in closed reproduction (although, as in the case of Frisian cows, this may involve millions of animals in the closed group).

The problem with this definition is that it depends too much on external characteristics that may be very useful for dog breeds but not necessarily for animals which main aim is to produce meat or milk in an efficient way. Moreover, the average performance changes with selection or genetic drift, thus the ideal animal ([1]) of the breed also changes (showing some delay with respect to the real animals). This dependency on external characteristics produces some paradoxes; for example, when recovering an extinct breed by crossing and selecting animals that were somewhat close to this breed, external characteristics are determinant for the success, and other characteristics for which the breed was known (meat quality for example) are not included in the recovering process ([2]).

Is a breed a tool?

This is a central point when examining breed conservation. If a breed is a tool for making meat, milk or eggs, conservation should be focused in whether this tool works well or not, or in whether there are expectations for using this tool in the future. In other areas we do not keep tools that are not going to be useful anymore (with the exception of some museums

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[1] Sometimes there is a representation of the "ideal animal" of a breed. Then farmers would be as giants linked with chains to the walls of a cavern with a fire behind them. The ideal animals would pass behind them projecting their shadows in the wall of the cavern, and the farmers will only see these shadows. The shadows would be the real animas and the ideal animals would live in Plato's world.

[2] If we recover a poultry breed that was well known by its meat quality but we only select the external appearance until we have an animal that looks like the old breed; what do we have, the old breed or a disguised chicken?

of technology, which would be the equivalent to zoos in the case of breeds).

Is a breed a human product?

Breeds have been created by humans first when domestication took place and then by selecting traits they particularly liked (see Hall, 2004 for a full description of breed origins). Breeds have been created for many purposes, and not only for feeding purposes, see for example pets. Some pigs, cattle or lambs are also kept as pleasure animals by some breeders. We still create new breeds nowadays; apart from pets, many companies of pigs, rabbits and poultry use now synthetic breeds without giving any importance to external characteristics with the exception of the functional ones. This is an important point to remember, because the extinction of a breed is completely different from the extinction of a species. Specie extinction by humans has been compared (rather hysterically) with genocide by Frankham et al. (2002). We cannot compare breed extinction with losing unrecoverable species created by natural evolution and forming part of a peculiar ecosystem.

How many breeds do we have?

Difficult question, given the imprecision in what breed definition is. To make a new breed is easy, and defining breeds by external characteristics leads to many breeds that are intermediate types having almost the same genetic background for productive traits that the breeds that originated them. According to the DAD-IS program of FAO, we have more than 13,000 breeds of domestic animals, but this figure should not be taken too seriously because it depends on what each country declares to be a breed, including popular commercial hybrids of pigs and poultry or common breeds that receive a particular name in some countries. The problem is how many of them are in danger of extinction and whether they should be conserved. The reasons for investing in breeds in danger of extinction will be examined below.

Breeds and genetic diversity
Genetic variability should be conserved

Here we should define what do we mean by *genetic variability* and establish why is so important to keep it. If the problem is to keep genetic variability, ¿should we keep breeds or genes? We can imagine several synthetic breeds having the most important genes that we want to keep instead of conserving many breeds in different separate programs. Moreover, if genetic variability is a good thing, we can prepare selection programs to increase genetic variability instead of conserving the breeds as they are. Let us confine the problem to genetic variability of productive traits; since the effective number of a population to keep *all* genetic variability is too high to be realistic (this is why evolution works and populations gain and loose genes). Genetic variability is useful in two ways. First it is needed for selection. Second, genetic variability implies a gene reserve that may also be useful when a rapid change in selection objectives is needed; for example, the critical fertility problem of Holstein can be attacked by crossing Holstein with more fertile breeds (Madalena, 2008; Hansen, 2006).

Is Genetic variation between breeds much higher than within breeds?

As we said before, first we should state which genetic variation we are talking about. It is not the same genetic variability for milk production than for resistance to ticks. Measuring the number of SNPs per kb in chicken, the International Chicken Genome Sequencing Consortium (2004) detected "surprisingly little difference in diversity in comparisons between red jungle fowl and domestic lines, between different domestic lines, and within domestic lines". Comparing frequency of SNPs of red jungle fowl and three domestic lines (broiler, layer and silkie), almost every pairwise combination gave a SNP rate of just over 5 SNPs kb^{-1}. For productive traits it is vaguely admitted that about 50% in genetic variability between breeds and 50% within breeds (Hall, 2004; Bennewitz et al., 2007) but ABRO's multibreed beef cattle experiment, for example, reported that the variation between breeds in food conversion rate was a 25% of the total variation (Thiessen et al., 1984). Therefore, we cannot state as a general law that genetic variation between breeds is much higher than within breeds, but we can still stress that there is useful variation between breeds that deserves to be conserved. We will talk later about reasons for keeping this genetic variability.

