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Item 5.1 of the Provisional Agenda

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

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BREEDING STRATEGIES FOR SUSTAINABLE MANAGEMENT OF ANIMAL GENETIC RESOURCES – DRAFT GUIDELINES (REVISED VERSION)

INTRODUCTION

1. This document presents draft guidelines for sustainable management of animal genetic resources, for information of and endorsement by the Commission. The preparation of the guidelines was initiated following the recommendation made by the Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture (Working Group) at its Second Session in 2000 that approaches, procedures and tools be developed to assist countries to plan, implement and further develop genetic improvement programmes and policies, directed at promoting sustainable development and food security[1].

2. Following considerable research and interaction with a broad spectrum of scientists and technicians with experience in developing and developed countries and a good understanding of a range of species and production systems, FAO took the initiative to develop such guidelines and initiated the process with a broad-based working group of experts.

3. At its Tenth Regular Session in 2004, the Commission on Genetic Resources for Food and Agriculture (Commission) emphasized the need for breed development in low- to medium- input production systems, and requested FAO, in collaboration with relevant partners, to finalize the development of the decision-support tools, to assist in the formulation of breeding programmes. The Commission stressed the importance of further implementing proven classical breeding programmes in extensive production systems.[2] The International Technical Conference on Animal Genetic Resources for Food and Agriculture, held in Interlaken, Switzerland in

[1] CGRFA/WG-AnGR-2/00/REPORT, xi)

[2] CGRFA-10/04/REP, paragraph 47

September 2007, requested FAO to continue the development of technical guidelines, to assist countries in the implementation of the *Global Plan of Action for Animal Genetic Resources*[3].

4. FAO, with funding from the Government of Norway, continued the development of guidelines on breeding strategies for the sustainable management of animal genetic resources. The guidelines were discussed and validated in six workshops held in France, India, Kenya, the United Republic of Tanzania, Peru and Italy. In total, 120 scientists, technicians and policy-makers from all regions contributed to the process.

5. The document, *Draft guidelines for establishing animal breeding strategies in low- and medium-input production system*[4] was presented to the Fifth Session of the Working Group, which requested FAO to revise the guidelines in the light of comments received from members of the Working Group by 1 April 2009, and to make the revised guidelines available to the Commission. FAO received comments from Finland. The revised guidelines are contained in this document.

6. Upon endorsement by the Commission, FAO will publish the *Breeding strategies for sustainable management of animal genetic resources* and distribute them widely as part of a guidelines series of publications prepared by FAO to support countries in the implementation of the *Global Plan of Action for Animal Genetic Resources*. The guidelines are intended for use by policy-makers and organizations involved in livestock development. They will help interested countries to specify objectives and priorities, identify the conditions necessary for the sustainable development of animal genetic resources, benefit from experiences with breed development in other countries with similar conditions, and find practical guidance on how to initiate or improve breeding programmes.

[3] *Global Plan of Action for Animal Genetic Resources*, paragraphs 22–23, Strategic Priority 14, paragraphs 58–61. ftp://ftp.fao.org/docrep/fao/010/a1404e/a1404e00.pdf

[4] CGRFA/WG-AnGR-5/09/Inf. 5

BREEDING STRATEGIES FOR SUSTAINABLE MANAGEMENT OF ANIMAL GENETIC RESOURCES

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FOREWORD

Animal genetic resources for food and agriculture are an essential component of the biological basis for world food security. Hundreds of millions of poor rural people keep livestock and often rely on their animals to provide multiple products and services. In harsh environments where crops will not flourish, livestock keeping is often the main or only livelihood option available. Livestock currently contribute about 30 percent of agricultural gross domestic product in developing countries, with a projected increase to about 40 percent by 2030. The World Bank has estimated that it will be necessary to increase meat production by about 80 percent between 2000 and 2030. This will require more efficient animal production systems, careful husbandry of natural resources and measures to reduce waste and environmental pollution.

The State of the World's Animal Genetic Resources for Food and Agriculture provides for the first time a comprehensive country-driven global assessment of the roles, values and status of animal genetic resources. It clearly shows that the full potential of animal genetic resources is not being realized and that an urgent global response is needed to improve the use and development of these resources and to address their current rapid erosion. The *Global Plan of Action for Animal Genetic Resource,* adopted by the International Technical Conference on Animal Genetic Resources for Food and Agriculture held in Interlaken, Switzerland, in September 2007 and subsequently endorsed by all FAO member countries, sets out concrete measures to address these needs.

The *Global Plan of Action* contains four Strategic Priorities Areas*,* which provide a basis for enhancing sustainable use, development and conservation of animal genetic resources throughout the world. Its implementation will contribute significantly to achieving Millennium Development Goals 1 (Eradicate extreme poverty and hunger) and 7 (Ensure environmental sustainability). The Interlaken Conference called on FAO to continue developing technical guidelines and technical assistance and to continue coordinating training programmes as a means to support countries in their efforts to implement the *Global Plan of Action*.

These guidelines on *Breeding strategies for sustainable management of animal genetic resources* have been prepared with the objective of helping countries to plan and develop effective genetic improvement programmes and to maximize the chances that such programmes will be sustained. The guidelines are intended for use by policy-makers and organizations involved in livestock development. They provide countries with advice on how to:

- specify their objectives and priorities;
- identify the conditions necessary for sustainable development of their animal genetic resources;
- benefit from the experiences of other countries with similar conditions; and
- find practical guidance on how to initiate or improve breed development programmes.

The preparation of the guidelines was initiated in accordance with the recommendation made by the Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture at its Second Session in September 2000 that develop approaches, procedures and tools be developed to assist countries to plan, implement and further develop genetic improvement programmes and policies, directed at promoting sustainable development and food security. The guidelines were discussed and validated at a series of workshops. In total, 120 scientists, technicians and policy-makers from all regions contributed to the process.

The guidelines will be refined and updated periodically as experience with their use in the field is accumulated. The assistance of the National Coordinators for the Management of Animal Genetic Resources and their country networks will be particularly important to this process of revision.

ACKNOWLEDGEMENTS

The preparation of the guidelines was initiated by Keith Hammond, formerly FAO Senior Officer for Animal Genetic Resources. Some of the sections were reviewed and rewritten by John Woolliams, Salah Galal and Joaquin Mueller, who were involved in the preparation process from the very beginning. The guidelines were reviewed, tested, validated and finalized at workshops held in France, India, Kenya, the United Republic of Tanzania, Peru and Italy. These workshops, attended by 120 scientists, technicians and decision-makers, were organized in collaboration with Vincent Ducrocq, Suresh Gokhale, Okeyo Mwai, Sachindra Das and Gustavo Gutiérrez, respectively. Case studies presented in the guidelines were prepared by Ben Kubbinga and Marie-Louise Beerling. Marie-Louise Beerling and Regina Laub addressed gender issues. Barbara Hall contributed to the copyediting.

The guidelines were prepared under the supervision of Badi Besbes, with the full support of the Chief of FAO's Animal Production Service, Irene Hoffmann, and of current and former officers of the Animal Genetic Resources Group: Paul Boettcher, Beate Scherf, Dafydd Pilling, Mitsuhiro Inamura, Manuel LuqueCuesta, Frank Siewerdt and Olaf Thieme. Administrative and secretarial support was provided by Kafia Fassi-Fihri and Carmen Hopmans.

FAO would like to express its thanks to all these individuals and to those not mentioned here who generously contributed their time, energy and expertise.

PREPARATION OF THE GUIDELINES

BACKGROUND

Livestock (including poultry) make an essential contribution to food and agriculture and rural development. The products and services they provide include meat, milk, eggs, fibre, draught power and manure for fertilizer and fuel. They make important contributions to livestock keepers' abilities to manage risk and help maintain and social networks within the community. The importance of livestock is increasing as human population growth, rising incomes and urbanization in developing countries are fuelling a massive increase in demand for foods of animal origin. The projected increase in demand is expected to drive major changes in the livestock sector during the period to 2020, a process that has been termed "the livestock revolution".

Animal genetic resources for food and agriculture (AnGR) provide the biological capital on which livestock production systems and food security are built. Planning for sustainable livestock development should, from the outset, take account of genetic differences among the species, the breeds and the animals considered for use, along with their adaptive fitness to the production environments in which they will be kept. The different ways in which animals are used in different production systems and communities should also be recognized.

The State of the World's Animal Genetic Resources for Food and Agriculture (FAO, 2007) indicates that the vast majority of developing countries have not been successful in sustaining genetic improvement in their livestock populations. Among breeds reported to the Domestic Animal Diversity Information System (DAD-IS), about two-thirds are in use in developing countries. The livestock keepers in these countries certainly have breeding goals and exploit local knowledge and technologies to pursue them, but according to the country reports on AnGR submitted during the preparation of *The State of the World's Animal Genetic Resources for Food and Agriculture*, 60 percent of developing countries declared that they have no structured breeding programmes for any of the five major livestock species (cattle, sheep, goats, pigs and chickens). Conversely, about 90 percent of developed countries reported that they have structured breeding programmes for at least one of these species. Many countries are therefore failing to take advantage of the opportunities that such programmes offer to develop animals that better meet the needs of livestock-keeping communities and supply the products that consumers demand.

Sustained livestock genetic improvement activities that meet national needs without jeopardizing community needs can make a vital contribution to food security and rural development. Lessons learned from countries that have initiated and sustained genetic improvement activity during the past half-century provide a solid basis for the effective use of animal genetic diversity. The results are impressive, especially those achieved in developed countries, where the productivity of breeds subjected to genetic improvement has been doubled or tripled. Around half of this gain has resulted from genetic improvement activity and the other half from a range of non-genetic interventions. The significance of these achievements is further underlined by the fact that most of the genetic improvement is comparatively permanent; the benefits of investments in genetic improvement are recouped year after year by livestock keepers and communities. Genetic improvement activity in developed-country production systems has now become, perhaps without exception, a fundamental and integral element of the ongoing process of improving productivity as a means to maintain profits, use input resources more efficiently and improve product quality, food safety and animal health. There is, however, a need to recognize that genetic improvement should be accompanied by improved management, as the higher-producing animals have higher requirements in terms of feeding and husbandry.

LESSONS LEARNED

It is important to understand why developing countries have generally not been successful in sustaining structured genetic improvement activities. For several decades, it was widely considered that developed countries could best assist developing countries to improve their AnGR by introducing highly selected breeds and establishing them as straight-bred or cross-bred populations to substitute the local ones. Experience has shown that such strategies have serious limitations. They are effective only where the developing country's production systems are already able to provide the introduced breeds with levels of inputs similar to those provided in their countries of origin. If this is not the case, the introduced breeds and their crosses are often exposed to intense stressors to which they are not well adapted (e.g. periodic feed and water shortages, diseases, climatic extremes and lower-capacity husbandry). Development strategies have also failed because the associated extension and communications focused on technical issues and on men only, neglecting the wider production system and women's role in animal management.

Box 1. Dairy development in Kenya – recognizing women's roles

In 1979 the Extension Service in Kenya initiated the National Dairy Development Project, which targeted smallholder farmers and involved setting up milk collection centres. The system was designed to deal with a steadily increasing volume of milk. But this did not materialize. When the quantity of milk delivered to the collection centres dropped to uneconomic levels, it was time for a critical review. A woman dairy production expert who had attended a gender course was put in charge. A questionnaire-based survey was designed. The enumerators consisted of extension agents and the sample population included both women and men.

The key to the extension effort was "zero-grazing" – the cross-bred dairy cows, because of their greater vulnerability and higher management requirements, had to be kept in a shed and stall-fed with Napier grass. Cows of this type need close inspection for parasites and diseases, and have to be milked twice a day. This was something new to the farmers. To familiarize them with the new system they were offered training and follow-up by the extension service; this focused almost exclusively on men. Three-day training courses were organized in central locations, which made it difficult for women to attend. When extension agents visited farms they usually asked, "Is the *Mzee* in?" (the "boss", the man of the household) and if he was not in would turn around and leave. Women were therefore not involved in the new developments.

Yet women formed an essential part of these projects. They were expected to clean the cowsheds and take the cows to the dip tank for anti-tick treatment. They milked the cows, and usually took the milk to the collection centre. But at the end of the month when the men received the cash many spent most of it rather than keeping it to buy new school uniforms for the children, doctors' bills or other necessities.

The study revealed a high level of dissatisfaction among women, who felt that their role in dairy farming had been entirely overlooked and their inputs unrewarded. They used their only means of protest: not doing their best. This explained most of the decrease in milk production.

Sources: Reynolds et al. (1996), Mullins et al. (2005).

Reproduction rates among the introduced breeds or crosses have also often poorer than those of the locally adapted breeds. Even more importantly, the survival rates of the introduced animals have frequently been low. Poor survival rates are a major concern because in lower-input production systems animal longevity is essential to productivity and efficient use of resources. The introduction, crossing and diffusion of exotic genetic resources in developing countries have often been well advanced before negative effects have been reported.

It is essential that the process of identifying the AnGR from which livestock keepers and communities are likely to derive the most benefit take account of differences between production systems. This applies to differences between production system within an individual country as well as to differences between developing- and developed-country production systems. For example, the type of chicken required for poultry production systems that have access to market

infrastructure is different from the type that contributes best to sustaining the livelihoods of the poorest in areas where there is no reliable market infrastructure or means to purchase inputs. In the latter situation, the chickens must have (among other characteristics) the ability to scavenge in search of feed, the ability to nest and brood so that they can reproduce without assistance and resistance or tolerance to a range of diseases and parasites.

Just as importantly, full consideration must be given to all the uses to which livestock keepers' put their animals. Livestock in low- to medium-input production systems are commonly kept for multiple purposes, while production in high-input systems focuses on one (or at most two) primary outputs. Consequently, genetic improvement strategies in the latter type of system emphasize combinations of traits that would not be appropriate for many developing -country production systems. When AnGR developed under the higher-input, lower-stress production systems are introduced to developing countries they frequently do not prove to be much better than the locally adapted AnGR, particularly in terms of life-cycle efficiency. Country strategies may therefore need to focus on developing genetic resources that are already well adapted to the local production systems and to livestock keepers' goals**.** Such AnGR will either have been developed locally or may be sourced from similar production environments elsewhere.

To move forward in the development of AnGR, it is essential to avoid repeating past mistakes and to build on lessons learned. In the vast majority of developing countries very few or no genetic improvement programmes are currently being sustained. What are the reasons for this? Have few programmes been initiated or have those that have been initiated in recent decades not been sustained? Reliable data are difficult to obtain – the parties involved are frequently unwilling to report negative results.

The Food and Agriculture Organization of the United Nations (FAO) has examined the above questions by commissioning a broad range of case studies (ICAR/FAO, 2000a) and by hosting several meetings of technical experts and e-conferences. The results of these investigations suggest that relative to the number of breeds in active use far fewer genetic improvement programmes have been initiated in developing than in developed countries (China, and to a lesser extent Brazil and India, may be exceptions to this pattern). Moreover, many breeding activities initiated in developing countries have not been sustained. The reasons for the general lack of successful breeding programmes in developing countries can be summarized as follows:

- Many countries do not have the technical and operational capacity fully to evaluate the range of available AnGR, the production environments in which they may be put to use, and the strategies and options for their development.
- Countries have often adopted policies that favour particular approaches to genetic improvement (e.g. introducing AnGR from developed countries) without fully assessing their long-term implications.
- Livestock keepers have not been adequately involved in the early planning and development of genetic improvement programmes to which they have been expected to contribute and from which they have been expected to benefit. This has resulted in a failure to ensure that the products of the programmes – the improved animals –meet the livestock keepers' needs without exceeding their capacity to manage the animals or to obtain the necessary external inputs.
- Genetic improvement programmes have been undertaken without detailed documentation of the operational plans. As a result, only a few livestock keepers, field technicians and/or policy-makers have clearly understood the intended objective of the development strategy and what was to be done, by whom and when.
- Genetic improvement activities have often been initiated through short-term projects. Conversely, experience from advanced livestock genetic improvement programmes,

particularly in developed countries, has shown that long-term evolving strategies involving the public and private sectors can be highly successful.

A STRATEGIC APPROACH TO SUSTAINABLE GENETIC IMPROVEMENT

A strategic and logistical approach to sustainable livestock development is required. To appropriately address the use of available AnGR and the role of genetic improvement in sustainable development, all policies, plans and programmes for the livestock sector must, from the outset:

- be based on soundly established and agreed livestock development objectives (LDOs) and well-integrated and realistic livestock development strategies (LDS) that are able to achieve the LDOs;
- account for major environmental, structural and socio-economic differences among the production systems concerned
- ensure participation of the end-users (the livestock keepers themselves). Both men and women should have access to relevant information, be involved in the formulation of policies and plans, and have ample opportunities to give their opinions;
- be appropriately funded;
- promote step-by-step development and the sustainability of the actions undertaken;
- be based on well-documented approaches understood and agreed by all the stakeholders involved at each stage; and
- take the fundamental principles of genetic improvement and their technical implications fully into account.

These guidelines on *Breeding strategies for sustainable management of animal genetic resources* have been developed based on this strategic approach in order to assist countries to develop and implement their livestock genetic improvement programmes more effectively and to help them to maximize the sustainability of these programmes.

DEVELOPMENT OF THE GUIDELINES

The idea of developing these guidelines emerged in September 2000 when the Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture recognized that genetic improvement of breeds must form an integral part of sustainable livestock development. It also recommended the development of approaches, procedures and tools for countries to use in planning, implementing and further developing genetic improvement programmes and policies directed at promoting sustainable development and food security. Further impetus was generated in September 2007 when the International Technical Conference on Animal Genetic Resources for Food and Agriculture, held in Interlaken, Switzerland, requested FAO (among others) to continue developing technical guidelines in order to assist countries in the implementation of the newly adopted *Global Plan of Action for Animal Genetic Resources*.

Following considerable research and interaction with a broad spectrum of scientists and technicians with experience in both developing and developed countries and a good understanding of a range of species and production systems, FAO considered it technically feasible to develop guidelines for animal breeding strategies. A broad-based working group of experts was convened to discuss and critically evaluate the approach to be taken.

The experts recommended the development of guidelines that would be simple to use and comprehensive in their coverage of genetic options and major animal species and that would help decision-makers avoid the recurrence of past causes of failure. They also provided a set of recommendations for completing the development and field-testing of the guidelines prior to general release.

It was deliberately decided to focus on classical breeding options based on quantitative genetics, which have demonstrated their efficiency and which are relatively easy and affordable to implement, and not to consider new technologies based on molecular genetics (gene-based selection or marker assisted selection). The latter technologies are not yet used routinely even by breeding companies in the developed world; they remain costly and require expertise and infrastructure that are generally lacking in developing countries.

The draft guidelines were discussed and evaluated at six workshops – held in France (September 2006), India (November 2006), Kenya (March 2007), the United Republic of Tanzania (March 2008), Peru (March 2008) and Italy (July 2008). The evaluations allowed gaps and weaknesses to be identified and the necessary amendments made.

