Options and Strategies for the Conservation of Farm Animal Genetic Resources

Report of an International Workshop

AGROPOLIS, Montpellier, France
7–10 November 2005

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The **System-wide Genetic Resources Programme** (SGRP) is a partnership programme of the 15 centres of the Consultative Group on International Agricultural Research (CGIAR). The International Plant Genetic Resources Institute (IPGRI), one of the CGIAR centres, is the Convening Centre for SGRP and hosts its coordinating Secretariat.

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Announcement
With effect from 1 December 2006, IPGRI will change its name to "Bioversity International". The name echoes the institute's new strategy, which focuses on improving people's lives through biodiversity research.

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Introduction

Farm animals play a crucial part in the livelihood systems and well-being of the poor in the developing world, and thereby in helping to meet the Millennium Development Goals. In addition to food, clothing and other goods, livestock are important for income generation, wealth accumulation, traction and nutrient cycling. Of particular significance is the contribution they make to the livelihoods and well-being of smallholders in marginal environments, especially women and children.

The diversity of cattle, sheep, goat, pig, poultry and breeds of other farm animal species represents an irreplaceable source of traits for livestock development in response to changing environmental and human needs. However, these genetic resources are being eroded as a result of changing agricultural practices and economic, environmental and other factors. Of particular concern are the high rates of loss of indigenous breeds in developing countries, which, coupled with inadequate programmes for the use and management of the genetic resources, is negatively impacting on livelihood options for the poor.

The need to reduce the degradation of farm animal genetic resources and establish programmes for their conservation and sustainable use is well recognized. It is embodied in the objectives of the Convention on Biological Diversity and in the development of the Global Strategy for the Management of Farm Animal Genetic Resources, led by the Food and Agriculture Organization of the United Nations (FAO). Noting the need for a greater understanding of the status of farm animal genetic resources and the measures necessary for their conservation and sustainable use worldwide, in 1999 the FAO Commission on Genetic Resources for Food and Agriculture initiated a country-driven process to develop the first Report on the State of the World's Animal Genetic Resources. The Report will be finalized at the First International Technical Conference on Animal Genetic Resources in September 2007, hosted by the Government of Switzerland.

With the aim of assisting the international community in developing a global framework for the conservation of farm animal genetic resources and identifying priorities for action, the System-wide Genetic Resources Programme (SGRP) of the Consultative Group on International Agricultural Research (CGIAR), in association with FAO, AGROPOLIS, France, and the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Germany, convened an international workshop on Options and Strategies for the Conservation of Farm Animal Genetic Resources in November 2005, hosted by AGROPOLIS in Montpellier, France. The workshop brought together 63 experts from 28 countries and from the CGIAR centres, FAO, the French scientific community, including the Institut national de la recherche agronomique (INRA) and the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), and GTZ.

The workshop findings are presented in this report.

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This workshop was convened by the System-wide Genetic Resources Programme (SGRP) of the Consultative Group on International Agricultural Research (CGIAR), in association with the Food and Agriculture Organization of the United Nations (FAO), AGROPOLIS, France, and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Germany. SGRP is a partnership programme of the CGIAR centres, coordinated by the International Plant Genetic Resources Institute (IPGRI) and involving the International Livestock Research Institute (ILRI) and the International Center for Agricultural Research in the Dry Areas (ICARDA). The workshop was sponsored by the Ministry of Foreign Affairs of France, together with FAO, GTZ and IPGRI/SGRP.

SGRP acknowledges with thanks the generous support of the French Ministry of Foreign Affairs, GTZ, FAO and, through FAO, the Australian government. It records its appreciation of the efforts of the workshop steering and writing groups, and especially those of the facilitators in ensuring the high quality of the discussion and output. Special thanks go to the participants for their substantive contributions and in particular to the presenters of the papers.

Partners in this publication

SGRP: The CGIAR System-wide Genetic Resources Programme (SGRP) joins the genetic resources programmes and activities of the centres of the Consultative Group on International Agricultural Research (CGIAR) in a partnership whose goal is to maximize collaboration, particularly in five thematic areas. The thematic areas—policy, public awareness and representation, information, knowledge and technology, and capacity-building—relate to issues or fields of work that are critical to the success of genetic resources efforts. The SGRP contributes to the global effort to conserve agricultural, forestry and aquatic genetic resources and promotes their use in ways that are consistent with the Convention on Biological Diversity. The steering committee includes representatives from the centres and the Food and Agriculture Organization of the United Nations (FAO). The International Plant Genetic Resources Institute (IPGRI) is the Convening Centre for SGRP and hosts its coordinating Secretariat.