Are selection programs exhausting genetic variability?

Classic quantitative genetics theory predicts the extinction of genetic variability by selection. Gene fixation or genes arriving to high frequencies would reduce genetic variability, which would not be compensated by mutation, since favourable mutant alleles are scarce. However, this image of genetic variability extinction does not agree with current data. Prof. W.G. Hill has stressed the fact that there is no loss of genetic variability in any selection commercial program (Hill, 2004). Long term selection experiments in quails (Calsborg et al., 2006, figure 1), and mice (Renneet al., 2003, figure 2), do not show any sign of exhausting genetic variance.
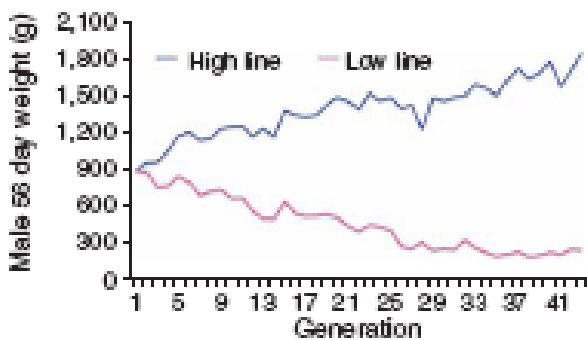

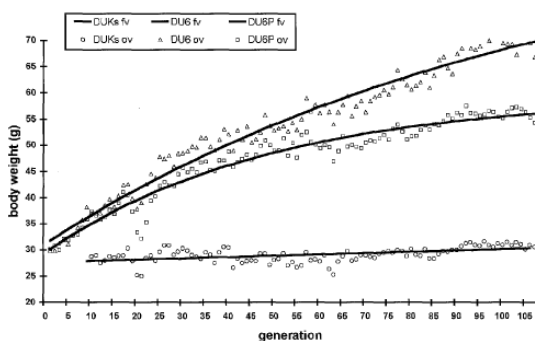Figure 1 - Growth rate of quails divergently selected for body weight. From Calsborg et al., 2006.

Figure 2 – Mice body weight selected for body weight (Δ) or for protein in the carcass(□) at 42 d, and control line (o). From Renne et al.(2003).

Heritability of milk production in dairy cattle is not decreasing with time but augmenting! (see, for example, Dechow & Norman, 2007), and this is not only

due to a better control of environmental variance or methods of correction, as the continuously maintained response to selection shows. The reason for this apparently non limits to selection are selection pressure on genes produced by mutation (which has a heritability of about 0.1%; Hill, 2004), or epistatic interactions, but even if epistatic interactions are important, additive variance typically accounts for over half, and often close to 100%, of the total genetic variance (Hill et al., 2008).

Should we keep genes for the future?

The core of the argument for maintaining between breeds genetic variability is that some breeds have genes that other breeds do not have or have in low frequency, because they may be useful in the future. It is a type of "insurance argument": insurance against changes in market or environmental conditions, and safeguard against potential emerging disasters as diseases (Gandini and Oldenbroek, 2007). There is nothing wrong in keeping everything when having an unlimited amount of financial resources, but if we should organize the spending in some preference order, this is not so clear. Keeping breeds is not different from other human activities. We do not keep everything just for the case that in the future we may need it unless we have a good reason for keeping it or a clear idea about what is going to be its future use. There is a pathology called "Diogenes syndrome", which involves "compulsive hoarding", the collection and failure to discard large numbers of objects even when their storage causes significant troubles to basic living activities. People suffering this disorder keep all they buy, useful or not, for the future, and die with their houses plenty of all kind of no valuable objects (rubbish, I would say) that were kept along their life. If a breed is a tool, old tools that are not useful anymore can be kept in zoos or other kind of "museums", but there is no reason for keeping them in a productive circumstance.

Breeds and sustainable systems

Are sustainable systems efficient?

