Ruminant Genetic Resources and their Resistance/Tolerance to Parasitic Diseases

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Introduction

Parasitic diseases like gastrointestinal (GI) nematodes and trypanosomiasis are worldwide an important cause of reduced production efficiency in ruminants, and partly even limiting livestock production in some regions of the world. GI nematodes are among the most important infections faced by livestock, especially affecting poor keepers (Perry *et al.*, 2002). A potential alternative to alleviate the problems is breeding for disease resistance. It has been well established that the ability of animals to acquire immunity and express resistance against diseases varies substantially among and within breeds and is at least partly under genetic control (Miller *et al.*, 1998; Amarante *et al.*, 2004). Beside the scientific evidence, there is much anecdotal evidence pointing to the greater disease resistance of different breeds. For example, when countries enter details of their livestock breeds in FAO's DAD-IS system, they have the opportunity to indicate whether the breeds have any particularly interesting trait like disease resistance. Currently, four goat and 13 sheep breeds were reported to DAD-IS as having resistance or tolerance to a certain degree against parasitic diseases in general or against specific parasites. Even if these claims are not based on scientific investigations they can be correct. The long evolutionary history for example of nematodes and their ancestors has produced a rich and complex series of coadaptations by host and parasite (Stear *et al.*, 2009). The fundamental theorem of natural selection suggests that evolution will fix genes that improve fitness (Fisher, 1930). Therefore, genes or alleles which are related to parasite resistance should mainly be found in breeds which originate from regions with high parasite burden because of high natural selection pressure. In this context, breeding of such native breeds, which until recently was neglected because these animals were considered to be poorly productive, is receiving increasing attention. However, the genetic component of resistance or tolerance against diseases is still not estimated for most of these local breeds. Therefore, more information is needed which underlines the necessity of conserving these animal genetic resources.

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At the first International Technical Conference on Animal Genetic Resources for Food and Agriculture held in September 2007 in Interlaken, Switzerland, the international community decided to make strategic choices on the future management of animal genetic resources, to develop and conserve them, and to raise awareness and appreciation of the various stakeholders and policy makers vis-à-vis the importance of such genetic resources. Along with this came an increasing interest in describing local breeds on different levels. One of the most promising trait complex of local breeds is the expected genetically based disease resistance or tolerance. The aim of this paper is to raise and partly answer the following questions:

1. Is there a need to look for genetically based disease resistance/tolerance of certain breeds in different parts of the world?
2. What are the breeds and what are the diseases we should look for?
3. How could classical and/or new technologies realistically be applied to identify the tolerant or resistant breeds?
4. What are the perspectives for the sustainable use and development of such breeds in different parts of the world?

Is there a need to look for genetically based disease resistance/tolerance?

Local breeds represent the vast majority of breeds in different parts of the world. This is explained, partly, by their resistance/tolerance/adaptation attributes. Information gathered in the last 10–15 years has yielded ample evidence that many importations of exotic breeds into Africa and Asia have not worked as it was expected. We need to know the best breeds to use in different places, and have strategies for conserving and exploiting such breeds. This is of particular interest when the disease is imperfectly controlled by the current available methods: no efficient vaccine available, appearance of resistance of the pathogen agents to drugs, residues present in the environment and/or in the milk and the meat, interest in decreasing the inputs, especially important for low-input systems. This is the case for some parasitic diseases (trypanosomosis, nematodes, tick and tick-born diseases).

What are the breeds and what are the diseases we should look for?

The question, however, of which breeds we should look for, is very difficult to answer because of the lack of information on the breeds, the number of breeds involved and the logistics to access and evaluate the large number of breeds. One can start with those reported in DAD-IS (or other databases), or in the various FAO survey documents, as having resistance or tolerance against parasitic diseases. In many cases, candidate breeds are identified by the fact that they live (or survive) and produce in endemic tropical environments without any modern health interventions (e.g., drugs or vaccines). However, initially, we should be most interested in breeds that are resistant or tolerant to those diseases that are difficult or expensive to control by drugs or vaccines (or these do not exist yet) and thus will have the biggest impact on flock productivity. Most important diseases will be endemic, and in a developing country context these include GI nematode parasites, ticks (and TBD), the various forms of theileria and trypanosomosis.