EXECUTIVE SUMMARY

These guidelines – *Breeding strategies for sustainable use of animal genetic resources* – are part of a series of publications prepared by FAO to support countries in the implementation of the *Global Plan of Action for Animal Genetic Resources*. The specific objective is to assist countries to plan and develop effective genetic improvement programmes and to maximize the chances of these programmes being sustained. The guidelines are intended to help countries to specify and prioritize their objectives; identify the conditions necessary for the sustainable development of their animal genetic resources for food and agriculture (AnGR); benefit from the experiences of other countries with similar conditions; and find practical guidance on how to initiate or improve breed-improvement programmes.

The guidelines aim to address policy, operational and technical issues, and how these interplay to shape the outcomes of breeding strategies. Policy-makers and organizations involved in livestock development are the main target audience. The broad scope adopted by the guidelines is intended as a means to avoid atomizing the topic and presenting policy, operational or technical matters in an unconnected way to different groups of users. A less comprehensive approach would deny the lessons learned from livestock breeding in practice, which demonstrate the need for activities to be coordinated and integrated in time and space in order to achieve clarity in direction and efficiency of operation, with the whole process being underpinned by a sound understanding of the technical issues.

The initial sections of the guidelines have a national or regional perspective. The later sections become progressively more targeted towards breeding organizations and those responsible for implementing specific breeding schemes – both cross-breeding and straight-breeding. Each section outlines a set of tasks that need to be carried out in order to achieve the desired outcomes. The tasks are further broken down into a series of actions. In all sections, a participatory approach is promoted wherever feasible and gender issues are identified. A common thread throughout all sections is the need to document plans and decisions.

Section A. Forming the working group for preparing animal breeding strategies.

Developing a successful breeding strategy first requires assembling a committed working group who recognize the potential importance of the work. In turn, the working group must be able to mobilize a range of stakeholders to become involved in the process. National and regional governments will normally be among the key stakeholders, particularly in developing countries. This section offers guidance on identifying the stakeholders who will be important to the development and implementation of the strategy. The working group needs to draw up a working plan that assigns responsibilities and establishes timescales for the planning process.

Section B. Setting livestock development objectives and strategies

Breeding strategies are implemented with the objective of creating genetic change in the livestock population in order to benefit livestock keepers and wider groups of stakeholders. Such benefits will only be realized if the desired changes are consistent with other trends affecting the livestock production systems targeted and if the resources are available to deliver the planned improvements. This section, therefore, looks beyond breeding to address livestock development as a whole; the objective is to provide guidance on identifying realistic development objectives for countries' livestock production systems and identifying development strategies appropriate to meeting these objectives. A substantial body of information will need to be sought out, collated and scrutinized. This will include information on government policies and legal instruments that affect livestock production (including how they promote or inhibit development strategies); the country's major production systems (human-development objectives that need to be addressed, the capacity and motivation of farmers to participate in development strategies, and the environmental sustainability of the production systems); and historical and predicted future

trends for each production system (social, market and environmental trends – including the effects of climate change).

Guidance is offered on how the information assembled may be used to identify clear livestock development objectives and sustainable development strategies. The strategy identified as being appropriate for a particular production system may or may not include a breeding component. It is suggested that a series of workshops be held in order to achieve the objectives described in this section. Guidance is offered on the range of expertise that may be needed to complete this element of the planning process.

Section C. Matching AnGR with production systems to achieve livestock development objectives

AnGR can be used in various ways to achieve livestock development objectives. Strategies may be based on the use of locally available breeds, introduced breeds, or both. The breeds chosen may provide the basis for straight-breeding or cross-breeding schemes. It is essential to ensure that the AnGR used are well matched to the production systems in which they will be kept, taking account of the development objectives and planned development strategies for these systems. Evidence gathered in the last 10–15 years has yielded ample evidence that in many cases local breeds provide a good fit to these needs; in such cases a decision to use a locally available breed will be appropriate. Conversely, in some cases there may be a *prima facia* case for introducing an exotic breed. However, experience shows that such introductions will only be successful if there is clear evidence that a substantial benefit is achievable *within* the production system and that local stakeholders will accept the introduction. It is recommended that such an introduction only be considered if there is evidence that it will give rise to benefits in excess of 30 percent. This is because introducing exotic breeds involves many risks and requires careful planning and rigorous breed evaluation that is costly and challenging.

Step-by-step guidance on the process of identifying appropriate breeds for a production system is offered. Emphasis is given to the need to seek evidence that goes beyond simplistic production figures drawn from the use of exotic breeds in exotic production systems. If, following careful consideration, a breed is to be introduced, it is recommended that a "germplasm introduction plan" be developed. The plan should include conservation actions for local breeds that may be affected by the introduction.

Section D. Developing straight-breeding programmes

This section provides guidance on the development of straight-breeding schemes (i.e. schemes that are based on selection within a specific breed). It is split into three phases; the first two are relevant to schemes at their inception and during their early development; the third is relevant to later development. Phase 1 is concerned with establishing detailed breeding goals and the associated goal trait values (measures of relative importance, such as economic value). The approach taken to Phase 1 is subjective and participatory. Phase 2 is initiated by identifying the current breeding practices and market structure, and by seeking ways of promoting community involvement, before proceeding to develop and document a standard operating procedure for a breeding nucleus. Clear recommendations are offered on the division of responsibilities for the various procedures involved (genetic, veterinary, financial, etc.). The plan for the straight-breeding scheme, once it is developed, will provide a basis for securing funding. The advice offered on the implementation of Phase 3 includes a number of measures that may speed progress, facilitate dissemination or promote the sustainability of the scheme.

Section E. Developing cross-breeding programmes

Cross-breeding is an alternative means of generating genetic change in a population. It may be implemented in various forms including sustained cross-breeding (in which all breeds contributing the cross also have to be maintained as straight-bred populations), the development of a new synthetic breed, or breed substitution carried out by recurrent crossing. In the latter two

cases, the cross-breeding programme will evolve into a straight-breeding programme. A cross-breeding programme can be a complex operation that needs efficient organization and possibly the stratification of the animal population into multi-tier breeding structures. Guidance is offered on the specification of breeding goals, the assessment of current breeding practices, and the development of a plan that will provide the basis for obtaining funding, implementation and further development of the scheme. Where sustained crossing is envisaged, particular emphasis is given to ensuring that the dissemination of the improved germplasm is feasible with the available technology and infrastructure.

Section F. Evaluating investment decisions

This section presents guidance on the conduct of an investment appraisal for a breeding strategy as a whole or for a particular breeding scheme. A classical economic approach is adopted, which includes identifying the appropriate level of appraisal (national, sectoral, community or household), whether the appraisal is retrospective or prospective, and the planning horizons and discount factors to be used. It is suggested that the appraisal calculate costs and returns for each group of stakeholders (livestock keepers, breeders, retailers, government, etc.); however, this may not always be possible. It is also suggested that consideration be given to non-monetary values which cannot easily be included in economic analyses but which will often play a critical role in determining the wisdom of the investment. Factors to consider include gender issues, food and livelihood security, the wider impacts of improved nutrition, and hard-to-quantify household and other services provided by livestock.

USER GUIDANCE

WHAT IS THE PURPOSE OF THESE GUIDELINES?

The guidelines have been prepared to assist with the planning and implementation of livestock breeding strategies. More specifically they:

- describe the prerequisites for developing AnGR;
- take the user through a step-by-step decision-making process, which leads to the formulation of a breeding strategy;
- explain how to plan and implement breeding programmes, technically and operationally;
- describe the need for theoretical and local knowledge to be integrated in order to plan the development of AnGR;
- describe the need for thorough discussion with community-level stakeholders – not just livestock owners, but also keepers, managers, herders and caretakers; and
- provide information on the possible time frame in which the planned activities should achieve measurable results.

UNDER WHAT CONDITIONS SHOULD THE GUIDELINES BE USED?

The guidelines have been designed for countries or organizations that wish to develop AnGR through breeding programmes but have limited experience and a limited number of qualified staff. It is assumed that the guidelines will be used in situations where:

- a developed infrastructure for breed development is not in place (direct adaptation of approaches from more developed situations are therefore not possible); and
- policies and strategies for livestock development exist – the guidelines are intended to complement them with regard to breed development.

WHAT IS THE TARGET GROUP?

The guidelines are intended for use by all persons and organizations interested and involved in planning and implementing breed development activities, particularly officials of national and regional governments, research institutions, non-governmental organizations (NGOs) and private institutions. Knowledge of the principles of animal genetics and breeding will be an advantage for using the guidelines, but not essential.

HOW ARE THE GUIDELINES STRUCTURED?

The guidelines are divided into a number of sections (Figure 1) which address the following objectives and tasks:

- forming a working group to take charge of establishing the genetic improvement strategy (Section A);
- identifying development objectives for the livestock sector in general and for the species and production systems under consideration (Section B);
- defining the ways in which breeding can contribute to meeting the objectives (Section B).

- deciding what "breed improvement" means: i.e. what the user wishes to achieve and for which breed(s) (Section C).
- deciding how to achieve the breed improvement (Sections D and E);
- estimating the costs involved (Section F); and
- internalizing the conditions required for achieving success in breed improvement (all Sections).

Each section is introduced by a description of its rationale and objective(s). This is followed by a description of the inputs needed (and where relevant advice on potential sources), a description of desired outputs and a list of the tasks that need to be undertaken in order to achieve these outputs.

Users are provided with a set of questions that can be used to judge the relevance of the topic of the section to their particular situation and how the subject matter may be approached. Answering these questions may require that the users seek information from other sources. The guidelines outline the options available and discuss the likely consequences of different decisions. Ultimately, however, decisions have to be taken by the users themselves. If the breeding strategy is to be formulated by a working group, the topics described in each section will be discussed among the group; once the working group has completed the activities described in each section it will prepare a written statement setting out its specific decision(s). Working through all relevant sections of the guidelines will lead users towards a breeding strategy for a specific breed in a specific production system.

HOW SHOULD THE GUIDELINES BE USED?

Formulating policies and strategies for the development of AnGR is team work. It might be undertaken by the National Consultative Committee established for the preparation of the country reports on AnGR submitted during the preparation of *The State of the World's Animal Genetic Resources for Food and Agriculture* or by a committee formed specifically for the purpose. The guidelines are intended to structure the working approach of such a committee, but can also be used by any interested individual for study purposes or to support decision-making. The sections of the guidelines are arranged in a logical sequence. It is suggested that users follow this sequence, but they have the option of bypassing sections and going directly to those that they consider most relevant.

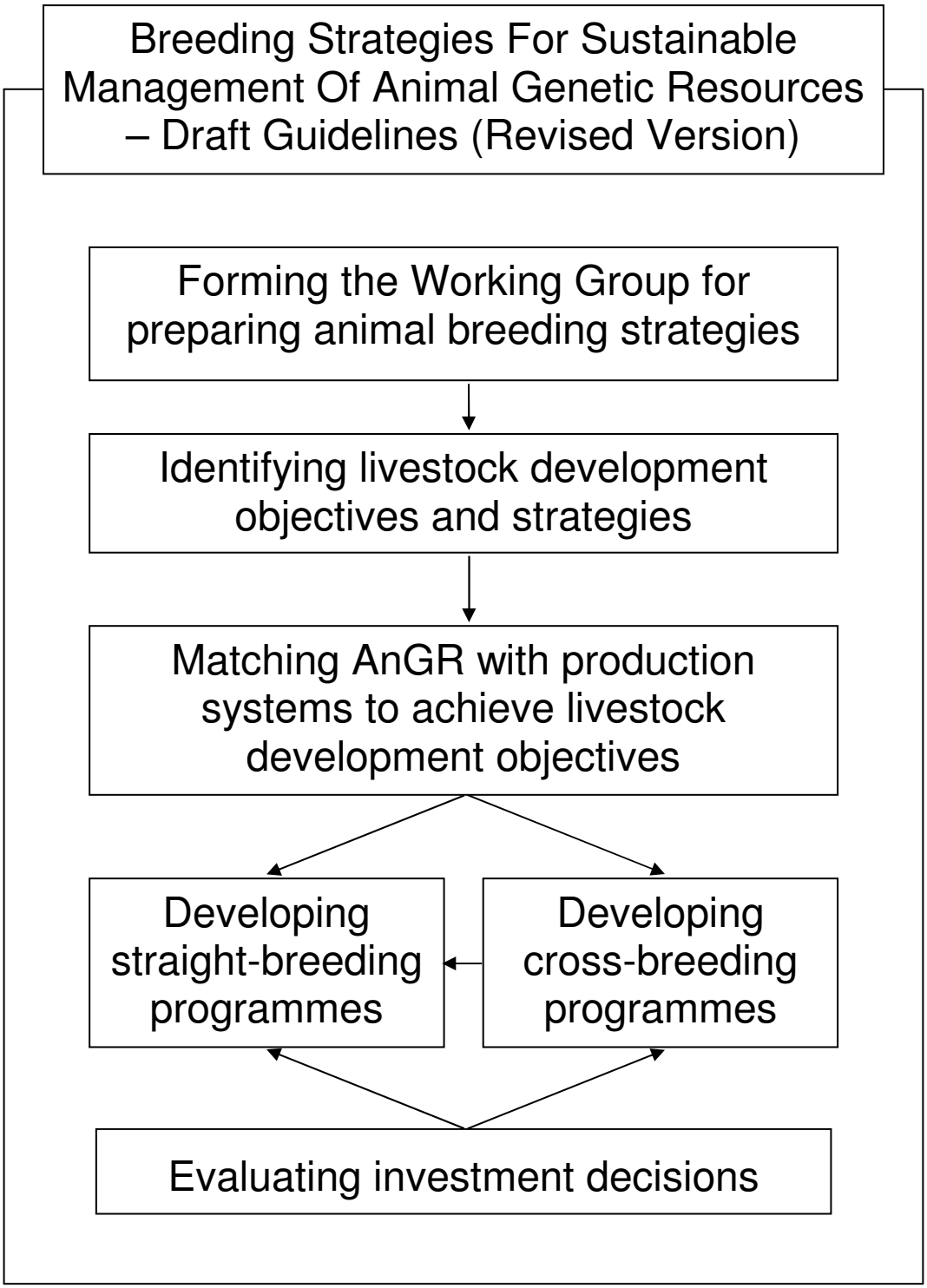
Development of AnGR is only one component of livestock development. Policies and strategies for other components, such as animal health, feed resources and marketing and other services, have to be taken into consideration when developing the breeding strategy.

Several workshops will be needed to formulate a policy and decide on a strategy. For each workshop, background material should be available to participants in advance. This material should include reports on from the outcomes of any previous workshops and on the results of wider consultations held with stakeholders not present at the workshops.

ARE THESE GUIDELINES ONLY FOR THOSE DEVELOPING NEW BREEDING PROGRAMMES?

No, they can also be used to assess and strengthen ongoing breeding programmes.

Figure 1. Structure of the guidelines



SECTION A: FORMING THE WORKING GROUP FOR ESTABLISHING ANIMAL BREEDING STRATEGIES

RATIONALE

The animal breeding strategy component of a country's livestock policy is the main formal instrument for a country's AnGR development and genetic improvement. The process of forming the working group that will formulate the livestock breeding strategy is critical for the subsequent effectiveness, credibility and legitimacy of the strategy. The working group needs to define its own working methods, agenda and responsibilities. It will also need to bring together additional stakeholders and expertise to help with particular aspects of the development and implementation of the strategy. This section provides advice on forming the working group and developing its working agenda.

OBJECTIVES

Establish a working group to formulate a livestock breeding strategy. Set its working agenda and assign responsibilities. Develop an inventory of stakeholders and other potential contributors to the development and implementation of the breeding strategy.

INPUT

Information on governmental and private institutions related to livestock policy and breeding strategies are needed, along with expert advice and collaboration.

OUTPUT

The outputs will be an operational working group that has a working plan and is prepared to prepare a livestock breeding strategy in a given time period. All stakeholders who will need to be involved in the process should have been identified.

TASKS

The following tasks need to be undertaken in order to achieve the above objectives:

1. Establish an inventory of stakeholders.
2. Identify key stakeholders and representatives and form the working group.
3. Discuss a working plan with the representatives.
4. Assign responsibilities.

TASKS AND ASSOCIATED ACTIONS

TASK 1: ESTABLISH AN INVENTORY OF STAKEHOLDERS

It is assumed that there will be an influential start-up group of persons aware of the importance of developing a livestock breeding strategy. This group is likely to be small and include some key stakeholders. It may include, for example, the head of the country's Department of Animal Production or equivalent governmental institution. It may also include members of the National Consultative Committee established for the preparation of the country report on AnGR and the National Coordinator for the Management of AnGR. The start-up group will appoint a leader or chair among its members. They may need to appoint a working group coordinator (the individual who will be responsible for conducting the entire process of establishing and coordinating the working group).

Establishing the actual working group requires the input of all key stakeholders, in particular those who will be responsible for the development and implementation of the strategy. This will not only ensure a useful breeding strategy, but also contribute to its credibility and legitimacy. Livestock keepers are among the most crucial stakeholders and should therefore be represented in the working group. Other stakeholders may be important at specific stages in the development of the document or the implementation of the strategy. The start-up group's first task is, therefore, to establish an inventory of all stakeholders that may contribute to the working group or to the implementation of the breeding strategy.

The inventory might be developed by the leader or chair of the start-up group. Alternatively, it might be assigned to someone else, such as the working group coordination.

Information-gathering and writing the livestock breeding strategy will be time-consuming and costly. The costs need to be projected, and it may be necessary to prepare a project document that outlines the budget for the working group's activities (honoraria, meeting expenses, communications and travel, etc.).

The choice stakeholders to be included in the inventory will depend on the scope and type of breeding strategy being planned and on the stage of development of the strategy. It is essential to include all the stakeholders who will be responsible for the development and implementation of the strategy. The following paragraphs identify potential candidates and describe their possible contribution to the breeding strategy. Table 1 provides a checklist that may help identify relevant stakeholders.

Table 1. Examples of national and local, regional and international stakeholders

Category	Organizations
National and local	Animal health authorities, livestock conservation organizations, breeder associations and companies, consumer organizations, education and training establishments, environmental agencies and associations, extension agencies, farmers' or livestock keepers' associations or unions, financing institutions and credit facilitators, marketing and trade organizations, ministries, departments or divisions in the national government, providers of breeding services (e.g. transport, artificial breeding, performance recording.), research establishments, rural development agencies, other national or local organizations including NGOs
Regional	Arab Center for Studies of Arid Zones and Dry Areas (ACSAD), Arab Organization for Agricultural Development (AOAD), Association of Southeast Asian Nations (ASEAN), Inter-American Institute for Cooperation on Agriculture (IICA), Secretariat of the Pacific Community (SPC), Southern Africa Development Community (SADC)
International	FAO, International Center for Agricultural Research in the Dry Areas (ICARDA), International Fund for Agricultural Development (IFAD), International Livestock Research Institute (ILRI), World Organisation for Animal Health (OIE), Organisation for Economic Co-operation and Development (OECD), World Bank (WB), World Health Organization (WHO), World Trade Organization (WTO), other international organizations including NGOs

National organizations

Farmers' and livestock keepers' associations. Livestock keepers are the key to the success of any breeding policy and it is therefore essential that they be involved right from the start. Their interests, goals and perspectives should be represented throughout the planning process.