FAO: The Food and Agriculture Organization of the United Nations (FAO) leads international efforts to defeat hunger. Serving both developed and developing countries, FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information. FAO helps developing countries and countries in transition modernize and improve agriculture, forestry and fisheries practices and ensure good nutrition for all. It is composed of eight departments: Administration and Finance; Agriculture, Biosecurity, Nutrition and Consumer Protection; Economic and Social; Fisheries; Forestry; General Affairs and Information; Sustainable Development; and Technical

Cooperation. FAO employs more than 3700 staff members and maintains five regional offices, five subregional offices, five liaison offices and 78 country offices, in addition to its headquarters in Rome. Since its founding in 1945, FAO has focused special attention on developing rural areas, home to 70 percent of the world's poor and hungry people. FAO's activities comprise four main areas: putting information within reach; sharing policy expertise; providing a meeting place for nations; bringing knowledge to the field.

AGROPOLIS: AGROPOLIS associates research and higher education institutions located in Montpellier and the 'Languedoc-Roussillon' region, in partnership with territorial authorities and private companies, in close cooperation with international institutions. This scientific community has one major objective: the economic and social development of Mediterranean and tropical countries. The role of AGROPOLIS is that of an international agricultural university. It represents a significant potential in terms of scientific and technological expertise: 2000 research scientists and lecturers in more than 200 labs, with the unique peculiarity of having 500 of its scientists outposted in 60 countries. AGROPOLIS research themes relate to: Mediterranean and tropical agriculture; biotechnology and food technology; biodiversity, natural resources and ecosystems; water, environment and sustainable development; rural development and societies; genomics and plant and animal integrative biology; food and health; and food quality and safety.

GTZ: The Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH is an international cooperation enterprise for sustainable development with worldwide operations. It provides viable, forward-looking solutions for political, economic, ecological and social development in a globalized world. GTZ promotes complex reforms and change processes, often working under difficult conditions. Its corporate objective is to improve people's living conditions on a sustainable basis. GTZ is a federal enterprise. Its major client is the German Federal Ministry for Economic Cooperation and Development (BMZ). The company also operates on behalf of other German ministries, partner-country governments and international clients. GTZ works on a public-benefit basis. GTZ employs some 9500 staff in more than 130 countries.

ICARDA: Established in 1977, the International Center for Agricultural Research in the Dry Areas (ICARDA) is one of 15 centers supported by the CGIAR. ICARDA's mission is to improve the welfare of poor people through research and training in dry areas of the developing world, by increasing the production, productivity and nutritional quality of food, while preserving and enhancing the natural resource base. ICARDA serves the entire developing world for the improvement of lentil, barley and faba bean; all dry-area developing countries for the improvement of on-farm water-use efficiency, rangeland and small-ruminant production; and the Central and West Asia and North Africa (CWANA) region for the improvement of bread and durum wheats, chickpea, pasture and forage legumes and farming systems. ICARDA's research provides global benefits of poverty alleviation through productivity improvements integrated with sustainable natural-resource management practices. ICARDA meets this challenge through research, training

and dissemination of information in partnership with the national, regional and international agricultural research and development systems.

ILRI: The International Livestock Research Institute (ILRI) works at the crossroads of livestock and poverty, bringing high-quality science and capacity-building to bear on poverty reduction and sustainable development for poor livestock keepers and their communities. ILRI works in partnership with many other organizations in livestock research, training and information in all tropical developing regions of Africa, Asia and Latin America and the Caribbean. ILRI's strategy focuses on three livestock-mediated pathways out of poverty: (1) securing the assets of the poor; (2) improving the productivity of their livestock systems; and (3) improving their market opportunities in the face of rapidly changing market channels and demands. ILRI is one of 15 centres supported by the CGIAR, which conduct food and environmental research to help alleviate poverty, hunger and environmental degradation.