How could classical and/or new technologies realistically be applied to identify the tolerant or resistant breeds in different parts of the world?

The phenotypic characterization of local [candidate] breeds and, ideally, their comparison with other susceptible breeds present in the same region, will allow the identification of tolerant or resistant ones. Recording of phenotypes will include not only qualitative and quantitative descriptive measures but also production and reproduction traits, as well as disease incidence and other related traits. By also recording pedigree in each population, it would be possible to initiate a selection programme for disease resistance and improved performance using classical quantitative genetics. Introducing molecular based information in such breeding programme requires higher capacities (expertise and infrastructure) if it is to be sustainable. This would be difficult in most developing countries.

What are the perspectives for the sustainable use and development of such breeds in different parts of the world?

In many developing countries, the prospects for the sustainable use and development of local breeds are probably quite bleak. Only where there is sustainable infrastructure and governance, can proper progress be made. The main problems are linked to the absence of breeders' organisation and institutional framework. The agricultural ministries must provide incentives for local breeds' development and marketing, and must support the establishment of suitable breeding programs and the creation of breeders' associations. Breeds' improvement will be based on classical "quantitative genetics approach", with the need to estimate breeding values, through phenotypes assessment, selection criteria, and pedigree record. However, there is urgent need for smallholder farmers in the tropical developing world to be made more aware of the value of their local indigenous livestock even though they may not be the biggest or most good looking livestock.

Conclusion

There is an urgent need to look for genetically based disease resistance/tolerance of certain breeds in different parts of the world. This trait complex is probably one of the reasons why we still have 'local' breeds in different parts of the world.

1. Disease resistance will be of special interest where normal control strategies do not work for different reasons, and it has an impact on flock productivity. Especially, some parasitic diseases meet these criteria.
2. Most important diseases will be of endemic nature. In a developing country context these are gastrointestinal (GI) nematode parasites, ticks (& TBD), the various forms of theileria and trypanosomosis.
3. First priority is to look for breeds which are located in regions affected by the diseases mentioned at points (2) and (3). Interesting candidate breeds are named in some FAO survey documents and various publications.

4. The identification of the breeds is based on phenotype recording under field conditions, and ideally on the comparison with other susceptible breeds present in the same region. Classical technologies are being used successfully.
5. For a nematode parasite perspective, very useful traits are available to identify resistant or tolerant breeds. However, more work to develop simple tools should be given emphasis.
6. Phenotyping requires an investment to: i) build up infrastructure, ii) educate people to do it, iii) buy equipment and labs, iv) monitor the animals, v) follow variables linked to the disease diagnosis, vi) measure phenotypes, vii) analyse the data and viii) assess covariables interfering with phenotypes.
7. Breed development can be based on classical "quantitative genetics approach", with the need to estimate breeding values, through phenotypes assessment, selection criteria and pedigree recording.
8. The perspectives for the sustainable use and development of disease resistant breeds in many developing countries are at the moment unpromising. The main problems are linked to the absence of infrastructure and financial support.
9. Governments must get involved in breed development and must support the establishment of farmers' and breeds' associations.
10. Funds are needed to undertake proper breed descriptions and breed comparison experiments. Results can not simply be transferred because of expected genotype-environment interactions.
11. Most of the resistant breeds are located in the developing world. The identification tools are however mostly in the developed world. So technology transfer and collaboration are needed.
12. There is good scope to identify more indigenous breeds in the tropics that are resistant or tolerant to parasites.
13. It can be expected that some of these breeds have a lot to offer to production in the developed and developing worlds. Their economic advantages need to be well documented and promoted. Smallholder farmers in the tropical developing world must become more aware of the value of their indigenous/local livestock.
14. Guidelines are needed to support further work in the field of disease resistance.
15. It can be expected that the resistance/tolerance of animals to diseases have a high impact on the maintenance of animal genetic resources worldwide.

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