There are many definitions of sustainable systems. Generally speaking, by sustainable systems we understand farming systems capable of maintaining

their productivity indefinitely without damaging the environment. This definition does not prevent having intensive systems with highly productive animals integrated in an industrial food chain, but for some reason what people normally understand by sustainable system is some kind of traditional farming at small scale in which waste is recycled, local breeds and local sources of food used and a rather high amount of hand labour is needed. Local breeds have a key role in this second type of sustainable systems, particularly when the environmental conditions are harsh or the food resources are not particularly good. This second type of sustainable systems is in general much less efficient for producing meat or animal products than intensive systems. There are, however, some reasons for establishing them:

1. *There are harsh environments in which no other systems will work properly.* A common example here is cattle in swamp tropical areas. This and other specific examples can be used to defend the second type of sustainable systems, but we should remember that this applies essentially to cattle, sheep and goats, and not necessarily to pigs, rabbits or poultry, which have been kept in much better conditions traditionally.

2. *Using these systems in poor areas we avoid land abandoning and migration of people to urban areas.* In other words: to keep some nice land and breeds we need poor people having a hard life. The result of a critical exam of these circumstances depends on ideological premises. Some people can think that urban misery is much worse than rural misery and some sustainable systems can help poor people in having a better life. Other people can think than even in this case, this type of sustainable system should be considered as a temporary solution, because this poor people have the right of having a better life for them and their descents, they would like their children to have the opportunity to go the University, to enjoy

Mozart and to get a culture that will allow them to read Kant (who, by the way, did not write only for Oriental Prussians but for the whole humanity). In this second case, sustainable systems of type 2 (non-intensive ones) would be only a temporary solution for people who deserve a better life. Nevertheless, some people can also think that assuming the University, Mozart and Kant as a better life is an ethnocentric consideration and people from these poor areas, and their descents, have a different life purpose that make then happier. We should even avoid asking them what they prefer, since classical occidental values can be a mirage and can destroy the roots of their civilization; some of the good-will of missioners in Africa and America may be an example of introducing foreign habits in tribes that were happier before the arrival of civilization. Although I am a firm defender of the desirable temporality of the second type of sustainable systems, the discussion here is not technical but ideological, out of the scope of this paper.

3. Sustainable systems (excluding sustainable intensive industrial systems) are more environmentally friendly and produce a better animal welfare. This may or may not happen, and we should examine critically case per case. For example, now that global warming is a main concernment, intensive systems using highly productive breeds produce less CO_2 per kg of meat produced than extensive or non intensive systems, because the maintenance energy per kg of meat is much lower, since these highly productive animals arrive to commercial slaughter weight much earlier[3]. The same can be said about welfare: free range hens are not necessarily happier than hens in enriched cages (WEBSTER, 2005). Looking for better animal welfare is not a particular task of industrial systems; it affects non intensive systems as well.

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[3] We have to add the CO_2 production associated to intensive farming; for example transport of animals or carcasses to larger distances than in other non intensive systems, but this is a small amount *per kg of meat produced* in comparison with the much higher maintenance costs produced by non intensive systems.

4.   Some of these systems provide farmers an independence from big multinational companies. This may be true, but is not necessarily good. Feeding people should be a priority of poor countries, and the cheapest way may be to buy the genes to multinational companies. Genetics is very cheap; the genetic cost of 1kg of pork, chicken or rabbit meat is less than a 1% of the total cost of the meat (see, for example, Baselga & Blasco, 1989, and Blasco, 1995), and the same can be said about the genetics of one litre of milk. On the other side, which are the benefits of the independence from multinational companies? Few companies provide the cheapest animal protein in the world (eggs and chicken meat and, up to a certain extent, pork meat), and genetics of dairy cattle is now managed in a world nucleus. Poor countries need more efficient material for meat production than this pretended independence from multinational companies.

Are local breeds better adapted to local environment?

Nowadays we know that this is not necessarily true. We have spectacular examples of foreign breeds particularly well adapted, as Nelore cattle in Brazil. On the other side, adaptation is a higher problem in some species than in others, as we have said yet. Poultry, pigs and rabbits have been raised in better environments than sheep or goats, thus intensive commercial breeds have less adaptation problems than in other species. Local food sources are of lower quality than the usual food provided to highly productive breeds, and it has been said that local breeds can take a better profit of it. This is highly speculative, since the information we have of these local breeds is normally scarce or null. Table 1 also shows, as Gibson et al. (2006), stressed, that small farms, which have lower quality food, can obtain a similar profit as better farms.