Farmers' and livestock keepers' associations, whose main objective is to promote the interest of their members, exist in various forms ranging from lobby organizations to producer cooperatives. Where there is a strong commercial sector, as there is in most developed countries, it is usually well-organized and influential. In many developing countries, however, farmers' and livestock keepers' associations are less well organized and sometimes scarcely visible. They vary in their capacity and the size of their membership. Furthermore, it cannot be taken for granted that such organizations represent the interests of all the farmers or livestock keepers' in the country. Fore example, the interests of farmers in mixed crop–livestock systems differ widely from those of nomadic pastoralists. A full inventory of all farmers' and/or livestock keepers' associations in the country is therefore necessary.

Farmers' and livestock keepers' associations are the link to the primary producers who are custodians of the indigenous knowledge that needs to be considered in the development and implementation of the breeding strategy. They also have a role to play in promoting the breeding strategy among their members and in implementing the strategy; their roles may include practical tasks such as distribution of improved genetic material, animal recording and securing finance. As the implementation of the breeding strategy may affect gender roles, labour and access to livestock and the benefits derived from them, there is a need to check whether women's interests are satisfactorily served by the associations.

Breed societies. These societies are important for the promotion and management of particular breeds. If there is no breed society for the target breed, it is worth establishing one. In addition to having responsibilities similar to those of farmers' or livestock keepers' associations, breed societies take special interest in animal recording, genetic improvement, monitoring the breed population and taking measures to protect the breed if it is threatened with extinction or genetic erosion. These societies are usually private, although some receive government subsidies, especially in developing countries. Breed societies are important for raising awareness among producers' and for organizing breed improvement programmes.

Breeding cooperatives and companies. These organizations provide services such as importing semen and animals, artificial insemination, feed supply, cryoconservation and veterinary and farm supplies. They may be owned or run by the private sector, the state or a mix of the two. They are in regular contact with producers and are therefore able to provide them with technical assistance or pass on specific technical knowledge.

Market operators. These operators are profit-driven and mostly private sector. They are important in promoting the animals or genetic material derived from genetic improvement programmes. If the genetic improvement programme gives rise to branded germplasm or products, these operators will be needed for their promotion.

Training and education institutes. These institutes are an important element of any genetic improvement programme. They train livestock keepers and advisers, and will be able to raise awareness of the programme. Genetic improvement programmes require many technical skills including animal identification and performance recording, animal breeding and genetics, animal husbandry, animal health management, data collection, data analysis and data interpretation. Training and education institutes are therefore crucial. They also provide a platform for networking, and many such institutes carry out extension work. In developing countries, the institutes in question are usually governmental or semi-governmental – universities for example – but the private sector is becoming more involved in organizing workshops, seminars and other training and educational activities.

Extension agencies. In most developing countries, extension services are provided by the government and national universities. Some cooperatives and companies also engage in extension activities. Extension agents are crucial to the genetic improvement programme. Their interactions with the end users (the livestock keepers) address many environmental, technical and socio-economic aspects of production (e.g. how to raise a cross-bred animal, the need for animal recording, and the potential benefits of using improved genetic material).

Financing institutions and credit facilitators. Genetic improvement programmes are multigenerational and continue for many years. They therefore need long-term financing. Some countries set up special funds for these activities, financed by various organizations including the government and foreign aid programmes. Livestock keepers may need financial support to enable them to participate in a genetic improvement programme and to pay for the improved genetic material. In such cases, the breed society or livestock keepers' association may act as collateral to facilitate credit. Credit may be offered by specialized banks, such as livestock banks or agricultural banks, or by general banks or loan associations.

Consumer organizations. These private NGOs represent the interests of the consumers.

National research institutes. These state institutions – universities, agricultural and veterinary schools and national agricultural and livestock research centres – can assist the breeding programme by researching topics such as genetic evaluation methods, breed valuation, dissemination of improved genetic material, the care of improved animals or the management of introduced germplasm. They can also provide expertise on production systems, socio-economics and gender issues, thereby helping to enhance the sustainability of the breeding programme.

National animal health authorities. Veterinary services need to be involved in all genetic programmes to ensure that germplasm is imported and disseminated safely and to provide the additional care needed by improved stocks. In developing countries, veterinary services are mostly provided by the public sector. However, in many cases the government does not have adequate resources to run them satisfactorily. Veterinary services are therefore increasingly offered by the private sector. Quarantine and import/export certification are still carried out by the government services.

Relevant national government ministries or departments. Government and legislative bodies are crucial to the success of genetic improvement strategies. Government ministries or departments will play a key role in identifying the LDOs that the strategies must address. An appropriate body of legislation and legislative environment are needed to ensure the smooth running of a breeding programme. In addition to its legislative and regulatory responsibilities, the government issues and supervises licences for activities such as importing and branding.

Local stakeholders

The responsibilities of local stakeholders will be similar to those of national stakeholders, but scaled down to the local level. Local responsibilities assume more importance in large countries with varying ecologies, topography and ethnicity. Farmers' or livestock keepers' organizations representing marginal groups, such as nomadic pastoralists or ethnic minorities, are more likely to be found at the local than at the national level.

Regional stakeholders

Regional stakeholders and their responsibilities vary greatly from one region to another, but they generally contribute to research, training, development and sometimes financing. Regional stakeholders may also play important roles when the breeding strategy involves a genetic resource common to a number of countries in the region (e.g. Simmental cattle in Central Europe, Boran cattle in East Africa and Awassi sheep in the Near East). In such cases, regional consultation and coordination are needed and the relevant organizations should be included in the stakeholder list.

International stakeholders

International stakeholders may be important when the breeding strategy involves international collaboration, such as the transfer of genetic material and associated information from one country to another. A number of different international intergovernmental organizations are mandated to deal with various areas of policy and technical development.

TASK 2: IDENTIFY KEY STAKEHOLDERS AND REPRESENTATIVES, AND FORM THE WORKING GROUP

Drawing on the stakeholder inventory (Task 1), relevant stakeholders should be contacted and invited to a workshop that will focus on a broad discussion of current and potential future livestock policies and breeding strategies. At the workshop, the stakeholders should discuss their perspectives on livestock policies and their potential roles as these policies are taken forward. Agreement should be reached on the need for a livestock breeding strategy. It is important for mutual understanding and acceptance that the decision-making perspectives and time frames of each stakeholder be identified (Box 2).

Box 2. Decision-making perspectives and time frames

Decision-making perspectives. If a national policy-maker is asked what direction livestock production should take, the answer will differ from the answer offered by an individual livestock keeper. Neither is wrong; they simply view the question from different perspectives. Logically, the national policy-maker is concerned with the national economy and the availability of food for all, while the individual livestock keeper is concerned with his or her family and with the profits and other benefits can be obtain from their herd or flock. *Thus, the answer to any question is likely to depend on who is asked.*

Decision-making time frame. If a veterinarian asks a livestock keeper what needs to be done during a visit, the livestock keeper may indicate that there is a sick animal that needs treatment because of a bacterial infection. On the next visit, the livestock keeper may say that the animals in the herd regularly suffer from the same infection, because it is endemic to the herd, and that he or she wants assistance in identifying animals that suffer subclinically from the infection. Over time, the veterinarian and the livestock keeper may set up a management programme to reduce the risk of clinical infections. If the veterinarian asks the livestock keeper what he or she will need in the future, the answer may be select resistant animals that will be easier to manage. The decisions and actions will change according to the time horizon considered. *Different stakeholders with different time horizons may come to different but equally valid conclusions.*

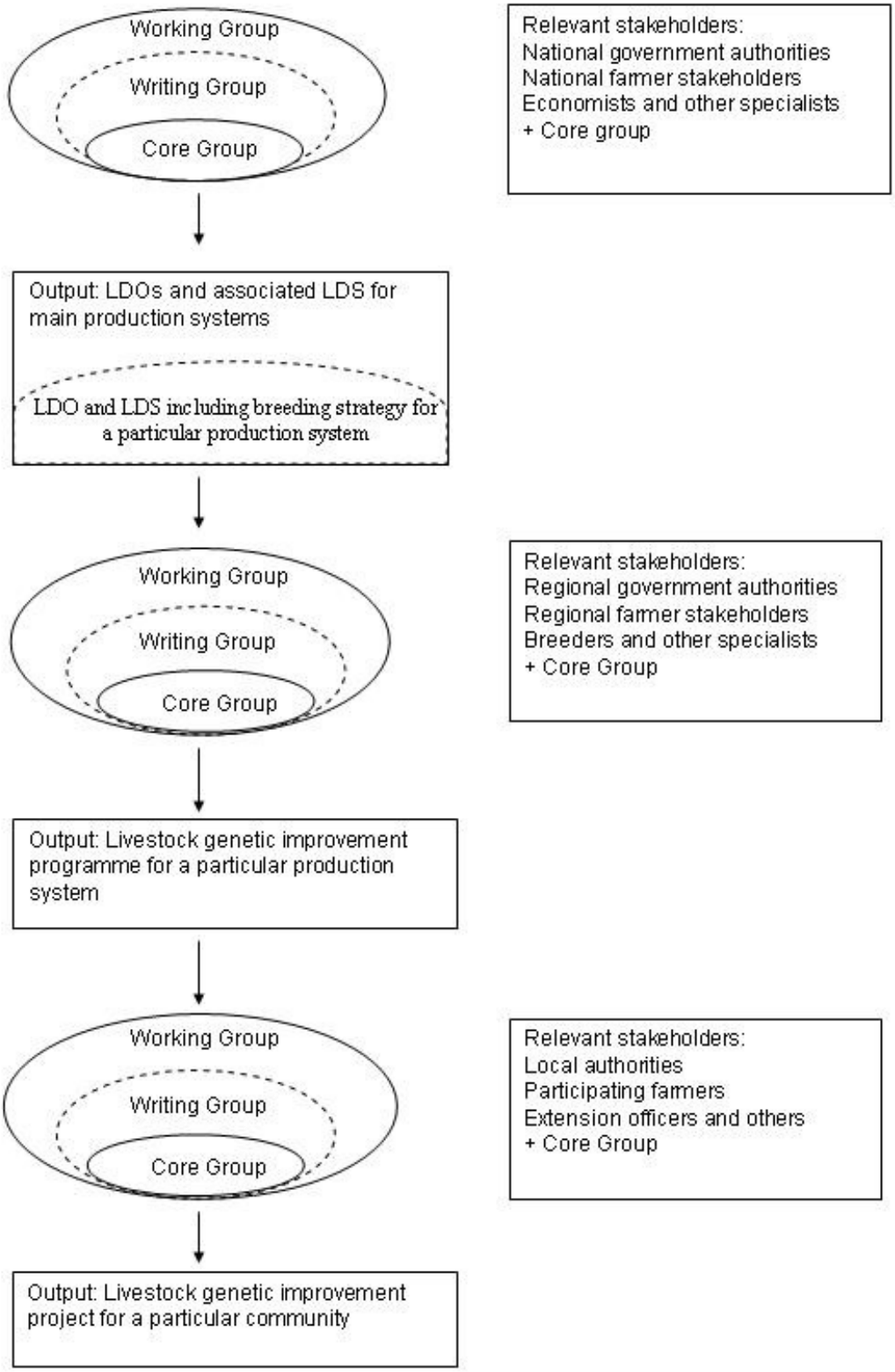
The establishment of a working group should be proposed and the workshop participants should agree on key institutions to join the group. The proposed institutions should be formally invited to become members of the working group and asked to nominate representatives. A list of names, contact addresses and potential contributions should be drawn up. If the list is long, it will be useful to record keywords for each contact in order to help identify their potential contributions. The individuals included on the list will constitute the initial working group that will be directly involved in developing the breeding strategy.

The working group will normally be too large to be an effective group for writing documents. It will be necessary to select a smaller writing group from among them**,** which is likely to require three to seven members. The other working group members should be called upon to participate in the major decisions regarding the content of the document and to review the draft.

As the working group will have to discuss and agree on a range of issues as the breeding strategy is developed, it may need input from additional stakeholders and experts. The composition of the working group may therefore change. However, a core group of members including the coordinator should remain throughout the process in order to ensure continuity and accountability (Figure 2 and Box 3).

One workshop should be sufficient to allow responsibilities to be distributed within the working group and the smaller writing group.

Figure 2. Dynamic composition of a working group – an example



Note: A core group of stakeholders should remain in the working group and in the writing group throughout the entire process of developing the breeding strategy.

Box 3. Composition of the working group

As the strategy is developed, the composition of the working group may change slightly, with a subgroup of its members remaining and new experts and specific stakeholders joining the group.

Example 1: Typically, the working group in charge of identifying a country's livestock development objectives will include: policy-makers, livestock officials and economists, with access to a wide range of technical experts, such as veterinarians, social scientists, economists, statisticians and livestock development specialists. The working group discussing the genetic improvement programme for a particular species in a particular production system will include local officials, animal breeders and livestock keepers. Breeders and livestock keepers should be, if possible, represented by their respective associations. Both working groups would benefit from the participation of sociologists and persons knowledgeable about minority groups and gender issues.

Example 2: Assume that the initial working group has prioritized the development of two livestock production systems: dairy production in fertile valleys and sheep production in high rangelands. The working group may split into two subgroups (with some overlap in their membership) each dealing with the formulation of the breeding strategy for one of the two targeted production systems. Representatives of artificial insemination centres and dairy breeders' associations may participate in the dairy subgroup and local wool buyers and local rangeland officials in the sheep subgroup.

Example 3: Assume that a genetic improvement programme in a particular production system involves more than one project. Again, the working group in charge of writing the strategy document for a particular project may include a subset of the stakeholders involved in the working group for the programme as a whole, with additional experts participating as necessary. Alternatively, the work may be delegated to a breeding company, cooperative or university. The working group may also consider other relevant ongoing or planned projects and describe them in the document if details are available and if they are consistent with the development objectives and strategy.

TASK 3: DISCUSS A WORKING PLAN WITH THE MEMBERS OF THE WORKING GROUP

Working group members should be invited to a second workshop to discuss a working plan for formulating the livestock breeding strategy. At the workshop, the objectives should be clarified and the duties of the working group and its writing group described and agreed upon.

The working group must establish its own working plan. Although it is impossible to suggest a universal format for such a plan, it is likely to include the following key elements:

- **Time schedule**. Typically, the final policy document should be ready for implementation in less than one year. This will help maintain stakeholder interest and will mean that decision-makers and investors are given an up-to-date document to consider.
- **Budget.** As mentioned under Task 1, operational costs of the working group must be projected and funding secured in order to allow the timely delivery of a high-quality final document.
- **Stakeholder involvement.** The commitment of stakeholders must be ensured. Their involvement in the working group should be commensurate with their expected roles and responsibilities in the breeding strategy. Participation and consultation must be organized so that all stakeholders, including those not directly participating in the working group, are able to express their opinions.
- **Availability of inputs from experts.** Terms of reference for experts' reports, seminars, specific training or other contributions to the process should be prepared.

- **Expected outputs and persons in charge.** This element of the plan is discussed as part of the next task.

As national stakeholders usually prefer to have few meetings, the schedule for working group meetings needs careful planning. The writing group may meet more frequently. Questions and doubts that arise while writing the document can be presented for discussion at working group meetings. Minutes of each meeting, including agreed points, should be kept.

As the preparation of the breeding strategy progresses, target production systems will be identified and specific genetic improvement programmes will be addressed. At this point, it may be advisable to bring in additional experts and to provide the working group with specific training. Participants' knowledge and experience should therefore be assessed. Special attention needs to be paid to gender related issues. If necessary, invest in coaching participants. This can be done, for example, through workshops at which presentations are made on current breeding plans, designing breeding programmes or other relevant topics. Avoid an overly technical focus and pay attention to issues such as the socio-economic changes likely to be brought about by the breeding programmes.

There may be a need to contract experts to undertake tasks such as collecting market information, performing investment analyses or assessing gender impacts. Funding for these contracts and for other working group operations may be sought nationally or internationally.

Box 4. A task force for formulating livestock breeding policy – an example from Kenya

In May 2007, the Kenyan Ministry of Livestock and Fisheries Development (MoLFD) appointed a Ministerial Task Force to formulate a livestock breeding policy as an integral part of the National Livestock Development Policy of 1980 (currently a Sessional Paper on National Livestock Policy) and established its terms of reference. The task force, chaired by the Chief of Animal Production at MoLFD, is composed of representatives of MoLFD, the Agricultural Development Corporation, the Kenya Agricultural Research Institute, International Livestock Research Institute, the University of Nairobi, Egerton University, the Kenya Livestock Breeders' Organization, and FARM–Africa (an NGO).

After various field visits and two regional workshops, the writing group of the task force produced a first draft of the National Animal Breeding Policy. Two other regional workshops were held and the views of the stakeholders were incorporated in the draft document. A national forum is scheduled for wider consultation. Funded jointly by the Smallholder Dairy Commercialization Programme (supported by the International Fund for Agricultural Development) and the MoLFD, the project was expected to be completed in one year. However, because of to an extra round of consultations the project was extended.

Provided by Cleopas Okore.

TASK 4: ASSIGN RESPONSIBILITIES TO THE MEMBERS OF THE WORKING GROUP

All members of the working group should be committed to developing a successful livestock breeding strategy. The working group coordinator will be responsible for the implementation of the working plan and should report to policy-makers. Most working group members are likely to be designated on an ad hoc basis by their respective institutions and will report to them. The writing group will be expected to complete its task on time. Responsibilities are therefore straightforward, but they should be explicitly described in the working plan.

A distinction must be drawn between the responsibilities that representatives and stakeholders have in the operations of the working group and the writing group and those that stakeholders will have in the implementation of the planned animal breeding strategy. The latter responsibilities should be formalized in letters of agreement or similar binding documents.

Establishing a sustainable animal breeding strategy requires coordinated efforts among many actors. The type of stakeholders involved and their responsibilities will vary depending on, *inter alia*, the country's system of government, its degree of development, the capacity of the private sector, and the species and breed(s) targeted. In low external input production systems in developing countries, local and national governments can be expected to play a dominant role at least initially. However, this may change once the strategy has become more established. Table 2 outlines stakeholders' roles and responsibilities.

Table 2. The main tasks and responsibilities of the implementing organizations

Organization / Tasks	Livestock keepers' associations	Breeders' associations or breed societies	Breeding cooperatives and companies	Training and education institutions	Market operators	Extension agencies	Financing institutes and credit facilitators	Consumer organizations	Research institutions	Veterinary authorities	Relevant government ministries or departments
Policy-making	●	●									●
Legislation/ regulations											●
Finance	●	●					●				●
Training and education				●							●
Extension			●	●		●					●
Technical			●	●					●		●
Marketing	●	●			●	●		●	●		●
Consumer orientation					●			●			
Environment considerations	●	●				●			●		●
Conservation		●	●	●		●					●
Service provision			●								●
Animal health services				●		●			●	●	●
Public relations	●	●						●			
Gender impact and gender issues	●			●		●			●		●

SECTION B: IDENTIFYING LIVESTOCK DEVELOPMENT OBJECTIVES AND STRATEGIES

RATIONALE

There is a need to be clear from the outset what objectives are to be addressed by the breeding strategy. Developments in the livestock sector, including any breeding activities undertaken, should ultimately aim to meet some desirable objective(s) in human development terms. These objectives will vary from production system to production system depending on the needs and aspirations of the livestock keepers concerned and those of other stakeholders at local and national level. Overall objectives will normally be set out in the country's existing livestock policy.