IPGRI: The International Plant Genetic Resources Institute (IPGRI) is an independent international scientific organization that seeks to improve the well-being of present and future generations of people by enhancing conservation and the deployment of agricultural biodiversity on farms and in forests. It is one of 15 centres supported by the CGIAR, an association of public and private members who support efforts to mobilize cutting-edge science to reduce hunger and poverty, improve human nutrition and health and protect the environment. IPGRI has its headquarters at Maccarese, near Rome, Italy, with offices in more than 20 other countries worldwide. The Institute operates through four programmes: Diversity for Livelihoods, Understanding and Managing Biodiversity, Global Partnerships, and Commodities for Livelihoods.

Executive summary

Sixty-three experts from 28 countries and eight international organizations met for four days in Montpellier, France, in November 2005 to review the options and strategies for the conservation of farm animal genetic resources (FAnGR)[1] and to identify priorities for action. The workshop focused primarily on the technical needs and opportunities and placed less emphasis on policy and institutional issues, although findings on such issues did arise naturally from many of the conclusions drawn. The workshop resulted in 11 major findings and 13 priorities for action. The workshop also identified four broad areas where information and knowledge were lacking. The findings and priorities for action are listed here in the executive summary and each is explained in more detail in the body of this report. They are presented in the order developed by the workshop. Participants did not attempt to rank the findings and actions.

Findings

Finding 1: Threats to FAnGR in the developing world have increased in recent years, causing an urgent need for action to limit the loss of diversity.

Finding 2: *In situ* (community-based management and conservation) approaches are to be preferred as a method of conservation where maintenance and management of the FAnGR is the best available livelihood option for the farmers involved. *In situ* conservation should be established as a preventive measure to protect against loss of the FAnGR.

Finding 3: *Ex situ in vivo* conservation in institutional or communally owned herds or flocks can successfully be used to support conservation of FAnGR that have current value.

Finding 4: Virtually all examples of *ex situ in vivo* conservation of FAnGR in the developing world are designed to support current use by farmers (or expected use in the near future) or are populations being maintained for research purposes. The establishment of non-use *in vivo* conservation programmes will be difficult and perhaps rare.

[1] Throughout this report FAnGR (farm animal genetic resources) is understood to encompass animal genetic resources that are or have been maintained to contribute to food and agricultural production and productivity. This includes livestock kept by pastoralists. Fish and other aquaculture and fisheries species and wild relatives of livestock are not included.

Finding 5: The majority of sustainable *in vivo* (*in situ* and *ex situ*) approaches to conservation in the developing world will be intimately linked to promotion of livelihoods.

Finding 6: *In vitro* conservation is urgently required to provide a secure back-up for the FAnGR of the developing world. This is to protect against a variety of threats that can drive FAnGR to extinction faster than monitoring can identify the threat and faster than alternative conservation approaches can respond to.

Finding 7: The various methods of conservation are complementary, with dynamic interactions among methods. A detailed analysis is required for each FAnGR, leading to a coherent strategy for conservation that will include an appropriate combination of *in situ* and/or *ex situ in vivo* and/or *in vitro* conservation methods.

Finding 8: A framework was identified that can guide decision-making at national, regional and international levels on a suitable combination of conservation strategies for a given FAnGR. The framework is based on the severity and speed of the threats the FAnGR is exposed to, the nature of the value of the FAnGR and the capacity for action.

Finding 9: There is a need to establish early warning and response systems to protect FAnGR against emergency threats such as civil unrest and outbreak of disease; such response systems need to be established and operated by the key agencies that deal with the threats.

Finding 10: Information on current status, future needs, current and future values and nature and severity of threats will remain imperfect for the foreseeable future. There is clear need to take action now rather than wait for substantially better information to become available.

Finding 11: There are many issues in common between conservation of FAnGR and conservation of other components of agrobiodiversity. There will be considerable benefits from sharing resources and knowledge with other areas of agrobiodiversity.

Actions

Actions were grouped into three broad areas: general priorities, conservation priorities and research and information priorities.

General priorities

Action 1: Develop policy that promotes use of appropriate FAnGR and supports conservation of FAnGR.

Action 2: Show the benefits and costs of conservation and raise awareness of the issues.

Action 3: Establish international funding mechanisms, legal frameworks and advocacy to support the actions of developing countries in conserving FAnGR.

Action 4: Develop policy and guidelines for biosecurity, exchange, ownership, access and benefit-sharing of FAnGR.

Conservation priorities

Action 5: Develop capacity for cryopreservation, including the development of human and technical resources.

Action 6: Determine the most appropriate system for regional and/or international cryopreservation programmes as a back-up for developing world FAnGR.