Table 1 - Sow Reproductive Performance of PIC pigs in Phillipines. From Gibson et al. 2006

	Ave total born per litter	Ave born alive per litter	Ave weaned pigs per litter	Ave birth weight kg	Ave 30 day weight kg
Large farm sector	10.7	10.2	9.2	1.4	7.7
Small farm sector	11.9	11.4	11.1	1.5	8.8

Local breeds of cattle, sheep and goats may be better adapted in some harsh environments, although it would be convenient to check whether this is true and when it is true. Whether it makes sense to produce meat in these environments has been discussed in 5.1.

Do local breeds produce better quality products?

The question is too general to give a simple answer. It is rather obvious that an Iberian pig (local breed) produces a much better cured ham than a Large White pig. Production of high quality products is among the main reasons to keep breeds that are less efficient in producing meat or meat products. It is nevertheless convenient to check whether this better quality is detectable by the public. Some products like fresh cheese are difficult to differentiate, mainly when the local breeds only show some external differences from the main breeds used for cheese production. To be produced by a local breed does not guarantee a better product at all, thus its quality should be tested before offering it as "better" uncritically. Finally, as St. Clair Taylor has stressed many times (see, for example Taylor, 1985), comparisons between breeds should be done at the same stage of maturity in order to avoid attributing higher meat quality, for example, to breeds that arrive to the commercial slaughter weight later and consequently at a more mature stage.

Breeds and cultural heritage
Breeds as part of the cultural heritage

Breeds are sometimes considered as a part of cultural heritage, and even an evaluation of their cultural value has been proposed (Gandini and Villa, 2003). Considerations about cultural value of breeds should probably better done by anthropologists than by animal breeders, and funds for keeping rare breeds

should come in this case from the Department of Culture instead of Agriculture. Although the opinion of an animal breeder is likely the opinion of an outsider, we will consider here the consequences of considering breeds as part of the cultural heritage. There is a long discussion about what can be considered as culture ([4]). A close definition to animal breeding is given by Durham (1991), who uses the concept of *meme* proposed by Richard Dawkins (1976). Some groups of people (nations, tribes, or merely locals having some sense of identity) have elementary units of values, beliefs, ideas, that are transmitted to next generation. Memes are under the pressure of evolutionary processes in a similar manner as genes are, but here cultural evolution is a much rapid process. Cultural products that are not appreciated nowadays by their usefulness (for example, Romanic churches) can be appreciated by the action of a meme containing the value of artistic pleasure or the value of reinforcing common identity. For example, Highland cattle are not particularly profitable, but Scottish people like to see them in the landscape of Scotland, or merely they like to know that these cows are still walking in the hills. Gandini & Villa (2003) put the emphasis in the capability of breeds to document the world in which they occurred, but this is just one of the products of cultural memes that can be considered, and their scaling system to evaluate this capability is largely arbitrary.

Why should breeds in danger of extinction be conserved?

Why are there breeds in danger of extinction? A definition of breed in danger of extinction can be "some bizarre animals that are not profitable even in their own environment". Breeds are tools created by humans, some of these tools made sense in some periods of some people history but later they do not make sense any more. This also happened with other agricultural tools that are now kept in agricultural museums. Some other breeds are not profitable now but we have good reasons to think that some genes of them may be profitable in the future. Some other breeds represent the extremes of

genetic variation for some productive traits (the lowest growth rate, the highest backfat, for example) and we think it may be interesting to keep them in order to maintain a high genetic variation between breeds although we do not have any clear idea about how they will be used in the future. Ruane (1999) and Bennewitz et al. (2007) give examples of uniqueness like hyperprolificity in some chinese pig breeds, hipermuscularity in Belgian Blue cattle, resistance to internal parasites in Gulf Coast native sheep, etc. There is nothing wrong with that, apart from spending money that may have alternative ways of being spent. This may be a critical point in developing countries, in which, following Thomas Hobbes sentence, they should *primum vivere, deinde philosophare* (first to live, then to make philosophy). In all these cases we may have reasons to conserve unprofitable breeds, but in many cases the order of preferences for investment can lead these breeds to extinction. Putting it crudely, if wealthy people of developed countries want some unprofitable breeds of developing countries to be kept, who should pay for this?