For any production system targeted it is necessary to identify how livestock development should fit in to national strategies for the livestock sector. An initial requirement is to identify objectives for livestock development within the production system that are realistically achievable given the current state of the system in question and the roles of livestock within it. This requires knowledge of the policies and legislation that may promote or hinder particular development pathways. It also requires knowledge of economic, social, technological, environmental and climatic trends that are affecting the production system. The above-mentioned stakeholder needs and aspirations also need to be taken into account. On the basis of a careful analysis of information on all these aspects of the production system, it should be possible to elaborate a set of "livestock development objectives" (LDOs) – clear and concise statements of high-level goals or targets specific to the production system. A medium- to long-term perspective is needed.

Addressing any LDO will require a corresponding set of livestock development activities. These activities constitute the "livestock development strategy" (LDS). An LDS will typically use a combination of five broad components – breeding, feeding, health care, husbandry and marketing. The contributions of these components will depend on the LDOs and the development opportunities within the specific production system. By identifying the LDOs, and the LDS needed to achieve them, it should become clear whether a breeding strategy is required for a given species within the production system in question, and what the strategy needs to achieve. Box 5 describes some qualities that LDOs and the associated LDS should have if they are to be successful.

Failure to identify appropriate LDOs or seeking to address the LDOs with a flawed LDS increases the risks that:

- the LDOs will not be fully achieved because of unforeseen barriers caused by national policies or other constraints, or because of unreasonable expectations regarding livestock keepers' capacities and motivation to manage the desired changes;
- benefits in terms of poverty alleviation or social development will be lower than expected;
- economic, social and environmental costs will be greater than expected; and
- some functions of livestock keeping will be neglected leading to unexpected and unwelcome consequences.

This rationale is relevant to national and regional governments. It is clear that the activities described in this section are not intended to be undertaken by a local community or cooperative seeking to introduce a breeding component into their activities. However, it is worthwhile for these groups to identify LDOs and an appropriate LDS for their country (region) as this help them to identify and respond to future developments and trends.

OBJECTIVES

Identify achievable LDOs and design an LDS to achieve the LDOs for all important production systems within the country (region), with particular emphasis on assessing whether there is a need for a breeding strategy and what its role might be.

INPUT

The input for this section is the list of stakeholders that will have been prepared during the implementation of the tasks described in Section 1.

OUTPUTS

The outputs are:

- an inventory of policies and legal instruments along with knowledgeable contacts;
- a report entitled *Identifying livestock development objectives* in which the LDOs is described;
- a report entitled *Identifying the livestock development strategy* in which the breeding strategy is described.

TASKS

The following tasks need to be undertaken in order to achieve the above objectives:

1. Prepare the *Livestock and enabling policy assessment*
2. Prepare the *Production systems assessment*
3. Prepare the *Trends assessment*
4. Identify livestock development objectives
5. Identify the livestock development strategy

Box 5. Qualities required in a set of livestock development objectives (LDOs) and the associated livestock development strategy (LDS)

For LDOs to succeed, they should provide a sound platform on which to develop an overall LDS and subsequently its breeding component. They should:

- be achievable;
- be sustainable;
- embody priorities for development over the medium to long term;
- recognize, consider and account for livestock keeping's various roles (e.g. providing food security and livelihoods to rural communities, contributing to the national economy and influencing the environment) and how these are changing;
- be supported by (and consistent with) policies that give a lead to livestock keepers, their associations and their service providers, encouraging them to become and remain involved in the development effort and even to champion it;
- recognize how different production systems can contribute to overall development objectives;
- recognize how achieving the objectives may have differential impacts on different production systems and on different actors within them (e.g. on men and women);
- recognize both national and international supply and demand trends for animal products;
- recognize environmental and social trends;

- recognize the implications of global climate change for each production system; and
- be based on wide stakeholder support and understanding.

An LDS for a specific production system should:

- address the agreed LDOs;
- be sustainable;
- be technically, institutionally and financially feasible, with an agreed time and schedule for implementation;
- not be socially harmful or disruptive, and have no negative impacts on women or on minority groups;
- integrate different strategic components, such as breeding, feeding, health care, husbandry and marketing;
- have a set of practical indicators for measuring progress towards the LDOs; and
- have wide stakeholder involvement, including clear allocation of responsibilities for implementing the actions that have been agreed upon.

Box 6 provides general guidance on how to get the most out of identifying LDOs and designing an LDS. It emphasizes the fact that good documentation is an investment for the future and shows the importance of concentrating on the fundamentals at the beginning of the process. Some of the questions posed in Tasks 1 to 3 are challenging and reliable information may be scarce or unavailable. Missing or uncertain information can be flagged and the need for further data collection highlighted.

Box 6. Getting the most from identifying LDOs and the associated LDS

Developing inventories of stakeholders, policies and legislative instruments, and understanding the different production systems within the country will require dedicating considerable time and effort to research and collating information. Clear inventories are important outputs and should be valued as resources that will allow future assessments to focus more directly on understanding and analysing how all these elements fit together. Sources (both documents and experts) should be carefully listed and accompanied by notes on their provenance and on their degree of informativeness. The information assembled should be used to identify and record strengths and weaknesses within the agricultural and livestock sectors.

When developing the LDOs it may be useful to consider the following questions:

- What are the social and economic roles of agriculture and livestock in particular?
- To what degree do policies enable livestock development to address the needs of communities and of different groups (consider age, social status, profession, etc) within the communities?
- What needs to be done to improve nutrition, alleviate poverty and promote sustainable livelihoods?
- What is a realistic assessment of livestock keepers' capacities and motivation to participate in an LDS?
- Are current practices within the production systems environmentally sustainable?

If an existing set of LDOs and LDS are being further developed, some of the work of compiling inventories will already have been done and experience will have been gained. Consider the following additional questions, which may help to strengthen the LDOs:

- How might the analysis be modified in the light of the successes and failures of previous LDOs?
- Do the LDOs recognize the roles played by different AnGR in livestock production and rural communities?
- Do the LDOs ensure that benefits accrue to both the livestock-keeping and the consuming sectors of the community?
- Do the LDOs promote livestock keepers' involvement (without a gender bias) with support services and in capacity building?
- Do the LDOs adequately recognize different gender roles in livestock management?
- If the LDOs provide for intensification of production systems, is this intensification sustainable economically, socially and environmentally?

TASKS AND ASSOCIATED ACTIONS

TASK 1: PREPARE THE *LIVESTOCK AND ENABLING POLICY ASSESSMENT*

The purpose of completing this task is to answer the following questions:

- What are the social and economic roles of agriculture and of livestock in particular?
- To what degree do policies enable an LDS to address the needs of communities?

Information will also be obtained on the policies that influence livestock keepers' capacities and motivation to participate in the LDS and on the sustainability of the production systems. This will help to answer the following questions:

- What is a realistic assessment of the livestock keepers' capacities and motivation to participate in the LDS?
- Are current practices within livestock production systems environmentally sustainable?

Box 7. Livestock policy is indispensable for formulating a breeding policy

The first attempt to formulate an animal breeding policy in the United Republic of Tanzania was in 1991. In 2003, a second attempt led to the presentation of a draft animal breeding policy. However, the Ministry of Agriculture realized that no livestock policy was yet in place and gave priority to establishing one. This was done in 2006. In March 2008, an FAO workshop on policies and strategies for the development of AnGR was held in Dar es Salaam, with the objective of revitalizing the draft animal breeding policy. A new task force was given the job of reformulating the policy. Similar cases in other countries such as Burundi illustrate that before formulating a breeding policy it is important to have established a comprehensive livestock policy that defines livestock development objectives and associated strategies.

Provided by Sachin Das.

Action 1: Obtain the relevant information

This first action is simply stated, but is challenging and time-consuming. Obtain copies of the most recent overall plans, policies and legal instruments affecting agriculture. It may be appropriate to hire consultants to do this before the working group meets.

Policies and legal instruments in the following areas should be considered:

- production inputs and outputs;
- availability of agricultural services (e.g. extension services and recording services);
- food security;
- poverty alleviation;
- sustainable livelihoods and the development of rural communities;
- credit and finance facilities;
- market development and trade;
- farmers' and livestock keepers' organizations;
- public–private sector involvement; and
- incentive systems

Other policy areas that may be relevant include food safety, import/export regulations (notably those concerning animal material), prevention or control of animal diseases (particularly transboundary diseases), biodiversity, animal welfare, minority groups (including pastoralists) and land tenure.

Policies and legal instruments affecting AnGR may emanate from a variety of government departments and ministries, including those concerned with food production, food safety, rural development and credit, employment, trade and marketing, tourism and culture, nature conservation and the environment, animal quarantine and biosecurity, and social and individual security. The policies and legal instruments of other countries may also be relevant, particularly those that affect trade. For example, the European Union places restrictions on the import of food products from countries where foot-and-mouth disease is endemic and sets standards for the quality of imported food.

The country reports developed during the preparation of *The State of the World's Animal Genetic Resources for Food and Agriculture* (FAO, 2007) may be valuable sources of information on livestock-related policies. If a previous set of LDOs has been well prepared, it should prove an excellent point of reference.

Note that agricultural policies may be annual or may cover a longer period. They may appear under various names – "livestock plan", "livestock strategy", etc. Short-term plans are less relevant than long-term plans to the development of an LDS because the strategies, particularly if they include breeding strategies, need to be sustained for a long period. Documents related to national budgets may also offer useful information on planned livestock-related activities, particularly when details in agricultural plans are minimal or non-existent. Examine policy documents other than those concerned directly with agriculture.

Consult informed people from the government and beyond. Such people are often extremely valuable sources of information who can clarify ambiguities in the documentation. Ask them to put some ideas on paper regarding how current and possible future policies may affect agriculture. Prioritize the search for information, particularly where time is limited. Build a foundation for the future by preparing a clear inventory (e.g. a spreadsheet) of the policies and legal instruments. Specify where the information has been collected and when, describe its relevance and, if appropriate, provide a contact.

Action 2: Clarify the role of livestock in the country's major production systems

This action addresses the question: What are the social and economic roles of agriculture and in particular livestock production? The production systems within the country or region will be identified. The production system classification developed at this stage will be used throughout the rest of the planning process because all development must be appropriate to the production system and its capacity for change.

(i) Identify the most important production systems in the country (or region). This will require technical assistance from a livestock production and development specialist. Even if a list of production systems is already available (e.g. from a previous set of LDOs), it should be reviewed and if necessary revised to ensure its appropriateness and relevance. Avoid making the list too long, so that the working group is able to address it adequately in the time allotted. If necessary, refine the list by grouping systems with similar characteristics. For example, intensified systems, those driven by agro-ecological considerations and those that potentially play important roles in poverty alleviation. Subsequent revisions of the LDOs can expand and strengthen the list.

(ii) Develop an inventory of the contributions of livestock to all aspects of the community. Draw on a wide range of sources including technical, sociological and farming-systems research, as well as relevant policies and legal measures. Livestock's contributions may include inputs to crop production (manure and draught power), marketed and non-marketed animal products, employment, and social and cultural roles. Carefully identify all livestock functions, paying special attention to non-monetary benefits, to non-quantifiable contributions and to indirect and

long-term benefits (Box 8). Be aware that customs may have a rational basis and serve production and management purposes (e.g. pastoralists have relatively large herds not for prestige or because of cultural attachment to their animals, but as a risk reduction strategy). Classify the roles that are relevant to each of the major production systems identified. Review the results by comparing them to existing literature, consulting researchers working on farming systems or socio-economics, and meeting with extension service agents and local livestock keepers. Revise the list if necessary.

(iii) Quantify the contributions of livestock wherever possible. Quantitative measures may be available from documentation associated with policies and legal instruments. If this is the case, examine whether the documents actually provide a full description of the all roles of livestock. Seek technical assistance to do this and to derive new measures if necessary. Ensure that the summary statistics are clear and meaningful. Where quantitative measurement is not possible, provide an estimate – for instance, to the nearest 10 percent or an even more approximately (e.g. "high", "medium" or "low"). Note any major differences between the roles that livestock play in different production systems.

Box 8. Measures of livestock's importance

Economic importance, based on marketed products. The following measures are based on marketed outputs from livestock:

- the contribution of livestock products to agricultural GDP;
- the contribution of livestock products to the rural economy;
- the contribution of livestock products to exports;
- the contribution of livestock products to meeting current and projected future demands for food; and
- the contribution of livestock-related activities to national employment.

Measures based on marketed products may grossly underestimate the importance of livestock, as some important outputs may not be taken into consideration. For example, livestock in low-input production systems are often major providers of fertilizer for crop production.

Economic importance, based on non-marketed products and services. There is a need to account for the degree to which rural communities are reliant on non-marketed livestock products and services as inputs to crop production and to meet household needs – items that would otherwise need to be purchased or obtained through other means. Examples include:

- fertilizer for crops;
- draught power for ploughing and transport;
- food for the household (milk, meat, eggs);
- fibre and hides for clothes, housing, ropes, containers and other household goods;
- dung for fuel and plaster;
- savings, absorption of surpluses, buffering of fluctuating income, risk management; and
- long-term livelihood security.

Social, cultural and environmental importance. Social and cultural processes that involve livestock need to be considered, as do any ecological or landscape services that livestock provide. Examples include:

- social relations/cohesion (social capital) forged and sustained via livestock transactions;
- gender roles – women derive status, autonomy and security from owning, holding in trust, transferring, managing and marketing livestock and livestock products;
- local and indigenous knowledge;
- maintenance of habitats for wild biodiversity; and
- interactions between livestock and minority groups including indigenous peoples.

(iv) Examine policies and legal instruments that affect food and agricultural production, and assess whether they adequately recognize the importance of livestock, both for their contributions to food and agricultural production and to society and culture. Note whether major differences between the production systems are adequately recognized. If they are not, note which contributions are neglected.

(v) Draft the first part of the *Livestock and enabling policy framework*. This will involve:

- listing and briefly characterizing the production systems that have been identified. The characterization should include:
  - the balance between subsistence and marketed production,
  - land tenure,
  - the kinds of people involved (e.g. their gender or whether they are indigenous peoples),
  - numbers employed and type of employment, and
  - the kind of institutions supporting agricultural activity (public, private or cooperative).
- describing the roles of livestock in the various production systems and, as far as possible, quantifying their contributions; and
- collating the results of the analysis of policies and legal instruments.

Action 3: Summarize policies and legal instruments related to the production environment, livestock, supporting infrastructure and human participation

The following questions should be addressed directly:

- To what degree do policies enable the LDS to address the needs of communities?
- How do policies influence livestock keepers' capacities and motivation to participate in an LDS and the environmental sustainability of production systems?

Unfortunately, there is no model set of criteria against which a country can judge the adequacy of its policy and legal instruments. Different countries may take different approaches to legislation and policy-making in order to achieve the same ends. Similarly, there is no comprehensive set of procedures for describing the variety and complexity of livestock development across all countries, each of which has its own social and cultural characteristics. Careful assessment of the various policy and legislative areas that may affect the development of the countries' production systems is therefore required. Consideration should be given to instruments that affect the production environment, the livestock themselves, the supporting infrastructure and human participation in development.

Policies and legal instruments related to the environment. Livestock can have both a positive and a negative impact on the environment. For example, while the effects of grazing and manuring can increase species diversity in the vegetation and the soil, overgrazing diminishes diversity and promotes soil erosion. Consideration must be given to the effects that policies and legal instruments may have on the environment, both locally and more broadly. Use Box 9 to identify potential environmental issues for consideration. Examine the policies and legal instruments and consider whether and to what degree they promote unsustainable use of environmental resources or inhibit sustainable intensification of production systems. Recognize the need to prepare for climate change and its potential impact on food and agricultural production. Note whether policies and legal instruments related to the interactions between livestock and the environment are integrated into wider environmental policies, such as national action plans on biodiversity. Note whether there are policies that affect particular production systems (e.g. those lying within national parks). Obtain relevant technical assistance to address the issues raised and to assess their implications for the LDS.

Box 9. Livestock-related environmental issues that may be covered by policies and legal instruments

Policies and legal instruments related to the following environmental issues, *inter alia*, may need to be considered when developing livestock development and breeding strategies:

- soil erosion associated with grazing systems;
- depletion of soil nutrients;
- disposal of animal waste;
- water availability and management;
- water pollution;
- gaseous emissions associated with climate change;
- forest conservation and management; and
- the integration of livestock management with the management of wild flora and fauna.

Policies and legal instruments related to livestock. Identify policy and legal instruments that affect the management of livestock. Obtain appropriate technical assistance to interpret their implications for the LDS (Box 10). Note whether there are policies that affect particular production systems.

Box 10. Aspects of livestock management that may be directly targeted by policies and legal instruments

The topics below are broadly grouped according to the different components of a livestock development strategy (breeding, feeding, health care, husbandry and marketing); some topics are relevant to several components. The list is not exhaustive:

- use of local breeds and introduction of exotic breeds;
- development of straight-breeding and cross-breeding programmes;
- value of AnGR adaptations to specific environments and production systems;
- use of reproductive and molecular biotechnologies;
- structure of markets to encourage livestock keepers' participation;
- responsiveness of markets to products from improved stock and special products;
- recognition of at-risk breeds and procedures to monitor them;
- provision of extra support for funding conservation programmes for at-risk breeds;
- conservation and use of feed and water resources;
- safety of feeds for animal consumption;
- quality of feeds to ensure safety of products for human consumption in domestic or export markets;
- administration of veterinary drugs and vaccines;
- quarantine requirements;
- import and export of AnGR;
- procedures for disease surveillance and control;
- access to veterinary services;
- geographic location and density of livestock and their housing;
- movement of flocks, herds and individual animals;
- health and safety of workers in the livestock sector;
- animal welfare – as affected by housing, feeding methods, milking, slaughtering and use of animals for work;
- barriers to trade in livestock or livestock products related to the production environment or disease problems; and
- marketing needs for different species.

Other relevant policy areas include:

- decentralization (newly created municipalities may impose access rules or movement restrictions for livestock);
- land tenure;
- settlement of nomadic pastoralists or use of pastoral land to resettle crop producers; and
- tourism (e.g. the development of game parks may affect livestock keepers' access to grazing grounds).

Policies and legal instruments related to the supporting infrastructure. Identify policies and legal instruments related to the supporting infrastructure for livestock development and obtain appropriate technical assistance to interpret their implications for the LDS. Box 11 lists issues to consider. Note any deficiencies and how particular policies affect particular production systems.

Pay particular attention to policies and legal instruments concerned with extension services and research and development. (including funding) and consider how they might affect the LDS. Consider whether these provisions cover the full range of strategies that might be used to improve livestock production (i.e. breeding, feeding, health care, husbandry and marketing). Note any deficiencies. Consider whether policies and legal instruments provide for the following:

- adequate planning and reviewing of research and development priorities;
- mechanisms for livestock keepers, their associations and support services to become involved in planning and reviewing research and development and in implementing the outcomes; and
- effective translation of research and development into practice.