Action 7: Identify hotspots of diversity and identify the most threatened FAnGR within those hotspots and take action to conserve them now.

Action 8: Establish early warning and response systems for emergency threats to FAnGR.

Research and information priorities

Action 9: Capture all existing information on FAnGR into an internationally accessible information system and couple this with tools for analysis and interpretation of information and for decision-making.

Action 10: Improve the level of knowledge about how to prioritize, design and operate conservation and utilization programmes that will be sustainable in the medium to long term.

Action 11: Complete global surveys of the molecular genetic diversity of the major livestock species.

Action 12: Undertake a critical analysis of the economies of scale for various conservation actions and interventions.

Action 13: Improve the technologies and reduce costs of cryopreservation of gametes, embryos and somatic cells of most species of FAnGR.

The origins and content of the report

Noting the rapid changes in agriculture globally and the potential impacts on FAnGR, and noting the advances in technology and knowledge over the past decade, the workshop was convened to review and analyze the options and strategies for conserving farm animal genetic resources (FAnGR). The primary emphasis was on the needs of developing countries. The workshop brought together scientists, managers of conservation programmes, international organizations and other experts involved with FAnGR from around the world. The workshop was facilitated, with a mix of workshop and plenary discussions. A full description of the workshop process is provided in Appendix 1. The participants are listed in Appendix 2. The papers presented at the workshop are included on a CD that accompanies this report.[2]

The workshop was designed to identify priorities for action and to contribute to the development of a global framework for the conservation of farm animal genetic resources. This report summarizes the key points of discussion and consensus. Eleven major findings are presented as they developed during the workshop, with an explanation of each finding. Four broad areas were noted where information or knowledge is currently inadequate and 13 priorities for action were identified; in each case a brief explanation follows each knowledge gap or action.

[2] SGRP. 2006. Options and Strategies for the Conservation of Farm Animal Genetic Resources: Report of an International Workshop and Presented Papers (7-10 November 2005, Montpellier, France) [CD-ROM]. CGIAR System-wide Genetic Resources Programme (SGRP)/Bioversity International, Rome, Italy.

Why is conservation of FAnGR needed?

Several of the background papers covered reasons for conserving FAnGR and participants discussed this topic in working groups. There was consensus that in any given situation there are usually multiple types of threat and reasons why FAnGR should be conserved, with the ranking of these threats and reasons varying between situations (countries, agro-ecosystems, farming system, species, breed, etc.). The following were identified by workshop participants as some of the primary justifications for conserving FAnGR.

- To prevent genetic erosion of populations that retain value for current use;
- To maintain sufficient genetic diversity to meet the needs of current and future utilization;
- To provide options for adaptation to changing environmental conditions;
- To support sustainable animal production systems for food security;
- To provide genetic resources for cross-breeding and development of new genotypes;
- To provide options to meet the demands of new markets for livestock products and services;
- To preserve cultural and historical values;
- To sustain the bequest[3] value of livestock;
- To fulfil the rights of an existing genetic resource to continue to exist.

In most of the above examples, the underlying justification for conservation is to protect the FAnGR against risk coupled with imperfect knowledge of what attributes FAnGR currently possess and what economic, social and cultural needs local, regional and global society will have in the short-, medium- and long-term future. Maintaining the option value[4] of FAnGR was identified in several discussions as a major reason for conservation, nationally, regionally and globally.

Based on what has happened and is happening in developed countries, the effects of economic development on diversity of FAnGR were seen as a process of first a narrowing of genetic diversity followed by expansion of diversity. In the early stages of economic development, increased intensification and specialization of animal production systems and products drives a narrowing of FAnGR diversity. As economic development proceeds further, markets expand and ability of consumers and society as a whole to pay for specialized products and services increases. This

[3] The bequest value is the value of passing a resource from one generation to the next as part of the cultural heritage of the individuals or group concerned.

[4] The option value is the value of FAnGR in providing options to meet future needs, recognizing that it is essentially impossible to predict with accuracy what future needs will be. Future needs include, *inter alia*, functional characteristics of livestock to have certain production characteristics, produce particular products, possess abilities to reproduce and thrive in specific conditions, possess resistance to diseases, possess specific behavioural characteristics, and social characteristics, such as to fulfil specific cultural and heritage functions.

drives an expansion of genetic diversity and of livelihoods associated with that diversity to provide a greater diversity of specialized products, to meet landscape and ecological management requirements and to fulfil heritage functions.

