

Section G

Research priorities

In this section, priorities for research and development are identified based on the expert analysis of the state of the art in AnGR management. The priorities have been identified in order to fill gaps in knowledge and provide the tools required to develop and implement management programmes more effectively, efficiently and sustainably. The rationale for the research and development priorities has been set out in the earlier sections, and only the briefest description is presented here.

1 Information for effective utilization and conservation

A major obstacle to decision-making in utilization and conservation of AnGR is the shortage of information on key traits and performance of local or indigenous AnGR, and the lack of reliable data on population size and structure. The following research tasks have to be completed so that researchers, policy-makers, decision-makers and advisors to farming communities have the information they require to make appropriate recommendations and take appropriate decisions for the conservation and utilization of AnGR.

- Improved methods and greater use of phenotypic characterization: is required in order to assign livestock populations to the appropriate breeds, and to overcome a lack of information regarding key adaptation traits of indigenous AnGR.
- Production environment descriptors: need to be refined and implemented in existing AnGR information systems to indicate the

environment to which particular breeds are suited, and as a proxy for adaptation traits.

- Improved methods of risk definition and monitoring: methods for estimating probability of extinction are poorly developed and need substantial further research. Improved monitoring methods have to be linked to regular entry of data on population size and structure into information systems to ensure that they remain up to date and relevant.

2 Information systems

Existing information systems have relatively little functionality beyond simple searches by country or breed. The functionality needs to be extended to provide stakeholders with the information they require in a more aggregated and user friendly way.

- Regular updating and correction of existing data, and completion of missing data: should be facilitated by system routines.
- Information system functionality: needs to be improved and expanded to allow extraction and customized analysis of phenotype and molecular genetic data within and between data sources. To supply such functionality will require development of improved methods of analyzing and interpreting diverse forms of genetic diversity data (molecular and phenotype).
- Georeferencing of AnGR information systems: to allow access to multilayered geophysical information linked to

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attributes of AnGR (specific adaptation), and to provide precise information about current and past geographic location and distribution of AnGR.

- Interconnectivity and interoperability between information resources/databases: options and modalities need to be further developed.

3 Molecular methods

Opportunities for utilizing molecular techniques in the management of AnGR are going to increase in the near future. However, the costs and benefits of applying these technologies, and, hence, appropriate strategies for their utilization, will vary depending on local conditions.

- Improved understanding of genetic diversity in the main livestock species: comprehensive assessments of genetic diversity using molecular genetic markers are required. This needs to be achieved in ways that maximize the value of the large amount of data which exist at present but are in fragmented form. Improved sampling methods will be needed, along with the development and supply of international reference samples. Results need to be entered into publicly accessible information systems.
- Worldwide identification of variants in genes for key traits.
- Enhanced understanding of the genetic basis of adaptive traits: explore the potential of new and emerging technologies to reveal the genetic basis of disease resistance, adaptation to difficult environments and production efficiency. Such understanding may provide new routes for conventional and transformative genetic improvement.
- Development of methods for the integration of molecular information into conservation and breeding programmes: methods have to be adapted to different environmental, agricultural and socio-economic circumstances.

4 Characterization

The increasing importance given to animal welfare, distinctive product qualities, human health concerns, improving the efficiency of resource utilization, and reducing environmental impact will require a wider range of selection criteria in future breeding programmes. To date, little is known about the genetic aspects of adaptation.

- Development and application of methods for molecular and phenotypic characterization and for the capture of knowledge associated with the breed and its management. Additionally, methods to assess the extent of genetic dilution of a breed need to be well developed. Linking the outcome of such research to regular inventories will inform decision-making about risk status and measures to be taken to halt the decline of genetic diversity.
- Understanding robustness: the value of different breeds with respect to robustness, as measured by reduction in genotype–environment interactions, needs to be determined; genes that explain variation in robustness and factors contributing to homeostatic imbalance under a given husbandry system or management practice need to be defined.
- Improved understanding of disease resistance: infection mechanisms and host–pathogen interactions need to be studied.

5 Genetic improvement methods

There is little information on how to adapt breeding strategies to low external input environments with little or no organizational infrastructure. In this regard, selection for functional traits such as robustness, disease resistance, behavioural traits, and efficiency of feed utilization are particularly relevant. Guidance is also needed for the initial decision as to whether to implement genetic improvement programmes.

- Detailed guidelines for the design of genetic improvement programmes in low external input systems: need to be developed and validated. These should include the development of breeding and production objectives in relation to national goals and policies and the role of adaptive traits.
- Development of stable cross-breeding systems with a role for native breeds.
- Simulation tools to predict the consequences of introducing exotic breeds into local populations should be developed (part of genetic impact assessment).
- Selection for disease resistance, where determining genes have been identified: strategies of how to implement DNA-based selection without compromising production traits should be developed.
- Selection for welfare traits: a clear definition of welfare traits is needed for each species; methods for the measurement of stress and psychological status (aggression, discomfort and frustration) need to be improved; and selection methods for more appropriate temperament, reduction of foot and leg problems, and incidence of cardio-vascular problems (in poultry raised for meat) need to be developed.
- Selection for increased efficiency of feed utilization: better knowledge of nutrient (e.g. amino acid) requirements under different conditions and genetic variation in digestion of specific amino acids and phosphorus is needed.