Box 11. Supporting institutions and services that may be the focus of policies and legal instruments

- Extension services
- Research and development services
- Finance and credit services
- Market access
- Transport services
- Breeding associations and breed societies
- Veterinary associations
- Agricultural training
- Direct or indirect government incentives or disincentives for the use of particular breeds or breeding stock or for the production of particular products
- Information technology (e.g. data protection acts restricting access to recording databases)
- Gender policy affecting the operations of extension services, research institutes and financial service providers (e.g. defining a female target group or prescribing special loan conditions for women).

Policies and legal instruments related to human participation. Identify policies and legal instruments affecting human participation in livestock development. Obtain appropriate technical assistance to interpret their implications for LDS. It is important to consider, *inter alia*, how policies and legal instruments affect:

- the role of indigenous knowledge;
- gender roles (e.g. in livestock husbandry);

- benefit-sharing among community sectors (e.g. livestock keepers, retailers and consumers);
- pastoral communities;
- land tenure and ownership;
- smallholders; and
- the availability of microcredit.

Consider whether policies and legal instruments take into account the differing capacities livestock keepers and other stakeholders in different production systems. Analyse whether policies and legal instruments strengthen or weaken livestock keepers' capacity to participate in breeding strategies, noting any major differences among production systems. Assess the risk of excluding certain groups (e.g. women, nomadic pastoralists or members of particular castes or tribes).

Action 4: Complete the Livestock and enabling policy assessment

Consider the following question and summarize the conclusions: To what degree do policies enable an LDS to address the needs of the communities? Summarize how policies influence livestock keepers' capacity and motivation to participate in an LDS and the environmental sustainability of current production systems. Where possible, assess and comment on the degree to which previous policies have been effective; assess the reasons for any failures.

Box 12. Policy-related constraints – the case of Nagauri cattle in Rajasthan India

In Rajasthan, India, animal welfare regulations interfere with the breeding of the Nagauri draft cattle breed. The demand for these animals is high in neighbouring states – for instance for rice cultivation. Animal welfare regulations prohibit the transport of the Nagauri cattle across state borders in order to prevent their illegitimate slaughter. However, the regulations also stop the cattle from being sold for other purposes. Selling the animals not only allows livestock keepers to make a profit, but it also contributes to the sustainable use and conservation of the endangered Nagauri. The consequence of the transport restrictions is that livestock keepers give up breeding the Nagauri.

The actual implementation of enabling policies may represent another obstacle. After decades of promoting cross-breeding only, the Indian Department of Animal Husbandry has changed its policy and now supports indigenous breeds. However, government veterinarians are still obliged to carry out a certain quota of artificial inseminations; the only semen available for this purpose is from exotic breeds.

Policy-related constraints to implementation need to be taken into consideration when preparing a breeding strategy.

Provided by Ilse Koehler-Rollefson.

TASK 2: PREPARE THE *PRODUCTION SYSTEMS ASSESSMENT*

The *Production systems assessment* should fully answer the question: What are the needs for improved nutrition, poverty alleviation and sustainable livelihoods? It should provide concrete evidence on livestock keepers' capacities and motivation to participate in an LDS and on the environmental sustainability of current production systems. It should also provide an initial assessment of the opportunities for development within each production system, based on its capacity for change.

Actions 1 and 2 address the human and livestock structure of production systems. Action 3 deals with the environmental aspects of production systems. Action 4 involves a SWOT (strengths, weaknesses, opportunities and threats) analysis of the production systems being considered. Action 5 summarizes the outcomes of the previous actions. Checklists are included that will help to generate the relevant information. These actions will need to be repeated for each of the production systems identified in

(Action 1 of Task 1). The *Production systems assessment* report is simply a compilation of the summaries produced for each of the main production systems.

Action 1: Describe the human structure of livestock-keeping communities

In order to assess the capacity and motivation of livestock keepers to participate in an LDS (i.e. their ability and willingness to change) it is necessary to find out how people manage their livestock and what needs are satisfied by livestock keeping.

(i) Describe the communities associated with the production system and the social structure of the households within these communities. Relevant information can probably be obtained from publications, in particular those related to farming systems research, anthropology and socio-economics. Studies conducted by NGOs may be useful sources. If such information is not available, then communities should be visited to obtain it. Sufficient time and budget must be made available along with the relevant expert technical input. Interviewing livestock keepers requires specific expertise, adequate preparation and careful selection of interviewees. Superficial field work will only confirm stereotypes.
Estimate the area of land under the production system, the number of holdings within the production system and the approximate number of people within the holdings. Calculate the average area of land per holding (or the extent of communal grazing areas) and the average number of people per holding.

(ii) Assess the nutritional well-being of the people within the production system. This will require specific technical input. The assessment will need to consider separately the diets of adults, pregnant women and children. Estimate the proportion of households, and of individuals within each of the demographic groups, that suffer from inadequate nutrition. Where inadequacies exist, note in what way(s) the diet is deficient. Identify whether there is evidence of disease caused by malnutrition and if so note how the disease is treated at present.

(iii) Assess the economic well-being of the households within the production system. This will require specific technical input. Provide an estimate of the proportion of households that are considered poor by relevant defined standards. This should be considered in the context of poverty in both rural and urban communities within the region and country.

Box 13. Questions on the human structure of livestock keeping communities

A. Questions relevant to production systems and communities

- Is the whole community or only a subgroup involved in the production system?
- Is there a relationship between the production system and the social aspects of the community?
- Is the production system strongly associated with particular sections of the community?
- What is a typical number of holdings per community?
- Are the livestock owned by the community or within households?
- Do the livestock keepers and their households make decisions on:
- day-to-day livestock-related actions (e.g. marketing, exchange and breeding purpose)?
- strategic planning and development of livestock production?
- Alternatively, is the responsibility for livestock-related decision-making shared within community structures?
- If so, what kinds of community structures are involved?
- Do livestock in general, or particular livestock species or breeds, have cultural significance within the community?

- If so, what is the nature of this cultural significance?
- How does it influence livestock production within the community or within households?

B. Questions relevant to households and household assets

- What is the type of holding (e.g. subsistence-oriented or market oriented)?
- Are the households fixed or mobile (nomadic or transhumant)?
- How many people make up a typical household within the production system?
- What is the age and gender profile of a typical household?
- What is the nature land ownership or tenure in the production system?
- What is the nature of livestock ownership in the production system?
- If decisions on livestock are made within households (rather than within the community as a whole) who makes the decisions on:
- day-to-day actions such as marketing, exchange and breeding?
- strategic planning and development?
- What is the capacity of the households to participate in livestock development?

Action 2: Describe the livestock structure of the holdings

In order to assess a production system's capacity and potential to change, the livestock structure and husbandry practices must be examined.

Characterize the livestock structure of holdings within the production system using expert technical input. The checklist in Box 14 can help in this characterization. Key variables that characterize a production system include:

- size and species composition of herds or flocks;
- inputs (from both internal and external sources);
- outputs (to both internal and external users/customers);
- management; and
- breeding.

Many of these variables are conditioned by non-technical factors such as livestock ownership, decision-making processes, rules governing access to resources (feed, pasture and water), availability of labour, distribution of benefits (rights and responsibilities) and gender issues. All of these need to be taken into account. Finally, risk factors and factors limiting the productivity of livestock within the production system must be identified, as they may affect the system's potential for development.

Box 14. Characterizing a livestock holding

1. Composition of the herd or flock within a holding

Describe the species composition and the size of the herd or flock in a typical holding (Table 3). There is no requirement to identify specific breeds and breed types (e.g. cross-bred or straight-bred) within species. However, some indication of the following is required:

- the relative use of locally adapted and introduced breeds (useful for assessing development opportunities and capacity); and
- the degree of reliance on replacement animals obtained from outside the holding.

2. Inputs

Describe, in general terms, the inputs to livestock production. Include those that come from within the holding as well as those from external sources.

- **Feed.** For each species, describe the nature, quality, quantity and seasonal fluctuations of locally available feed and the degree of reliance on feed from external sources. For production systems in which communal feed resources are used (pastoralism, semi-extensive systems), consider access to pastures and conditions for access.
- **Water.** Describe the sources and availability of water and possible seasonal fluctuations, noting to what extent there is reliance on non-local sources. Note the conditions that apply for access to water, and any factors that contribute to poor water quality.
- **Labour.** Describe the sources of labour for livestock keeping. Note the proportion of household labour devoted to livestock-related tasks (feeding, herding, milking, processing, marketing, etc.), the gender division of labour within the household/holding and the degree of reliance on labour from outside the household/holding.
- **Health care.** Describe the degree of reliance on veterinary services (vaccination and treatment) and on indigenous (ethnoveterinary) knowledge.

3. Outputs

Describe in broad terms the outputs obtained from each species kept (Box 8) and where they go. Answer the following questions:

- Does the output remain within the household/holding and does it meet the household's needs?
- Is there a surplus that is marketed (or exchanged for goods or services)? Approximately what proportion is marketed?
- Does the household add value to the product before marketing (e.g. processing milk into cheese)?
- For food products consumed within the household: how important is the product for meeting the household's nutritional needs for dietary energy, protein, vitamins and minerals?
- For other products used by the household: how feasible is it to obtain alternatives to these products and how much do they cost?
- For marketed products: approximately how much is marketed per holding? What is its quality? Does the quality vary? Provide some measure of quality (e.g. fibre diameter). What is its relative importance to household income?
- For outputs of social or cultural value: provide some relevant measure of significance.
- For a product that neither supplies the household nor is marketed: what are the reasons for this lack of use and is the product of potential value?

4. Husbandry variables

Describe how the livestock are managed. Answer the following questions:

- Are animals stabled, tethered, kraaled or otherwise confined? Are they confined all day or for part of the day or night? Are they confined during mating?
- Are animals stall-fed or grazed? Is fodder cultivated? Are rangelands managed? Who is in charge?
- What are the main diseases and disease management activities?
- Do all holdings have animals of both sexes? Are the sexes allowed to mix continuously or only at mating?
- Are animals identified? If so, how? By parent group or individually? Subjectively or objectively?
- Is there individual animal recording? If so, what kind (e.g. inputs and outputs relevant to health and performance)? Are measures subjective or objective?
- What local or introduced breeding technologies are used (e.g. exchange of males, artificial breeding techniques)?
- How are replacement animals obtained? Are there specialist breeders?

5. Risk factors and limitations to productivity

Describe the risks and limitations affecting livestock production. Answer the following questions:

- Is the environment subject to drought, flooding, fire, earthquake, plagues (e.g. of locusts) or other natural disasters? If so, with what frequency?

- Is the production system threatened by significant environmental degradation (e.g. soil erosion)? If so, what kind and how severe?
- What are the diseases that cause significant losses in the various livestock species?
- Is there significant predation of livestock?
- Are there significant social disruptions (e.g. war or civil unrest, migration of labour to cities)?
- Are key resources seriously limited in the production system (e.g. access to capital or credit, availability of labour)?

6. Sustainable opportunities for development

Describe the practical opportunities for sustainable livestock development in the production system. Where appropriate, include a description of the adequacy of access to markets.

Table 3. A framework for collecting data on the structure of a herd or flock

Production system:					
Species	Sex	Numbers of breeding individuals	Average age of breeding individuals	Percentage of breeding replacements obtained on the holding	Percentage belonging to locally adapted breeds
Cattle	Females				
	Males				
Buffalo	Females				
	Males				
Sheep	Females				
	Males				
	Females				
	Males				

Action 3: Describe the environment associated with the production system

Characterize the nature and the state of the ecosystems affected by production system and the interactions of the production system with the environment, identifying any constraints or opportunities that arise from these interactions. This will require expert technical input. See Box 15 for relevant questions.

Box 15. Characterizing the environment associated with a production system

- Briefly characterize the nature – including major seasonal features – and the state of ecosystems affected by the production system. Consider groundwater, forest and forest habitat, other flora, wild fauna and soils.
- Are there components of the ecosystem that are sensitive to changes in livestock management?
- Are there components of the production system that are sensitive from the possible effects of global climate change?
- Is there evidence that the production system causes environmental damage?

- How does the production system enhance ecosystems (e.g. providing organic fertilizer or maintaining habitats)?
- Are there constraints or opportunities resulting from interactions between the production system and the environment, including those that are seasonally dependent?

Action 4: Conduct a SWOT analysis on the production system

Based on the information gathered during the previous actions, assess the strengths and weaknesses of the current production system. This assessment should consider the conditions of the human population maintained within the production system including both their nutritional and economic states, the sustainability of the production system within its environment and the productivity of the production system. It is appropriate at this stage to consider a range of practical options for the production system and to identify major opportunities for development, along with threats to the system and to its future development.

Action 5: Prepare the **Production systems assessment** *report*

Summarize the outcomes from Actions 1 to 4 for each production system. The report should provide:

- answers to the question: what are the needs of the community for improved nutrition, poverty alleviation and sustainable livelihoods?
- practical evidence regarding livestock keepers' capacity and motivation to participate in an LDS;
- information on the environmental sustainability of current production systems; and
- information on any opportunities identified for development.

TASK 3: PREPARE THE *TRENDS ASSESSMENT*

Action 1: Review past performance

Review past national developments (e.g. the last ten years). Relevant topics for the review are presented in Box 16.

For each of the production systems identified (Action 1 of Task 1):

- identify whether trends in the production system have been stronger or weaker than the national trends;
- describe past LDS within the production system and their impact;
- describe any changes in livestock practices that were not associated with development strategies; and
- describe changes in livestock keepers' capacity.

Box 16. Topics for historical review

- Past policies and legislative instruments concerned with livestock development.
- National trends in the output of agricultural products.
- National economic performance of agriculture and livestock production in particular.

- Institutional changes relevant to livestock development.
- Changes in market structure for agricultural products and for livestock products in particular.
- Changes in market demand for agricultural products and for livestock products in particular.
- Trends in human health (e.g. proportion of people with nutritionally deficient diets) – consider urban and rural communities separately.
- Trends in social structure (e.g. regional depopulation and urbanization, proportion of population dependent on agriculture and livestock for income, prevalence of poverty in rural and urban communities, gender roles, and the status of rural communities).
- Changes in environmental conditions (e.g. soil erosion, desertification, and frequency and severity of droughts). Note that this may require a perspective of more than ten years.
- Trends or shifts in the focus of foreign aid projects.

Action 2: Predict the consequences that social trends will have on production systems

Box 17 presents relevant questions for analysing social trends. For each production system, note whether the consequences are likely to be more or less marked than the overall national picture.

Box 17. Questions and issues for analysing the impact of social trends on production systems

- What is the expected rate of growth of the human population? Disaggregate expected changes in birth rate, infant mortality and adult mortality.
- What are the expected trends in economic well-being? Disaggregate rural and urban communities.
- What are the expected trends in regional and rural depopulation and urbanization?
- What are the major causes of these trends?
- What are the aspirations of young people of both sexes?
- Consider educational aspirations and attitudes to work in livestock keeping and in alternative activities including urban employment.
- Consider how this will influence trends in regional and rural depopulation and in urbanization.
- What other forces or drivers are affecting rural communities?

Discuss the consequences of all the above for:

- demand for agricultural products – consider this in relation to achieving national food security, the type of products produced and their quality;
- gender roles within communities and households involved in agriculture and in particular livestock production;
- the nutritional needs of households involved in agriculture and in particular livestock production;
- availability of labour for agriculture and in particular for livestock production;
- the economic status of households engaged in agriculture and in particular livestock production; and
- the proportion of population dependent on agriculture and in particular livestock production as a source of income.

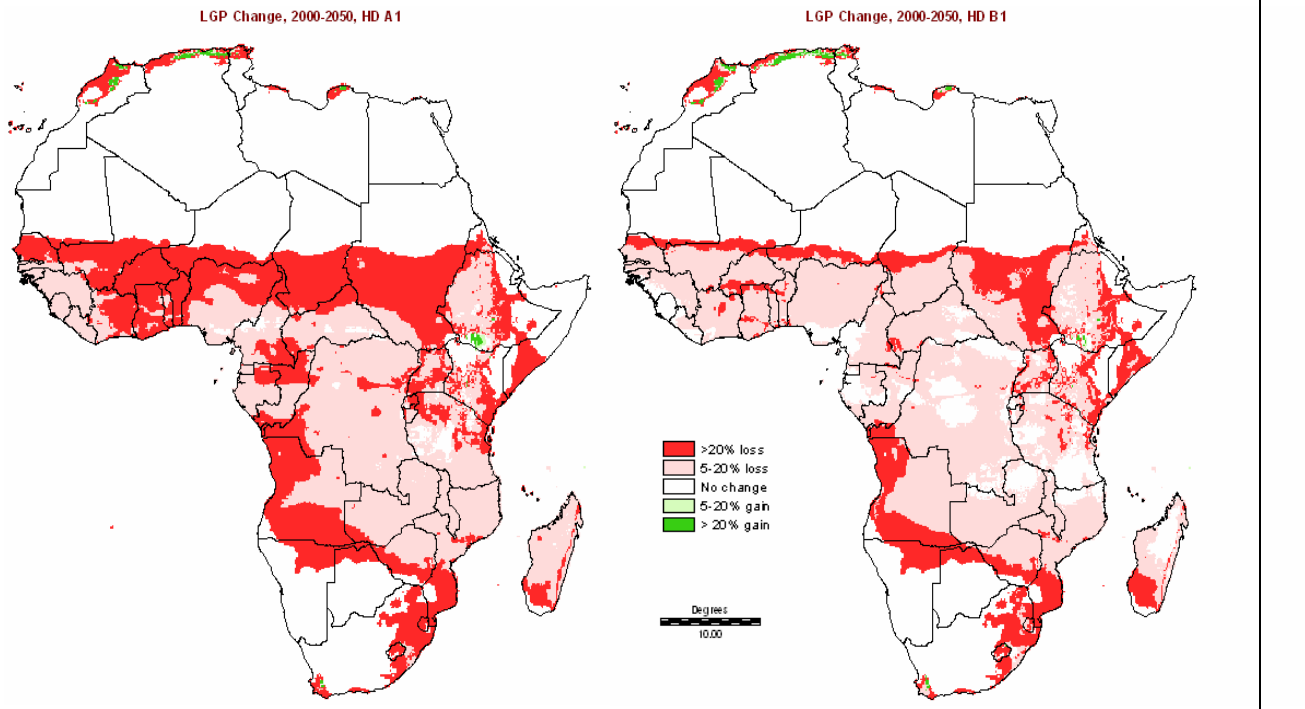
Action 3: Predict the consequences of environmental trends for livestock production systems

(i) Obtain information on regional climatological trends predicted by climate change studies. Assess the implications of these trends for the production systems under consideration. For example, if severe droughts have historically (e.g. for the last 50 years) occurred on average once every five years and the prediction is that there will be a 20 percent decline in precipitation by 2050 as a result of climate change, what is the predicted frequency of droughts over the next 50 years? Expert technical assistance is needed for this climatological analysis. Note that projections of future climate change depend on assumptions regarding the degree of international action and its coordination. Also note that it is estimated that there will be a time lag of approximately 20 years

in the response of the climate to any mitigating actions that are taken. For example, if an agreement on the reduction of greenhouse gas emissions were to be reached in 2010 it would not influence the projected trends until about 2030. At the time of writing (2009) global action to address climate change is minimal and poorly coordinated. It is recommended that assessments be based on more pessimistic scenarios (Box 18).