It was generally agreed here, and in later discussions in the workshop, that most societies can be expected to reach a certain stage of economic development where the desire of the society to restore its heritage is matched by its economic capacity to do so. This will ensure that a high proportion of FAnGR that are put into cryopreservation will eventually be restored as live populations. Once restored for their heritage value, such populations again become available for further characterization and research for broader use purposes. This overcomes the concerns that populations in cryopreservation might never be restored because of their uncertain use value due to the poor state of characterization of many FAnGR coupled with the relatively high cost of restoring populations from cryopreservation and subsequently evaluating them.

It was also noted at several points in the workshop that rapidly advancing genetic and reproduction technologies have in recent years greatly increased the ability to identify and utilize genes underlying particular characteristics of FAnGR. The power of these technologies is expected to continue to increase rapidly, further increasing the options and ability to utilize conserved FAnGR diversity in the future. In the context of such advances in technology, conservation of FAnGR can be aimed at conserving adaptive traits, the individual genes controlling which can in future be more easily identified and utilized than at present.

The workshop discussed whether there was an appropriate unit of conservation. It was concluded that there was no universal unit of conservation. In many cases, the unit of conservation will be a clearly defined breed. In some cases it might be a meta-population covering a range of phenotypes and regions. In other cases the unit of conservation might be an allele of a single gene that is not currently desired but might have potential future value. The appropriate unit of conservation will need to be defined on a case-by-case basis.

Overall the workshop concluded that the reasons for conserving FAnGR were manifold and compelling. But it was noted that these reasons have not been well articulated to society and to agencies that might fund conservation of FAnGR. There is a need to develop detailed analyses of socio-economic justifications for conserving FAnGR and to present these reasons to a wide audience.

What are the nature and status of threats to FAnGR?

The nature and status of threats to FAnGR were identified in several working groups leading to the following broad consensus.

Finding 1: Threats to FAnGR in the developing world have increased in recent years, causing an urgent need for action to limit the loss of diversity.

The following table summarizes the key factors identified as causing threats to FAnGR in the developing world along with the dynamic of the threat (an assessment of whether the threat is increasing, decreasing or stable). In the case of environmental degradation and natural disasters, the participants felt they were not in a position to assess the dynamic of these threats.

Several of the threats operate through diverse and overlapping mechanisms. For example, economic development generally causes an intensification of livestock production, which creates a demand for widespread cross-breeding and/or breed substitution that can severely threaten the survival of local FAnGR. Such changes

Table 1. Key factors identified as causing threats to FAnGR in the developing world and the dynamic of the threat.

Factor (source of threat)	Dynamic
Changes in production systems/Intensification	Increasing
Changes in market preferences	Increasing
Rural migration/Urbanization	Site and system dependent
Competition for natural resources	Increasing
Environmental degradation/Pollution	Unknown
Political and economic instability	Constant
Lack of appropriate livestock policies	Increasing
Lack of political will	Increasing
Lack of valuation of local breeds	Decreasing
War and civil conflicts	Constant
Natural disasters	Unknown
Epidemic diseases	Increasing
Climate changes	Increasing
Endemic diseases	Constant
HIV/AIDS	Increasing
Trade agreements (e.g. WTO)	Increasing

in agricultural production may be entirely appropriate objectives of economic development. Changes in market demands may drive similar changes. But inappropriate or inadequate policy may also promote widespread cross-breeding or breed substitution where the imported FAnGR are not the most appropriate solutions to the economic needs of farmers or society at large. As another example, threats to FAnGR can arise through failure of production systems, which can be caused by rural migration, environmental degradation, political instability, war and other factors.

In working groups the participants discussed the dynamics of the various factors causing threats to FAnGR in the developing world and concluded that, as a broad generalization, the majority of the most serious threats to FAnGR had increased in recent times and would continue to increase in future. Only one factor, lack of valuation of FAnGR, was seen to be decreasing, and then only slightly, because methods of valuation had been advanced in recent years and awareness and application of these methods was expected to increase in the future.

It was noted that threats to FAnGR can be broadly categorized according to the severity of the likely impact caused by the threat and timescale over which the endangerment caused by the threat was operating. One working group reviewed different types of threats in terms of their impact and timescale. A summary of their qualitative assessments were that, as illustrated in Figure 1, threats tended to group in five blocks with broadly similar locations in terms of impact and timescale of threat.