How much do we loose when a breed is extinct?

Not very much, in many cases. Breeds are easy to create, and many of the existing breeds are intermediate steps between other breeds or just blends of genes that can be found in many other breeds. For example, the pig breed "Manchada de Jabugo" is, according to FAO's DAD-IS program, an "hybrid of Iberico Negro and Iberico Retingo[5], with pigs imported from United Kingdom", it was created in 1920 (thus, it is not of "cultural value") and it is in danger of extinction; why should we keep this nice experiment made by some farmers in the 20s? The rabbit breed "Gigante español" (Spanish giant) was created by a farmer of Valencia in 1914 by blending Flemish Giants with local common rabbits, it was a popular breed from the 40s to 60s and it almost disappeared when industrial rabbit production arrived. Apart from its name, promoter of patriotic feelings, should we invest in keeping this experiment? Rabbit Flemish giants are bigger, and modern terminal sires are also giant breeds with better characteristics,

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[4] Definition of culture is completely out of the scope of this paper. The interested reader can consult the many textbooks on anthropology that are available. A good book containing a detailed discussion about this topic is Harris (1998).

[5] They really mean "Retinto"

thus which are the reasons for keeping them, apart from curiosity or other minor feelings?

Several scientists have listed several reasons for keeping endangered breeds (for example, Ruane, 1999 or Gandini & Oldenbroek, 2007). We have also considered some reasons for keeping breeds in danger of extinction in 6.2. There are some attempts in evaluating objectively the benefits of conserving breeds. Simianer (2002) proposes utility functions based in the current available information about valuable characteristics of breeds. Roosen et al., 2005 list some of the "diversity values" that can be considered (Table 2) and propose to develop farm simulation models and other approaches to better assessing values in order to improve decision making with genetic resources.

Table 2 - Biodiversity values proposed by Roosen et al. (2005).

Value	Description/origin	Main characteristics
Values under certainty		
Use values		
Active-use values	Production	Static
	Consumption	Ex post
	Amenity	
Passive-use values	Amenity	Static
		Ex post
Non-use values	Existence value	Sympathy towards animal
	Bequest value	Intergenerational altruism
Diversity values	Variety in space	Maintain variability
	Variety in production and consumption	Preference for diversity
Values under uncertainty		
Option value	Option to use alternative traits and to develop new ones in the future	Static
		Risk aversion
		Soft uncertainty
Quasi-option value	Preference for flexibility	Ex ante
	Hysteresis, learning about breed values	Dynamic
		Risk-neutrality
		Hard uncertainty (irreversibility)

However, a main problem is that for most endangered breeds we do not have any information, or the information is so scarce that it is of little use; for example, Ethiopia lists 34 breeds of cattle in the program DAD-IS, but for most of them we only know their name and number of horns. Current information is so vague that it is difficult to take sensible decisions in a global context. An obvious need is to collect information before we decide to invest in a long term conservation program.

John Ruane, a well known animal scientist, proposes to conserve as many breeds as possible (Ruane, 1999). I disagree with his opinion. Even having a large amount of financial resources, I think it would not be sensible to keep everything, for the reasons detailed in 4.4, 6.1 and 6.2. I think we are faced to what

Simmianier (2002) called "Noah's dilemma", which breeds to take aboard the arch?, and the answer is not simple, because we have other strong needs to be covered and we have little information about the characteristics of the candidates to be in the arch.

Conclusion

A breed is a human product that was created to serve as a tool for feeding, labour or other reasons. If this tool is still useful it should not be in danger of extinction. However, some of these tools, not useful now but with possible uses in the future, may disappear unless some investment is made for their conservation. Cultural arguments can also be claimed for these conservation programs. In all cases there should be some reason for conserving a breed, and this reason should not be a vague statement like "we never know what the future needs can be", since we do not use these type of reasons for other human activities. Funds are not infinite, and a decision about how to invest public funds can move breed conservation to a lower order of priority when competes with feeding people, mainly in developing countries. Many breeds have been created rather recently by blending genes of previously existing breeds, and new breeds are continuously created nowadays by using the same procedures, thus we have to select what we want to save from this fluent continuous process. Keeping breeds with extreme characteristics, with clearly established cultural values, with a definite possible use for the near future, may be some of the decision rules to employ, but if we have to derive funds from feeding people to breed conservation, we have always to have a good reason.

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