Box 18. Scenarios for the potential impact of global climate change on the length of the (crop) growing period in Africa

Brief descriptions of the scenarios are given in the notes below. The two maps represent extremes (i.e. a high greenhouse gas emission scenario and a low emission scenario) for potential impact of climate change on the length of the growing period (LGP) in Africa, taken from a range of scenarios. The colours deep red, light red, white, light green and green, respectively, represent reduction in excess of 20 percent, reduction of 5–20 percent, less than 5 percent change, gain of 5–20 percent and gain in excess of 20 percent.



Notes:

1. Regions gaining 5 percent or more in the LGP occupy considerably less than 1 percent of the coloured regions for either map; examples in both maps are limited to the North African coast and to the south of the Great Rift Valley in Ethiopia.

2. The maps are derived using the Hadley Centre Coupled Model, version 3. The two scenarios shown are:

- on the left A1: assuming very rapid global economic growth, global population peaking mid-century, rapid introduction of new and efficient technologies, with an emphasis on fossil fuel energy;
- on the right B1: assuming rapid change globally to service and information economies, global population peaking mid-century, the introduction of clean and efficient resource technologies, with global planning but no new climate initiatives.

Source: Thornton *et al.* (2006).

(ii) Predict the consequences of environmental trends (climate change, pollution, soil erosion, deforestation, desertification, etc.) for food and agricultural production nationally or regionally. Environmental changes may affect resource availability (e.g. forage and water) thereby influencing the viability of keeping particular livestock species or breeds and the stocking densities at which they can be kept sustainably. The production system may be affected by additional risks that affect its long-term sustainability (e.g. more frequent or more severe droughts with less time for livestock populations to recover). Assessing these impacts requires expert technical input. While predictions will be informed by evidence of the effects of past climatic trends on livestock production, consideration will also need to be given to emerging evidence of the effects of climate change. Note that the most serious effects of climate change on livestock

production may result from the frequency of extreme climatic events, rather than from changes in the average temperature or average rainfall.

(iii) Predict the impact of environmental trends for each production system by noting whether the consequences identified in (ii) are distinct from the picture for the country or region as whole. This will require expert technical input.

Action 4: Predict future demand and supply trends

Predict future demand and supply trends. Consider both quality and quantity. A minimum list of commodities to consider would include finance and credit, transport, labour, land, natural resources (e.g. water and forage), technological inputs and livestock outputs. Where appropriate, trends should be summarized in terms of price projections; this will require considerable technical input. An approach is outlined in Box 19.

Box 19. Predicting trends in supply and demand

1. Obtain information

Obtain price information relevant to each of the commodities being considered. Relevant information can be located by:

- examining current prices and predicted consumption trends in local, national and world markets;
- identifying trends in market preferences for quality aspects of the commodity, in particular, those that may influence the relative price of local products compared to those from external sources;
- identifying trends in the availability of resource; and
- examining schedules for changes in the regulation of global markets and the predicted outcomes of these changes.

Try to quantify prices in monetary terms, even if the current exchange practices are not based on money. General information on the local availability of commodities will have been obtained by completing the actions related to social and environmental trends. A useful starting point for information on the trends in the global market and on regulation is the World Trade Organization (http://www.wto.org).

2. Predict changes in prices

Predict changes in the prices of each commodity over 5, 10 and 15 years. This is an uncertain task, which inevitably involves subjective judgement. Try to be as objective as possible (e.g. consult a statistician), but *reflect carefully before making simple historical extrapolations*. Historical trends are relatively easy to obtain and may represent the best guess for future trends, but be aware that they may not continue. Factors that might distort or reverse historical trends should be identified. Possible examples include:

- changes in enabling policies and legislation;
- trade agreements;
- environmental factors such as limitations sustainable stocking density; and
- consequences of climate change.

3. Prepare a summary

Summarize the analysis. Include the sources drawn upon and a description of how the trends have been calculated. For each commodity, comment as to whether the degree of uncertainty in future price is large, medium or small in relation to the absolute price. Where feasible:

- Present values that represent the median of the possible range (i.e. it is estimated that the chance that the price will be higher than this value is equal to the chance it will be lower).
- Present a value that represents the lower quartile (i.e. it is estimated that the chances are three times as great that the price will be higher than this value than lower).
- Present a value that represents the upper quartile (i.e. it is estimated that the chances are three times as great that the price will be lower than this value than higher).

Action 5: Prepare the **Trends assessment** *report*

Summarize the outcomes of Actions 1 to 4. Conclude the discussion by considering whether trends have been characterized in sufficient detail to enable an informed and constructive debate among stakeholders on the (i) the critical social, agricultural and environmental trends that may affect future livestock production and the speed of change; and (ii) broad opportunities for identifying LDOs that are relevant in the medium and long term.

TASK 4: IDENTIFY LIVESTOCK DEVELOPMENT OBJECTIVES

Action 1: Identify priority human objectives

(i) Review the information gathered during the three previous tasks, with a particular focus on the needs and aspirations of the human population and how they may change or be forced to change as a result of changing circumstances.

(ii) Prioritize broad human development objectives for each primary production system. Ensure that this development is relevant to future social and economic conditions. The objectives might concern, *inter alia*, achieving food security, alleviating poverty, providing sustainable livelihoods, increasing economic development or securing and managing the environment.

(iii) Provide guidelines on the time frames over which the development objectives should be evaluated for each production system. Note that to be sustainable they will have to be relevant over the medium and long term. Focusing on the short term may lead to unsustainable objectives and a situation in which short-term benefits are dissipated, development is set back and the production system is unable to adapt sufficiently quickly to medium- and long-term demands.

(iv) Document the prioritized objectives and time frames for each production system in the first part of a report entitled *Establishing the livestock development objective: consultative draft*.

Action 2: Identify livestock development objectives

(i) For each primary production system, use the *Production systems assessment*, the *Trends assessment* and the *Livestock and enabling policy assessment* to identify and examine options for achieving the priority human objectives through livestock development. A preliminary outline of the options may have been prepared under Action 4 of Task 2, but at this point the full spectrum of relevant options should be considered.

Obtain technical assistance to assess each option over the short, medium and long term with respect to:

- the degree of development that can realistically be expected over a given period of time;
- how development based on the option may be affected by the social, economic and environmental trends that have been identified;
- the effectiveness of the option in addressing the priority human objectives that have been identified;
- the changes in enabling policy that may be necessary or desirable in order to implement the option;
- the strengths and weaknesses of the option;
- the external threats that may undermine success in implementing the option; and
- possible indicators for measuring progress towards the implementation of the option.

A assessment for the assessment is presented in Table 4. It is important to consider the feasibility of the development options as a function of time. Consider the capacity of the production system as identified in the *Production system assessment* and the trends identified in the *Trends assessment*. Be aware of trends that may affect productivity within the production system, such as the costs of inputs and the availability of labour. Also consider possible threats to production, such as increases in the frequency and severity of droughts.

(ii) Summarize the outcome in a draft report entitled *Establishing livestock development objectives: consultative draft*. Ensure that it summarizes all options, irrespective of assumed utility, as the consultation may identify means to overcome the perceived problems.

(iii) Contact each of the relevant institutional stakeholders from the list compiled (Section A). Seek assistance relevant experts in determining the modalities of the consultation. Send the report to the stakeholders and ask for comments. Summarize the stakeholders' responses and append the summary as an annex to the draft report.

(iv) Draw on the responses obtained during the consultations to draft the LDOs. They should be a set of concise statements of objectives: generally a small number for each production system. Each statement should be measurable and time-bound. Longer-term objectives should be accompanied by intermediate objectives to gauge progress.

(v) Review the implications of the LDOs for enabling policy and consider whether amendments and developments are needed to facilitate progress towards the LDOs. Reconcile these changes with the more general needs for policy development identified under Action 4 of Task 1. Design a time-bound plan for implementing any necessary policy changes. Append it to the draft report.

(vi) Review the LDOs taking into account the requirements listed in Box 5. If the review reveals inadequacies in the LDOs, revise them and repeat the review process. If the LDOs are adequate, add them as the conclusion to the report, which should be renamed *Establishing the livestock development objective*. Send the report to the responsible authorities asking them to agree to and formally accept the LDOs.

Table 4. Assessing options to include in LDOs – an example

Production system: Upland											
						Priority human objectives addressed	Future trends addressed			Compatibility with policy and production frameworks	
Option		5 yrs	10 yrs	20 yrs	Capacity		5 yrs	10 yrs	20 yrs		
1	Increase livestock protein for household consumption; by 10% by greater reliance on poultry	5%	10%	10%	15%	Eliminate childhood protein deficiency	1. Greater cost of protein from market sources		...	Required policy changes	Micro-credit facilities for flock building
										Helpful policy changes	
										Strengths	Feed resource available for scavenging birds
										Weakness	Vaccination services required, protection from predators needed
										External threats	Avian influenza, predation
										Indicators of progress	Proportion of households keeping poultry, average number of eggs produced per household ...
2	Reduce by 20% by 2010 feed costs per unit output per year	...	...	...	...	...	...	...	...	Required policy changes	...
										Helpful policy changes	...
										Strengths	...
										Weakness	...
										External threats	...
										Indicators of progress	...

TASK 5: IDENTIFY THE LIVESTOCK DEVELOPMENT STRATEGY

The LDS determines how the development of each production system will achieve the objectives for set out for it in the LDOs given the conditions described in the *Production systems assessment*.

(i) The first step in designing an LDS is to choose a set of criteria for ranking strategies. Possible criteria include:

- likely impact as measured by the livestock keepers' participation and the spread of benefits among them;
- likely contribution to the LDO elements that the strategy addresses;
- the potential for ongoing development;
- the scale of threats to the strategy;
- the likelihood of sustainability; and
- the approximate cost (Box 20).

(ii) Seek specific technical assistance in carrying out this task. For each of the production systems considered, identify feasible options for addressing the LDOs using the various strategic components of livestock development (breeding, feeding, health care, husbandry and marketing). A spreadsheet may be useful; an example is shown in Table 5.

(iii) Consider the following for each strategy option (consider both the start-up phase and ongoing implementation):

- requirements for specialized human resources, their availability and any capacity-building requirements;
- special institutional and infrastructural requirements – the mix of public-sector and private-sector participation, and policy, operational and technical requirements; and
- approximate costs.

A spreadsheet may be useful for collating the information. An example is shown in Table 6.

(iv) Based on the criteria developed by completing the previous task, consider each strategy option in terms of its impact and benefits. A spreadsheet may be useful; see the example presented in Table 7.

(v) Identify and describe opportunities for integration among the strategy components, particularly actions that markedly increase benefits and reduce costs and threats. Such opportunities will often arise from cross-cutting strategy elements in which each element is used for more than one strategy either within or across the primary production systems. An example of a cross-cutting element would arise if one element of the strategy is to set up a recording scheme for cattle and another to set up a scheme for sheep; the infrastructure required for recording can be shared between the two species resulting in a more cost-effective strategy overall. Review the broad costing and capacity needs identified under items (iii) and (iv) in the light of the opportunities for integration.

(vi) On the basis of the information gathered, decide what strategy should be recommended as a means to meet the LDOs. Seek a technical appraisal of these decisions from those who have provided technical assistance. Reconsider the proposals in the light of the appraisal, addressing any weaknesses identified.

Table 5. Identifying feasible options for addressing the LDOs for a production system – an example

Production system name: smallholder Delta Region				
Agreed LDO element		Livestock (species)	Strategic component	Feasible options
1	Increase smallholder income from livestock by 50% by 2012	Chickens (scavenger)	Breeding	1.1 Introduce and substitute chicks of a higher-producing breed from a similar production system
				1.2 Initiate a selection programme in three local communities based on a breeding layer
			Feeding	1.3 Promote the strategic use of supplementary feed in the first six weeks of life
			Health	1.4 Introduce vaccination against Newcastle disease
			Husbandry	1.5 Develop night housing to protect against predators
				1.6 Community training on the subject "profit from chicken production"
			Marketing	1.7 Develop community infrastructure to market excess eggs and chickens to the city
		Cattle	Breeding	…
			Feeding	…
			Health	…
			Husbandry	…
			Marketing	…
2	Reduce feed costs per unit output by 20% per year by 2010	Goats	Breeding	…
				…
				…

Table 6. Capacity and institutional requirements and costs of strategy options addressing the LDOs in a production system – an example

Production system name: smallholder Delta Region										
Feasible options		Capacity and institutional requirements						Broad costing	
		Getting started			Ongoing				
		Human resources	Public instruments and services	Private services	Human resources	Public instruments and services	Private services	Getting started	Ongoing
1.1	Introduce and substitute chicks of a higher-producing breed from a similar production system	Type …							
		Required:							
		Available:							
1.2	Initiate a selection programme in three local communities based on a breeding tier								
1.3	Promote the strategic use of supplementary feed in the first six weeks of life								
1.4	Introduce vaccination against Newcastle disease								
1.5	Develop night housing to protect against predators								
1.6	Community training on the subject “profit from chicken production”								
1.7	Develop community infrastructure to market excess eggs and chickens to the city								

Table 7. Identifying impacts and benefits of strategy options addressing the LDOs for a production system – an example

Production system name: smallholder Delta Region														
LDO element		Feasible options	Likely impact – the period of time (years) required for:						Likely contribution to LDO element (%)	Potential for ongoing development Score: 1 to 10	Threats to the predicted impact	Likelihood of being sustained Score: 1 to 10	Overall priority ranking of option	
			x% of all livestock keepers participating			y% of all livestock keepers benefiting							Getting started	Further development
			x=10%	x=50%	x=90%	y=10%	y=50%	y=90%						
1	1.1	Introduce and substitute chicks of a higher-producing breed from a similar production system	3	8	12	2	5	8	10	6	…	…	…	…
	1.2	Initiate a selection programme in three local communities based on a breeding layer	5	10	14	4	12	14	8	9	…	…	…	…
	1.3	Promote the strategic use of supplementary feed in the first six weeks of life	...	...	...	…	…	…	…	…	…	…	…	…
	1.4	Introduce vaccination for Newcastle disease	...	...	...	…	…	…	…	…	…	…	…	…
	1.5	Develop night housing to protect against predators	...	...	...	…	…	…	…	…	…	…	…	…
	1.6	Community training on the subject “profit from chicken production”	...	...	...	…	…	…	…	…	…	…	…	…
	1.7	Develop community infrastructure to market excess eggs and chickens to the city	...	...	...	…	…	…	…	…	…	…	…	…
2	2.1	...	...	...	...	…	…	…	…	…	…	…	…	…
	2.2	...	...	...	...	…	…	…	…	…	…	…	…	…

(vii) Summarize the conclusions in a draft report. For each component of the strategy, add a schedule for the start-up and practical indicators (measurable and time-bound) for assessing progress.

Prepare separate summaries describing the various phases of strategy implementation for each species targeted within each production system targeted. Indicate in the summaries the interdependencies that exist among the phases and components of the LDS – for example, whether any components depend on others being in place before they can be implemented.

Identify the way in which the breeding component of the LDS contributes to achieving the LDOs.

(viii) Contact the relevant stakeholders from the list compiled earlier in the planning process (Section A). Seek assistance from relevant experts in order to determine the modalities of the consultation. Send the report to the stakeholders and ask for comments. Summarize the responses and add them as an annex to the report. Revise the report as appropriate. Review the LDS taking into account the requirements listed in Box 5. Rename the report *Identifying the livestock development strategy* and send it to the responsible authorities asking them to agree and formally accept the LDS.

Box 20. Criteria for assessing the potential effectiveness of strategy element

Criterion 1. Participation of livestock keepers and the distribution of benefits among them

The proportion of livestock keepers participating in a livestock development strategy element and those receiving benefit from it are distinct measures of impact and should be treated separately. Useful measures of impact include the following:

- the spread rate of livestock keepers' participation in the strategy element, i.e. how long will it take for *x* percent of the livestock keepers to participate – useful values are 10 percent, 50 percent and 90 percent of livestock keepers; and
- the rate of spread of the benefits among livestock keepers, i.e. how long will it take for *y* percent of the livestock keepers to benefit from the strategy element – useful values are 10 percent, 50 percent and 90 percent of livestock keepers.

The distinction between these measures can be seen from the following examples:

- **Breeding:** the livestock keepers benefiting from the breeding schemes will not only include the those participating in the straight-breeding scheme by recording and using improved breeding stock, but also the livestock keepers that obtain the improved breeding stock from them.
- **Animal health:** the use of vaccines will primarily benefit participants, but when the participation rate is high there may be benefits to other livestock keepers because the risk of epidemics is reduced.
- **Feeding:** only participants will benefit.

Criterion 2. The contribution that a strategy element makes to achieving the livestock development objective (LDO)

This builds on the assessment of Criterion 1 by evaluating the impact that the strategy element would have on individual livestock keepers and interpreting it in terms of an LDO. This should provide a broad perspective on the expected benefit to be derived from the strategy element in terms of achieving the LDO. For example, if the LDO is to increase protein intake by 20 percent in rural areas, vaccination is an element of the strategy, then its expected contribution can be calculated on the basis of the proportion of livestock keepers who will vaccinate, the additional number of chickens that a livestock keeper who vaccinates will raise successfully each year for consumption or sale, and the impact that this additional production will have on protein intake among those who depend on the livestock keeper for food.

Criterion 3. The potential for ongoing development

Strategy elements will vary in terms of their potential for ongoing development. In the case of breeding programmes, for example, the infrastructure put in place to tackle one LDO can probably be adapted at limited cost to tackle future objectives. Conversely, some strategy elements may have little scope for further development.

Criterion 4. The level of risk associated with the strategy element

It is important to assess the risk associated with potential strategy elements as well as their expected outcomes. A very low-risk strategy element is one that can be relied upon to deliver the expected or close to the expected benefits under all foreseeable circumstances. Conversely, a very-high risk strategy element may deliver considerable benefit in favourable

circumstances, but deliver no benefit if circumstances are unfavourable. A simple five-point scale of risk should be sufficient (very high, high, moderate, low and very low) to address this criterion. Risks to consider include the following:

- How reliable are the estimates of participation? For example, what is the possibility that the uptake will be twice as rapid or half as rapid?
- Are there social, cultural or gender issues that may affect the rate of uptake?
- How does the rate of uptake affect the benefit to individual livestock keepers? For example, if a livestock keeper is receiving a service and the uptake is lower than expected, will this mean a higher cost for the livestock keeper or a threat to the continuation of the service?
- How secure are the funds needed to implement the strategy element?
- What would be the impact of a sudden withdrawal of funds from the government or international donors?
- What environmental threats (e.g. drought) might interfere with the success of the strategy element and how likely are these threats to be realized? The risk to the strategy element increases both with the potential impact of the threat and the likelihood that it will be realized.
- What impact might the threat have on the strategy element and the LDOs? For example, a breed introduced as part of the strategy may prove to be unfit for the production system and thus completely undermine the entire strategy for the period considered.