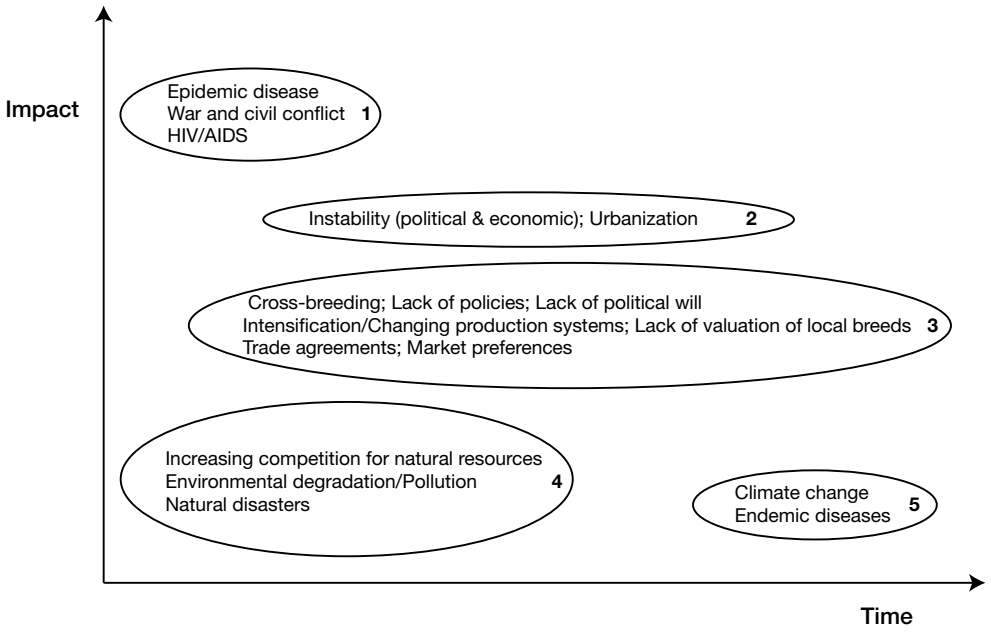

Figure 1. Grouping of threats to FAnGR according to the timescale and the severity of the threat.

Epidemic disease causing death from disease of animals or slaughter as part of disease control measures was one threat identified as having very high impact (severe risk of extinction of the breed) and very short timescale for that impact. Conversely, climate change was identified as a threat operating very slowly (long timescale) and likely causing fairly low impact.

It is clear that the importance and the dynamics of the threats vary significantly across regions and species. A working group assessed the relative importance and dynamic of the threats by major geographic region. Using the clusters identified and numbered in Figure 1, the group ranked the five clusters of threats according to region, differentiating by wealth within each region (Table 2). The numbers in each column (i.e. region) represent the scale of importance (1 to 5) of threats in the five clusters. For example with regard to Africa/poor, cluster number 4 was ranked as the most relevant (rank 1). Rankings were not made for the Americas and Africa/rich as it was felt there was not enough competence within the group to make an assessment.

Table 2. Ranking of threats by region (1=highest relevance, 5= lowest relevance).

Threat cluster (ref. Figure 1)	Regions						
	Europe		Africa	Asia		North Africa + Middle East	
	rich	poor	poor	rich	poor	rich	poor
1	4	4	4	4	1	4	4
2	5	2	3	3	3	1	3
3	2	1	4	5	2	2	2
4	1	5	1	3	4	3	4
5	3	3	5	2	5	5	5

There was no consensus about whether the clustering of individual threats or the rankings in the above table correctly reflected the variation across regions, but there was consensus that use of such a framework would be a useful approach for detailed assessments at the regional, subregional or national level. Further work will be required to define and cluster the factors driving threats, the mechanisms by which the threats operate and the various dimensions and ranking of the threats.

What forms of conservation will be required?

In much of the literature on conservation of FAnGR, conservation methods are broadly grouped into *in situ*, *ex situ in vivo* and *in vitro*. The participants recognized that there were a range of *in vivo* conservation approaches ranging from *in situ* conservation involving continued use as part of an ongoing livelihood strategy at one end through to conservation in zoos with no connection to ongoing use at the other. Theoretically, after having passed a certain threshold of endangerment, populations that are put under *in situ* conservation programmes will have to be managed with specific conservation breeding programmes. In practice it is difficult to determine where management of FAnGR ends and conservation begins, in particular in developing countries. In practice it is also difficult to determine where *in situ* conservation ends and where *ex situ in vivo* conservation begins. For the purposes of this workshop, the working groups adopted a working definition that *in situ* conservation included continued maintenance of FAnGR by livestock keepers in ongoing livelihood-based production systems, while *ex situ in vivo* conservation includes any off-farm maintenance, whether by farmer groups, institutions, government herds or others.