6 Conservation methods

There is little experience in establishing conservation programmes that will be sustainable in less developed countries, or in how to operate conservation programmes that operate across a number of countries, or regionally rather than nationally. Research is required better to

understand the socio-economic, infrastructural, technical and policy constraints to the establishment and sustaining of conservation programmes.

- *In situ in vivo* conservation methods: research and development is required to understand how to implement *in situ in vivo* conservation in ways that are sustainable, maximize livestock keepers' livelihoods and support development objectives.
- *Ex situ in vivo* conservation methods: there is a need to identify approaches to *ex situ in vivo* conservation in the developing world that are closer to being self-sustaining, and thereby less vulnerable to collapse than are approaches that are heavily dependent on state support.
- Sampling and storage for genetic material for backup systems related to breeding programmes: methods are required to optimize ongoing sampling and storage in systems where the primary objective is to provide a backup to ongoing genetic improvement programmes.
- Cryoconservation and reproduction techniques: improved effectiveness and expanded access to cryopreservation and reproductive techniques for gametes and embryos are required in species for which the technologies already exist. The technologies also need to be extended to other species. Cheap and effective somatic cloning would substantially improve the safety and cost-effectiveness of *in vitro* conservation.
- Policy, legislative and zoosanitary frameworks for *in vitro* conservation: research and development is required to identify the policy, legislative and zoosanitary frameworks that will permit storage and promote access to AnGR held in national and multinational genebanks.

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7 Decision-support tools for conservation

Tools to analyse complex data and optimize resource use, and to design programmes that assist researchers, policy makers and advisors better to understand the consequences of decisions, as well as to optimize such decisions are required. As conservation will often involve utilization and improvement of the genetic resources, such decision-aids need to include aids to the design and operation of breeding programmes. The following are the key areas for research and development:

- Methods for resource optimization: research is required into how to combine information of varying degrees of uncertainty to optimize the choice of AnGR for conservation, and the allocation of resources for conservation.
- Optimization tools: user friendly tools for optimization of resource allocation in conservation need to be developed, and these tools need to be included within the next generation of information systems.
- Early warning and response mechanisms: with defined triggers and actions need to be developed for use at country level.

8 Economic analysis

In relation to individual conservation and utilization decisions, improved methods that can be used in a wide range of situations to accurately value individual AnGR and the various characteristics of AnGR which might be conserved or improved are required. It is important to continue to field-test promising valuation methods, and to systematically apply proven ones to different traits, breeds and species across diverse production systems. In addition, it will be necessary to facilitate application of the methodologies and results at regional and national levels, thereby providing opportunities for influencing policy decisions related to

conservation and sustainable use. A detailed costing of conservation alternatives across a wide spectrum of situations is needed to assist countries and other agencies to make decisions on cost-effective conservation programmes. Analytical methods are required to define the global benefits of AnGR conservation. This will require:

- Identifying uses and farmers' trait preferences for local breeds under different production systems: this analysis should include a systems evolution perspective as well as the forces influencing such factors and the use of alternative breeds. This will necessarily include measuring breed performance parameters, in addition to characterizing actual and potential breeding systems.
- Carrying out market analysis for livestock breeds and their products, and cost-benefit analysis of breeding programmes: this will guide decision-making whether to embark on structured breeding programmes with local breeds.
- Carrying out *ex ante* analyses of the effects on livelihoods of using alternative breeds: this will support pro-poor targeting of interventions, together with constraints to adoption, and potential access/dissemination mechanisms.
- Estimation of the costs of alternative conservation strategies: choice of the appropriate balance of conservation strategies will depend on the costs of alternative approaches. The costs of a given conservation approach will vary markedly between countries and regions, depending not just on local costs for various inputs, but also on the levels of existing infrastructure and accessible expertise.
- Developing and applying decision-support tools for prioritization of breeds: these tools should identify best options for cost-efficient diversity-maximizing conservation programmes.

9 Access and benefit-sharing

Access and benefit sharing in the field of the exchange and use of AnGR is a matter of increasing international debate, the outcomes of which will have a large impact on the willingness of various states, agencies, institutions and companies to invest in the conservation and further development of AnGR. It is necessary to ensure that the anticipated international debates on the subject are well informed, and that effective decisions can be taken. Detailed analyses are required to improve understanding of the relationship between access and trade in livestock germplasm, and research and development, along with an assessment of the costs and benefits arising from such research. The need for, and the potential impacts of, frameworks for access and benefit sharing of conserved AnGR need to be assessed. Better information on the costs and benefits of past movements of AnGR would provide a valuable background to such analysis. This requires:

- Assessment of how to improve public and community use of biodiversity (e.g. improved community-based management of AnGR), including through the enhancement of existing benefit-sharing at local level.
- Improved understanding of the significance of national regulatory interventions (i.e. macroeconomic interventions, regulatory and pricing policy, investment policy, institutional policy and animal disease control protocols).
- Ensuring current and future benefits from global flows of livestock germplasm: design of mechanisms at national and international levels to protect and enhance existing forms of benefit-sharing, and assessment of needs in relation to future scenarios which might affect or change flows and the share of benefits.
- Exploring the legal and technical framework for the setting up of a genebank of AnGR, including wild relatives, to be used for research purposes.