Criterion 5. The probability of the strategy element being sustained

Consider the probability of the strategy element being maintained over the medium to long term, i.e. do not only consider the start-up phase when there are high levels of support and enthusiasm, but also the subsequent phases when operations are more routine yet need to be more effective.

Criterion 6. Cost.

Estimating the cost is likely to require expertise beyond that available in working group itself.

SECTION C: MATCHING ANIMAL GENETIC RESOURCES WITH PRODUCTION SYSTEMS TO ACHIEVE LIVESTOCK DEVELOPMENT OBJECTIVES

RATIONALE

This section is based on the assumption that the procedures described in Section B have led to a decision to implement a breeding programme as part of the LDS. The development of the programme needs to take clear direction from an overall breeding goal, which should be in line with the LDOs for the production system. AnGR can be used in different ways to fulfil an overall breeding goal. Options include straight-breeding or cross-breeding schemes, using locally available breeds and/or introducing breeds from elsewhere.

Matching AnGR with production systems means looking for the optimal breed to satisfy the needs of the production system. Research on production systems and local and indigenous knowledge systems during the last 10–15 years has yielded ample evidence that in many cases the locally available breeds represent the "best fit" in terms of adaptability to the physical and animal-husbandry environment. If this is the case for the production system(s) under consideration and unless there is clear evidence for the benefit of using an exotic breed, a decision to use the locally available AnGR would be a reasonable outcome of the decision-making process.

Straight-breeding and cross-breeding programmes can differ substantially in terms of the potential gains and the risks involved, as well as in the level of organization required. The decision-making process must weigh the level of organization required and the risks involved against the potential benefits. Rigorous evaluation of breeds and crosses is required to address these issues. It will be a costly and challenging process that requires great and attention.

The following description of the tasks involved in matching AnGR to production systems is intended to help decision-makers to grasp opportunities while minimizing risks. The process must be repeated for each production system for which breeding strategies are to be implemented.

OBJECTIVE

Define the overall breeding goal. Describe locally available breeds and possible alternative ones. Provide arguments on the basis of which a decision can be taken regarding which breeds should be used and what type of breeding programme should be developed.

INPUTS

The main inputs are the LDOs and the description of production systems (Section B). Other important inputs are information on AnGR and the views of the stakeholders on the breeding goals and the breeds considered.

OUTPUTS

The outputs will be a concise overall breeding goal that addresses traits to be improved and a clear decision, taken with the support of key stakeholders, as to the breed(s) and the breeding programme to be used.

TASKS

The following tasks need to be undertaken in order to achieve the above objectives:

1. Define the overall breeding goal for the production system of interest
2. Collate available information on experiences with breeding programmes
3. Collate available information on the roles and characteristics of locally available breeds
4. Examine possible alternative breeds
5. Decide whether the breeding programme will be based on locally available or alternative breeds
6. Conduct a feasibility study for introducing an alternative breed
7. Prepare the *Germplasm introduction plan*
8. Implement the *Germplasm introduction plan*

TASKS AND ASSOCIATED ACTIONS

TASK 1: DEFINE THE OVERALL BREEDING GOAL FOR THE PRODUCTION SYSTEM OF INTEREST

Action 1: Consult relevant stakeholders to identify traits of interest

The stakeholders that should be consulted at this point will be chosen from the inventory established earlier in the planning process (Section A). The most relevant stakeholders are those representing livestock keepers, marketing and retail chains and breeding support services. These stakeholders should provide a list of major traits that are relevant to:

- the LDOs for the target production system;
- the inputs and outputs of the production system; and
- the characteristics of ideal animals for this production system.

In this crucial phase of the decision process, it is essential that both men and women livestock keepers have their say. The hierarchically layered system of representation often used in consultative fora may not be appropriate in this case; it is therefore recommended that participatory group discussions be conducted right at the grassroots, focusing on the question "what is the ideal animal and why?".

Box 21. The importance of consulting livestock keepers to identify traits of interest

Goats have been well adapted to the Korean Peninsula for more than 700 years. With increasing demand for goat meat in the early 1990s, Boer goats were imported into the Republic of Korea and widely used for cross-breeding with the native black goats. Even though the Boer cross-breeds had a better growth rate than the native goats, they were not popular with the livestock keepers, because they did not have the same black coat as the local goats. This prompted the importation of the feral Black Australian breed, which has the same colour as the native animals.

The appraisal by livestock keepers – the end users of the breeding programme – of a new breed or cross-breed is thus an essential step in establishing the breeding goal.

Source: adapted from FAO (2007).

Box 22. Breeding criteria of the Karamoja pastoralists

East African pastoralists of the Karamoja cluster have a detailed list of traits that they value highly in breeding bulls and cows. Both cows and bulls should be adapted to the harsh environment (resistant to diseases and parasites, tolerant of heat and cold and able to retain body weight during periods of drought and feed shortage). They should also have a good temperament. The coat colour and horn configuration of bulls are identified with owners or communities. Coat colour and body size and conformation should be suitable for marketing. Bulls should stay in the herd and not show aggression towards other herd members. Breeding cows should have stable high milk yield – regardless of the season – that is tasty and has ample butterfat content. They should also calve regularly, produce quick-growing offspring and have wide udders with complete teats.

This example illustrates that livestock keepers have their own breeding criteria. It is therefore important to take their opinions into account when defining the breeding goal.

Source: adapted from FAO (2007).

Action 2: Synthesize traits to define the breeding goal

Define a small number of groups of traits with a few traits in each group. For example, the groups could represent production traits (e.g. milk yield, weaning weight) or functional traits (e.g. fertility, health, behaviour). From among the traits suggested in the consultation (Action 1), choose those for which there is broad stakeholder agreement. If there appear to be large differences between or within different categories of stakeholders, consider repeating the consultation until broad agreement is reached. Be aware that such consultation may entail a negotiation process in which there may be a danger that the interests of certain categories of stakeholders are neglected.

Action 3: Define the breeding goal

Write a concise sentence outlining goal traits agreed by stakeholders. An example might be improving productivity while maintaining adaptability to the local environment. Other examples of breeding goals are presented in Box 23.

Box 23. Examples of breeding goals

LAMBPLAN™. In its early stages, LAMBPLAN, a scheme designed to improve lamb performance in Australia, chose the following as its "default" breeding goal:

Lean growth: designed to give equal (in genetic standard deviation units) improvement in weight at a constant age and fat depth at a constant weight.

N'Dama. The directors of the livestock/veterinary services and of the research organizations dealing with livestock in the Gambia, Guinea, Guinea-Bissau Senegal and Sierra Leone made the following qualitative statement on breeding goals:

The N'Dama will remain the cattle breed of choice for the low-input system from the Gambia southwards. Throughout the region, the breed is regarded as triple-purpose (for milk, meat and traction) and emphasis for improvement will be on milk and meat without the loss of disease-resistance and other adaptive traits.

After further consultation and analysis to set the goal values, the breeding goal was defined as 0.22 × (breeding value in daily gain in grams) + 0.52 × (breeding value in milk in kg), without loss of disease resistance.

Note: The absolute values of the weighting factors are irrelevant, as the same animals will be selected as long as the ratio of the two weighting factors (0.22:0.52) stays the same.

Sources: ICAR/FAO (2000b), ICAR/FAO (2000c).

TASK 2: COLLATE AVAILABLE INFORMATION ON EXPERIENCES WITH BREEDING PROGRAMMES

Collate positive and negative experiences on breeding programmes for the species of interest implemented in similar production system in this and other countries.

TASK 3: COLLATE AVAILABLE INFORMATION ON THE ROLES AND CHARACTERISTICS OF THE LOCALLY AVAILABLE BREED(S)

It is essential that the current socio-economic uses of the locally available breeds and the cultural values associated with them be documented before considering any change, because this will provide the baseline for an assessment of their suitability for inclusion in the breeding programme. Any change will cause significant upheaval in the production system; it may therefore be appropriate to regard the use of locally available breed(s) as the default option.

Action 1: Review the socio-economic and environmental characteristics of the production system

This section will ultimately involve making comparisons between locally available and exotic breeds. It is important to ensure that such comparisons are fair. The current production system and the production system envisaged for the future of the local area need to be taken into consideration. Therefore, before describing locally available breed(s), review the descriptions of the local production systems drawn up when implementing Section B. If this is not available, describe the production systems in as much detail as possible.

To compare locally available breeds with breeds from other areas, it will be necessary to compare their production environments (geographic location, terrain, climate, etc.). A description of the production environment that can be used for inter-area comparisons is therefore needed. This will require relevant technical expertise. The set of production environment descriptors developed for inclusion in the Domestic Animal Diversity Information System (DAD-IS at http://www.fao.org/dad-is) provides a common framework that is intended to facilitate comparisons between production environments both nationally and internationally (FAO/WAAP, 2008). It may, of course, be feasible to collect more detailed descriptions than those outlined in the framework, but it provides a standard baseline for such work.

Action 2: Describe the breeds that are present in the production system and their roles within it

The description should include the distribution, population size, roles and functions in farming and livelihood systems, morphological and performance traits, longevity, adaptability and special features of the breed. Collect livestock keepers' views on the strengths and weaknesses of the locally available breeds. The views of women livestock keepers and livestock keepers' wives must be sought; their perspectives will complement the views of the men. Use the information to identify what roles each breed might play in meeting livestock keepers' needs in the current and future production system. Note that because of the long time frames of breeding strategies, careful consideration must be given to potential changes in the production system. Identify whether there are any roles and objectives envisaged in the LDOs that are not currently filled by a locally available breed – for example, an opportunity to use a terminal sire breed. Note whether any of the breeds under consideration have weaknesses that are likely to affect their abilities to fulfil their proposed roles.

Box 24. Matching animal genetic resources with production systems – the case of the Indian Chilika buffalo

Many local breeds have unique characteristics and that enable them to perform functions within the local production system that cannot be matched by any other breed. Chilika buffaloes, for example, are prevalent in the islands and periphery of Chilika Lake on the coast of eastern India; they are found in three districts: Khurda, Ganjam and Puri. The animals are well suited to the backwaters of the lake and enter the knee-deep waters to feed on weeds and grasses, generally during the night. During the daytime they rest on the shore, under the trees. The Chilika buffaloes have an important ecological role – their dung and urine support zooplankton, which support the lake's fish population, which in turn supports livelihoods around the lake. Their multiple roles in this production system are not easily matched by other breeds. The Murrah buffalo or Murrah-Chilika crosses, for instance, do not survive in this environment, as they are less well adapted to the humid conditions and the absence of non-saline drinking water.

Provided by Devinder K. Sadana.

TASK 4: EXAMINE POSSIBLE ALTERNATIVE BREEDS

The introduction of AnGR from outside the locality should be considered; such breeds may offer benefits that cannot be provided by the breeds currently kept within the production system. There is a need to decide how widely the search for alternative breeds should extend, and then to collate and evaluate available information on all the breeds that might be introduced.

Action 1: Set criteria for the search for alternative breeds

It is important that the requirements of the alternative breed should not overstretch local resources nor disproportionately increase livestock keepers' workloads, especially those of women. The following requirements, *inter alia*, need to be considered:

- **Nutrition:** is the area into which the breed is to be introduced able to produce the quantity and quality of feed needed? Is the expertise needed to grow the feed locally available? What would be the impact on land allocation?
- **Health:** depending on the alternative breed's level of resistance to prevailing diseases and parasites, a higher level of preventive and curative treatment may be necessary.
- **Management and care:** additional requirements might include shelter, stall-feeding, better care of young animals, or more monitoring and protection of the herd/flock. Larger or less docile animals may be more difficult to handle.
- **Reproduction:** external resources such as a breeding bull or AI may be needed. Animals may need assistance when they give birth.
- **Investment (e.g. shed, concrete floor, chaff cutter, dip tank and the animals themselves)***:* high prices may make it difficult for poor households to acquire the introduced animals.

Given that there are many breeds that might be examined as potential candidates for introduction, there is a need to set criteria with which to narrow the search. Use the information collected during the earlier phases of the planning process to identify livestock functions that may need to be strengthened through the introduction of an alternative breed and possible roles for introduced breeds in the future breeding programme. The search for alternative breeds should take account of current policies and perceived risks that may restrict the locations and production environments from which the alternative breeds can be sourced. The following should be considered:

- diseases to which the alternative breeds would be exposed in their new production environments;

- diseases endemic in the home regions of the alternative breeds that need to be kept out of their new production environments;
- attributes of the alternative breeds that may have unwelcome consequences for the country's key agricultural products (see Box 25 for an example); and
- capacity to access funds and properly evaluate and manage germplasm from alternative breeds, (e.g. the ability to handle germplasm stored in liquid nitrogen or to manage quarantine procedures).

Box 25. Avoiding negative consequences of introducing an alternative breed

Australia maintains a strict policy on importing alternative breeds of sheep. One policy objective is to protect the quality of its wool clip, where one black fibre per million is sufficient to considerably reduce value. Therefore, the proportion of black fibres in the fleece is a critical attribute of an imported breed. A second policy objective is to keep scrapie (a sheep disease) out of the country; no breeds that might introduce the disease are therefore considered for importation.

Action 2: Gather information on alternative breeds

Use different information sources (e.g. DAD-IS) particular attention to the adaptedness of the alternative breed to the production environment into which it would be placed and to how the breed might be accessed (e.g. live animals or embryos). As information on alternative breeds and their traits may come from a variety of sources and studies, trait values may need to be pooled together. Seek technical advice on this if necessary.

TASK 5: DECIDE WHETHER THE BREEDING PROGRAMME WILL BE BASED ON LOCALLY AVAILABLE OR ALTERNATIVE BREEDS

This task involves a pivotal decision within the process: whether the locally available breeds will be improved using a straight-breeding programme or whether alternative breeds will be used either as pure breeds or in a cross-breeding programme with the locally available ones. Development of straight-breeding and cross-breeding programmes is described in Sections D and E, respectively.

The following *key question* needs to be answered: is there sufficient information to predict whether an alternative breed from outside the locality will provide an increase of more than 30 percent in overall economic performance? At this point in the process, attention must be paid to possible trade-offs – better performance but at what cost and to the detriment of what or whom? The value of 30 percent is to some extent arbitrary, but should only be reduced where a high level of technical capacity is available. This figure is recommended because introducing new breeds can be costly and requires a managed implementation programme, including testing, over a period of years, and involves a variety of risks that may lead to failure. There is, however, a need to recognize that a straight-breeding programme with local breeds will also generates additional costs, as the higher-producing animals have higher requirements in terms of feeding and husbandry.

If the answer to the key question is "no", then recommend that a straight-breeding programme be developed for the locally available breeds. No alternative breeds are needed. Summarize the reasons for reaching this recommendation and initiate a wider consultation process to ensure its wide support among stakeholders. If there is support for the decision, proceed to develop the straight-breeding programme (go forward to Section D), if there is no support the working group should review the decision but must take the final responsibility and decide.

If the answer to the key question is "yes", the introduction of alternative breeds from outside the locality is a possibility. A more detailed evaluation is therefore needed. Proceed to the next task in this section.

TASK 6: CONDUCT A FEASIBILITY STUDY FOR THE INTRODUCTION OF ALTERNATIVE BREEDS AND TAKE A DECISION

If it is decided that one or more alternative breeds may have a role in the breeding strategy, it will be necessary to conduct a feasibility study for its/their introduction. The study should be completed within a short time and address the following questions:

- Do veterinary regulations allow the introduction of germplasm from the alternative breed?
- Is it feasible to access sufficient germplasm for an effective introduction?
- Can the local infrastructure (e.g. within the production system sustain the introduction?

Action 1. Review regulations and capacity

Review zoosanitary regulations to establish whether live animals or preserved germplasm can be brought into the local administrative area, and if so under what conditions. Review the justification for any restrictions. If the candidate breed is available in several countries, identify whether there are differences in the regulations affecting imports from the various potential sources. If the introduction of live animals is being considered, document the requirements for safe transport and quarantine, and whether the required facilities are available in the local administrative area. If frozen germplasm is available for import, document whether the local administrative area has the facilities and capacity to store, manage and use the material effectively. List and prioritize options for:

(i) the form and source of the genetic material;

(ii) any improvements to infrastructure that may be required; and

(iii) any additional skills and training that may be required.

Action 2: Assess the feasibility of the introduction

Attempt to answer each of the questions listed in the introduction to this task. If the answers are not immediately clear, seek further information or clarification from the relevant sources and revise the answers accordingly. Address the following issues:

- If veterinary regulations pose barriers to the introduction of the genetic material needed to implement the envisaged programme, seek legal advice regarding the possibility of having the regulations changed or obtaining an accommodation that allows the introduction to take place within the framework of the present regulations.
- If problems obtaining sufficient germplasm are foreseen, investigate whether they can be overcome. For example, if direct substitution does not appear to be feasible because of the number of live animals required, examine the feasibility of upgrading.
- If problems with sustaining cross-breeding in the production system are foreseen, investigate whether they are surmountable. For example, problems associated with there being an insufficient number of female animals to sustain a two-breed crossing system might be resolved by encouraging specialized keepers to become established within the production system (see Box 26 for a description of the role of specialized keepers in Merino production systems in Australia).

Decide whether the introduction of the candidate breed(s) is feasible and under what circumstances. If the study indicates that feasibility is limited (i.e. the answer to one or more of the above questions is negative) do not opt for an alternative breed – use a locally available breed instead.

Initiate a wider consultation to ensure support among stakeholders for the decision taken and any developments that will be required in the production system. The consultation must be conducted in a manner that is appropriate to the circumstances of the stakeholders. For example, commitment is needed from both livestock keepers and retailers of livestock products; yet the approaches required in order to obtain an informed response from these two groups of stakeholders will be different. Particular attention needs to be paid to this issue when livestock keepers' associations and breeders' cooperatives are poorly developed or absent and when the livestock keepers are largely smallholders or pastoralists.

Box 26. Specialized livestock keepers – an example from Australia

Australian Merino ewes are straight-bred for most of their productive lifetime. Some keepers specialize in purchasing draft Merino ewes (culls from the straight-bred flocks) and crossing them to a terminal sire breed for the production of lambs for slaughter. The reproduction rate of the Merino ewes in their production environment is low. Moreover, the production system is extensive, making it difficult for the Merino keepers to cross to the terminal sire breed and manage the lambs appropriately. The specialized keepers make this element of the production system feasible. The benefits are shared – the specialized keepers obtain a return on the lambs sold and the Merino keepers have a developed market for their draft ewes.

Action 2: Organize a study tour to visually appraise the candidate breed in its own production system

The person responsible for this action should ensure that the plans for the study tour are appropriate to its objectives. The visiting livestock keepers (both men and women) should be able to meet and discuss with livestock keepers who actually own, use and manage the alternative breed in comparable circumstances. The person responsible should also identify livestock keepers who are willing to join the study tour (possibly with financial aid) and who are committed to participating in and supporting the evaluation of the alternative breed in the local production system (see Task 7). This commitment is necessary as the evaluation will be expensive and risky, and will require livestock keepers' direct involvement. Livestock keepers need to share ownership of the decisions taken.