Finding 2: ***In situ* conservation approaches are to be preferred as a method of conservation where maintenance and management of the FAnGR is the best available livelihood option for the farmers involved. *In situ* conservation should be established as a preventive measure to protect against loss of the FAnGR.**

There was a clear consensus that *in situ* conservation was the preferred method of conservation where it could be established with a high probability of success. This is because *in situ* conservation ensures that a breed is maintained in a dynamic state and, when coupled with appropriate genetic improvement programmes, can ensure that the breed retains its relevance to changing production, marketing and social environments. Where *in situ* conservation can be established without external subsidies, it is also a low-cost form of conservation.

The workshop analyzed existing experiences with *in situ* conservation of FAnGR in the developed and developing world and identified the following essential conditions for success:

- The breed is sufficiently defined and its value recognized;
- The cause of breed decline can be identified, properly addressed and overcome;
- Conservation intervention takes place before the breed becomes critically endangered;
- Livestock keepers have a socio-cultural environment that makes them desire to maintain their FAnGR;
- The *in situ* conservation provides a sufficiently rewarding livelihood option that the livestock keepers do not adopt alternative livelihoods;

- The livestock keepers can be organized into a community-based management approach or other forms of breeding organization;
- The production and marketing environment is reasonably stable;
- The political and policy environments are favourable.

The need to provide livestock keepers with a sufficiently rewarding livelihood option, both short and long term, was identified as being absolutely critical to success of *in situ* conservation. If this is not assured then it is clear that the livestock keepers will eventually adopt an alternative livelihood, either switching breeds or species or moving out of livestock keeping altogether and the *in situ* conservation will fail. To ensure that *in situ* conservation supplies a sufficiently rewarding livelihood requires that the causes of breed decline can be identified and counteracted and that intervention takes place sufficiently early when the breed is not already critically endangered (from which state *in situ* conservation on its own is unlikely to be able to assure survival of the breed).

Taking these requirements into account, it is clear that *in situ* conservation is in reality a livelihood development strategy which needs to be embedded in the development strategy of countries, donors and supporting agencies. Conservation of the FAnGR is a secondary byproduct of the development strategy rather than the primary goal. It would be preferable to avoid the term '*in situ* conservation' and adopt the term 'community-based management' to emphasize the livelihood focus of the approach.

The workshop was unable to determine in what proportion of cases *in situ* conservation would prove successful in the developing world. The general consensus was that, given the rates of change in economic development and in agriculture production systems that are expected in much of the developing world, *in situ* conservation is unlikely to be sufficient to conserve most FAnGR. Other approaches to conservation will clearly be required.

Finding 3: ***Ex situ in vivo*** **conservation in institutional or communally owned herds or flocks can successfully be used to support conservation of FAnGR that have current value.**

Finding 4: **Virtually all examples of *ex situ in vivo* conservation of FAnGR in the developing world are designed to support current use by farmers (or expected use in the near future) or are populations being maintained for research purposes. The establishment of non-use *in vivo* conservation programmes will be difficult and perhaps rare.**

Preliminary analysis of the country reports submitted through the State of the World (SoW) FAnGR process reveal a large number of *ex situ in vivo* conservation programmes operating in the developing world. In most cases it is not possible from the information provided to determine the link to livelihoods or the likelihood of successfully sustaining the breed. The collective knowledge of the workshop participants was that virtually all *ex situ in vivo* conservation programmes in the developing world were, in some way, supporting continued use of the FAnGR by

farmers (e.g. serving as a nucleus herd or by providing semen). There were a small number of cases of *ex situ in vivo* herds/flocks of developing world FAnGR being maintained purely for research purposes. Some of these herds/flocks are located in the developed world. With the possible exception of some small flocks of poultry, no examples were identified where populations of FAnGR were being maintained purely for conservation purposes with no expected use in the near future.

There are a very wide variety of ways in which the connection between the *ex situ* population and the use by farmers is made. Examples include nucleus herds/flocks, which sample from local populations and in which genetic improvement is made and returned to farmers, multiplier herds/flocks that sample local populations and return multiplied stock to farmers, and nucleus herds that are essentially closed to outside sampling and which sometimes form the main remaining repository of the pure breed which might be used primarily for cross-breeding by farmers.

The following key factors for success of *ex situ in vivo* conservation programmes were identified:

- **Sustained funding:** in most cases, the maintenance of *ex situ* populations is supported by external (usually government) funding. The security of such populations is dependent on the long-term maintenance of that external funding. Examples exist of such populations having been maintained for many years, but equally many such *ex situ* populations have since disappeared. External funding is vulnerable to change in priorities of the external funding agency and to economic and social instability. Existing examples were identified which participants felt could be self-financing. But these examples were maintained by government departments and the accounting rules of most government departments in most countries make it difficult to achieve self-sustained funding. Thus government-supported populations can sometimes remain vulnerable to changes in funding support even when they could in principle achieve self-sufficiency.
- **Appropriate policy:** whether in government-run facilities or other structures, there needs to be a policy environment that supports the establishment and maintenance of the *ex situ* populations.
- **Continued use and benefit to farmers:** as long as the population continues to contribute to the operation of farmers it is possible to justify to funding agencies their continued support of the population. Long-term financial support is likely to be difficult to maintain when there is no immediate use for the FAnGR being conserved.
- **Ability and capacity to manage the *ex situ* population:** whether at the government level or self-organized by farmer cooperatives, maintenance of *ex situ* populations requires a high capacity to organize, maintain and use the population. In particular, in order to self-organize, farmer groups require a very high capacity of members of the group. Successful self-organization without external support is probably feasible only at high levels of economic development.

Finding 5: The majority of sustainable *in vivo* (*in situ* and *ex situ*) approaches to conservation in the developing world will be intimately linked to promotion of livelihoods.

This finding follows from the observations above on *in situ* and *ex situ in vivo* approaches to conservation. *Ex situ in vivo* conservation appears in general to be sustainable where it supports continued use by farmers, and continued use by farmers is itself only sustainable where such use promotes improvement of livelihoods. Improvement of livelihoods by *in situ* and *ex situ in vivo* conservation can, if required, be achieved by provision of external funds to subsidize the conservation, but such subsidization will increase the risk to the FAnGR, which might be rapidly lost if the financial support is withdrawn. The conclusion is that a high proportion of populations maintained in *in situ* or *ex situ in vivo* conservation will remain under substantial risk of loss unless they are clearly, and without external financial support, a livelihood maximizing option for farmers. It is not clear how often this will be true, but the consensus was that maintenance of their existing FAnGR will not be a livelihood maximizing option for farmers in the short term in a substantial proportion of cases.

Finding 6: ***In vitro*** **conservation is urgently required to provide a secure back-up for the FAnGR of the developing world. This is to protect against a variety of threats that can drive FAnGR to extinction faster than monitoring can identify the threat and faster than alternative conservation approaches can respond to.**

While conservation of FAnGR as live animals was recognized as having many advantages and wherever sustainable would be the preferred method of conservation, as discussed above, there was consensus that most live-animal conservation in the developing world would remain exposed to very substantial risk of loss of the FAnGR. This is particularly so in the short term and in countries where economic development has not yet reached levels that would support maintenance of FAnGR for cultural or heritage purposes or through development of higher value niche market products. There was consensus that there was urgent need to develop a system of cryopreservation of FAnGR of the developing world.

Cryopreservation can act as a back-up to secure FAnGR from external threats. In emergency situations, populations can be restored from cryobanks after the crisis. Cryobanks can also provide insurance against inappropriate genetic improvement programmes that result in undesirable genetic changes and can provide insurance against excessive inbreeding induced by intensive genetic improvement programmes or the maintenance of small populations. In systems with relatively high levels of infrastructure and capacity, they can also be used to support ongoing genetic improvement programmes, nationally and internationally.

A past criticism of cryopreservation of FAnGR has been that the high cost of restoring extinct populations from cryobanks will mean that cryopreserved FAnGR will rarely, if ever, be restored to living populations. There was consensus that this criticism is incorrect. For example, there was consensus that if European breeds that are now extinct had been preserved in cryobanks, the majority of such breeds would have been restored from cryobanks by a combination of private and public efforts because of the public interest in their heritage value. As economic development