Action 3: Decide whether to introduce the candidate breed

Based on the outcome of the feasibility study, the degree of support expressed by the stakeholders consulted and the number of livestock keepers willing to participate in the evaluation within the local production system, decide whether to proceed with an introduction or to use locally available breeds. In the case of the latter decision proceed to Section D; otherwise proceed with the next task in this section.

TASK 7: PREPARE THE GERMPLASM INTRODUCTION PLAN

Introduction of a breed from outside the locality requires the coordination of many actions. The *Germplasm introduction plan* should be prepared to serve as a reference for all concerned. The plan should indicate who is to carry out which actions, how and when. An essential element of the plan will be an evaluation of the breed in its envisaged role within the local production system. The detailed plan will serve as a basis for attracting funds for introducing the breed.

The plan should consist of two phases:

- Phase 1: introduction of a limited quantity of germplasm for evaluation purposes;
- Phase 2: larger-scale introduction based on the results of the evaluation.

Action 1: Plan how to access germplasm from the alternative breed

The following issues have been considered from the perspective of their feasibility; they must now be considered from an operational point of view.

- **Veterinary regulations.** These regulations will have been documented as part of the previous task.
- **Costs of acquiring germplasm.** Different options have different costs. The amount of germplasm initially required will be determined by the design of the evaluation in Action 3.
- **Sources for initial and subsequent acquisition.** Options for obtaining germplasm should have been identified and recorded during the study tour. Will the sources identified provide enough germplasm for both phases? Note that the method used to acquire the initial relatively small amounts of germplasm may be different from the method envisaged for acquisitions in the longer term; the plan should account for this.
- **Facilities for using the germplasm.** If frozen germplasm is to be used, are the facilities needed to handle and store it available in the local area?
- **Technical capacity for using the germplasm.** Is the technical capacity needed to use fresh or frozen semen, oocytes or embryos available in the local area?

Based on these considerations, determine the most viable option for the initial acquisition of germplasm and for sustained access over the longer term.

Action 2: Plan how to manage the risks associated with the introduction of the alternative breed

Risks associated with introducing an alternative breed need to be managed, as do uncertainties regarding the breed's performance.

Risks to the locally available breed(s). Risks may arise because of the potential for diseases to be brought in with the introduced breed. These risks should be managed by applying the relevant veterinary regulations when the breed is imported. If risks that have not been identified in the feasibility study come to light, alert the policy-makers and document the risks in the plan. Another risk to be aware of is that uncontrolled crossing with the locally available breed may undermine its genetic integrity.

Risks to the introduced breed. The following risks are relevant if the introduced breed is acquired in the form of live animals or embryos:

- **Disease risks.** Management of disease risks will require veterinary advice. Methods to minimize risk might include vaccination or isolating the introduced breed from other animals.
- **Climatic risks.** The introduced breed may require more elaborate shelter than is normally provided to animals in the local production system. Seek advice from a livestock specialist or veterinarian.
- **Nutritional risks.** Feeding practices may need to be adapted to ensure that the nutritional needs of the introduced breed are met. Nutritional advice may be required, including expert advice from the native region of the breed.
- **Animal welfare issues.** If animals are introduced into an area where conditions (parasites, temperature, drought, humidity, feeding, housing, handling, etc.) differ greatly from those that they are used to, the animals will suffer stress and will not thrive.

Take special note of any measures taken to reduce the risks faced by the introduced breed (e.g. providing them with housing) that may introduce bias into the evaluation of the performance of the introduced breeds relative to that of the locally available breeds.

Action 3: Plan the evaluation of the alternative breed in the local production system

Ideally, decisions as to which breed(s) should be introduced and for what use (pure-breeding or cross-breeding, and in the case of the latter what grade) should be based on an evaluation of the alternative breeds and their crosses in the production environment in which it is intended that they be kept. Such an

evaluation is a very lengthy and expensive process (Box 27); it requires expertise in design and planning The following approach can help to narrow the options and facilitate the evaluation:

- Decide which traits are to be improved (will have been identified during the completion of Task 1 of this section).
- Define the production environment under which the improved stock will perform (Section B and Action 1 of Task 3).
- Critically review the literature on breeds and crosses used in similar production environments for the trait of interest; pay attention to adaptability traits (e.g. reproduction and disease tolerance). Based on the review, select the breed or cross-breed to be included in the evaluation.
- If a decision is made to use crosses, approximate the performance level that the production environment can sustain and calculate the expected performance of cross-bred animals assuming an additive mode of inheritance between the breeds. For example, if the performance of the locally available breed (B) is 1 000 kg per lactation and that of a potential breed for cross-breeding (A) yields 6 000 kg, then the half-bred cows would be expected to yield 3 500 kg and the ¾A ¼B cows would yield ¾ (6 000) + ¼ (1 000) = 4 750 kg. Ensure that the prospective production environment can sustain this level of production.
- Review your decision as you continue with the programme.

Be aware that in addition to technical and statistical aspects of the evaluation, there is also an equally important subjective element. The evaluation should therefore also expressly seek to evaluate the experiences of the end users.

Box 27. Exhaustive evaluation of alternative breeds in the local production system

It is recommended that the evaluation be carried out in a sequential manner: In Step 1, evaluate whether the benefits that the introduced breed is projected to provide in terms of production traits are actually obtained in practice under local conditions. In Step 2, evaluate the fitness traits (e.g. reproduction and adaptation) of the introduced breed in comparison to those of the locally available breed.

The rationale for this sequence is that the differences in production-related traits are likely to be large and that only a small number of animals will need to be tested in order to confirm the projected benefits. If during Step 1 the projected benefits do not materialize, an immediate decision can be taken not to proceed with the introduction of the breed (i.e. there is no need for Step 2). Step 2 involves testing for the small but important differences in fitness that may undermine the benefits that appear to be achievable in terms of production. Testing for these small differences will require a much larger number of animals. However, proceeding with the introduction without implementing Step 2 of the evaluation may have very serious consequences.

The following points should be considered when planning the evaluation:

Facilities for evaluation

It is highly desirable that the evaluation take place on real farms or holdings within the local production system. If the evaluation does not take place in the normal production environment of the locally available breed, the whole process may be undermined and long-term costly mistakes may be made.

Recording traits for evaluation

Only production traits need to be recorded in Step 1. However, in Step 2, key fitness traits in the local production environment must be recorded. In addition to identifying which traits need to be recorded, the following questions should be addressed: Who will record the traits? How will they be recorded? Who will collate, document and store the data? How will the data to be stored (electronically or on paper)?

Procedures to avoid preferential treatment

The design of the evaluation should aim to minimize the potential for preferential treatment of the introduced breed. Failure to eliminate preferential treatment (e.g. additional shelter, better quality feed) will certainly lead to an overestimation of the benefits associated with the introduced breed and may lead to incorrect decisions regarding recommendations for its wider use.

Time scale for the evaluation

Draw up a detailed and realistic schedule for the evaluation, indicating the number of animals to be evaluated over time.

Seek technical advice on the following:

Breed types to be involved in the evaluation

Key comparisons among breed types must be identified and described in detail in order to clarify how conclusions are to be drawn. For example, the locally available breed that traditionally occupies the intended role should be evaluated under the same management conditions as the introduced breed.

Validity of the comparisons

The design should not confuse genetic comparisons with environmental factors (e.g. years, farms, feeding regimes or housing conditions). Avoid confusion.

Number of animals required

The precision of the evaluation will increase as the number of animals increases. A total of 40 animals from the introduced breed may be sufficient for evaluating production traits. This recommendation is based on the assumptions that the potential benefit must be 30 percent or more in order for the introduction to be considered and that these traits have a relatively low coefficient of variation. However, for evaluating fitness traits, a total of 1 500 animals may be appropriate.

Sampling procedure within breeds

The animals evaluated should be a random sample from the introduced and the locally available breeds rather than a highly selected sample. Ensure that the test animals are derived from a minimum of five sires per breed for the first step (production traits) and 25 sires per breed for the second step (fitness).

Action 4: Plan conservation actions for local breeds that will be affected by the introduction of alternative breeds

A conservation plan must be considered if a locally available breed may be placed at risk by a decision to upgrade it or to create a synthetic breed that includes its genes. Active conservation of the breed should be a high priority, especially if the production environment suffers sporadic disasters, such as droughts, which may not have been encountered during the evaluation period.

The conservation plan should be proactive, as the best animals in the best-managed herds are likely to be among the first to be used for crossing. For conservation options, see FAO (1998a).

Action 5: Collate and cost the Germplasm introduction plan

Use the outputs of the previous actions to draw up a draft plan. The costs of completing all the above actions will need to be estimated.

Action 6: Seek funding for the Germplasm introduction plan

Once the plan is satisfactory, seek funding and carry out a cost–benefit study (Section F). The costs of the plan must be met by stakeholder agreement. If necessary, seek to refine the plan to address any constraints that come to light. If the plan cannot be properly funded it may be necessary to use locally available breeds only.

Action 7: Review the draft Germplasm introduction plan *and approve it if appropriate*

Once the plan is drafted, review it and check it for consistency, practicality, resource needs and costs. Before approving the plan, ensure that feasibility and long-term implications have been fully thought out:

- If long-term access to germplasm is necessary, can this be ensured?
- Are there any costs that have not been recognized?
- Is the time scale for the plan realistic?
- Is the conservation element of the plan properly integrated with the introduction of the new germplasm?

Bear in mind that even though the benefits of success may be substantial the introduction of an alternative breed is a costly and risky procedure and that failure will have long-term consequences.

If the plan is satisfactory, approve it subject to the availability of funding. If it is unsatisfactory, further work will be necessary to address and resolve the problems.

TASK 8: IMPLEMENT THE *GERMPLASM INTRODUCTION PLAN*

If a decision has been taken to introduce a breed, the introduction plan will need to be implemented and its progress monitored and evaluated. If the results of interim evaluations clearly indicate that the introduced breed is unlikely to deliver the expected benefits, then a decision should be made to terminate the plan and review the strategy.

Action 1: Assign responsibilities for the implementation of the plan and reporting on progress

Examine the elements of the plan and decide who will be responsible for each element. After taking these decisions, brief those responsible on their responsibilities, the time scales,) the reporting procedure and procedures for resolving unforeseen difficulties. Clarify any ambiguities regarding areas of responsibility and obtain the formal agreement of those involved that they will discharge their responsibilities.

Action 2: Introduce the germplasm

Manage the introduction according to the plan.

Action 3: Evaluate the introduced germplasm

At the end of Phase 1, draft a comprehensive report presenting results, both encouraging and disappointing, on production and fitness traits. Make a recommendation as to whether the introduction should be encouraged or stopped. Irrespective of reporting schedules, alert the policy-makers if the introduced breed has serious problems with disease or in adapting to other aspects of the production environment.

Action 4: Implement conservation measures

Ensure that the conservation measures envisaged in the plan are implemented. Review progress regularly and check that the plan is being fully implemented. Document these reviews in interim reports. For guidance on technical aspects of conservation, see FAO (1998a).

Action 5: Monitor and report on progress

Interim reports should be prepared regularly throughout the process of introducing the breed. The reports should address all the issues covered in the previous actions, documenting the degree to which objectives set out in the plan have been achieved. If objectives are not being met or not being met on time, obtain clear explanations of the problems from those concerned, list options for overcoming the problems and evaluate them and decide on the best way to address them. Where disputes over

responsibilities arise, identify areas of ambiguity and clarify them. Amend the plan and its schedules accordingly.

SECTION D: DEVELOPING STRAIGHT-BREEDING PROGRAMMES

RATIONALE

Sections D and E both deal with the genetic improvement of breeds and therefore have much in common. It is, however, intended that each section should be able to stand alone. Reading them in sequence will involve some unavoidable repetition.

Selection and cross-breeding are the two main tools that can be used to achieve genetic changes in livestock populations. Selection implies genetic improvement based on variation among individuals within the population (breed). This process is often referred to as straight-breeding. In contrast, cross-breeding involves making use of variation among populations (breeds). Straight-breeding and cross-breeding programmes may represent components within a broader breeding strategy; they are not mutually exclusive and are often used in combination. However, such combinations depend on first developing the capacity to operate each element in a sustainable manner. Many factors have to be considered in the development of a breeding programme; these include:

- the animal species involved;
- the types of traits considered;
- the availability, accessibility and affordability of different breeds;
- the production environment;
- the time frame for the planned genetic improvement, (improvement through straight-breeding usually takes longer than through cross-breeding); and
- the infrastructure of the livestock sector and the resources allocated to the programme.

The relevance of these factors is elaborated further in the descriptions of the various tasks in this and the following sections of the *Guideline*s.

Figure 3 presents a simplified procedure that can be used to aid the decision as to whether a straight-breeding or cross-breeding programme should be chosen. This section deals with straight-breeding, while Section E focuses on cross-breeding and creating synthetic (composite) breeds.

OBJECTIVES

Develop a sustained straight-breeding programme using the genetic variation within the breed(s) being targeted.

INPUTS

The main inputs are the breed(s) that are the focus of the programme (identified by implementing Section C); the LDOs (identified by implementing Section B) and the overall breeding goal (identified by implementing Section C).

OUTPUT

The outputs will be:

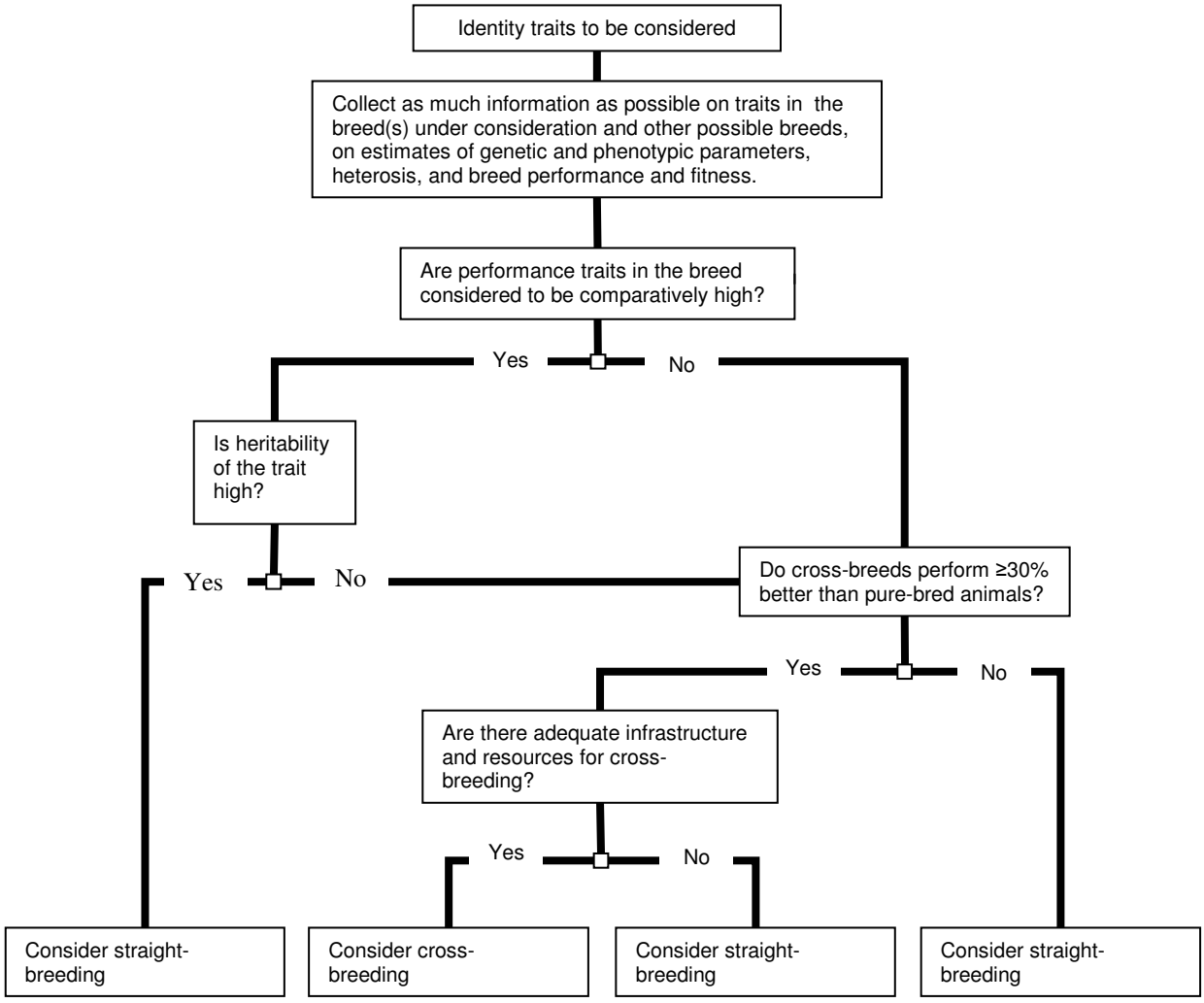
- a well-planned straight-breeding programme and a detailed list of the tasks and actions that need to be undertaken at each stage of implementation; and
- a description of the roles that the various actors involved will play in all aspects of the programme, i.e. the institutional structure of the programme.

TASKS

The following tasks need to be undertaken:

1. Review the breeding goal and allocate responsibilities for planning and implementing the programme
2. Assess the current state of breeding practices, capacity and infrastructure
3. Prepare the Plan for the *Plan for the start of the straight-breeding programme*
4. Set up the financial and organizational structures
5. Implement the straight-breeding programme
6. Open the nucleus to superior genetic merit
7. Improve dissemination and distribution
8. Improve recording and evaluation
9. Optimize the selection intensity and the generation interval
10. Secure the delivery of the programme

Figure 3. Simplified decision-making process for choosing a breeding programme



Box 28. Definitions: tiers within a breeding programme

The structure of breeding programmes is usually divided for convenience into tiers (i.e. layers or strata) as follows:

- **Top tier:** where genetic improvement takes place and breeding animals are produced (in a cross-breeding programme this may be an introduced breed);
- **Bottom or production tier:** where improved animals are actually utilized for production (e.g. cross-bred cows used for producing milk or cross-bred males used for meat production).

Between these two tiers, there may be one or more additional tiers. In the case of a cross-breeding programme, there might be a multiplication tier to supply F1 animals, a tier to produce more-complex crosses (e.g. ½ A, ¼ B, ¼ C), and so on.

TASKS AND ASSOCIATED ACTIONS

Implementing an efficient programme will generally involve technical, operational and policy-oriented tasks. The programme needs to be operationally effective in each of its constituent actions and effective in coordinating these actions.

Tasks are divided into distinct phases: Phase 1 reviewing the breeding goal and assigning responsibilities; Phase 2 establishing a simple breeding programme; and Phase 3 establishing a more advanced programme. At the end of each phase, users should ensure that the elements necessary for the following phase have been carried out.

A. PHASE 1

TASK 1: REVIEW THE BREEDING GOAL AND ALLOCATE RESPONSIBILITIES FOR PLANNING AND IMPLEMENTING THE PROGRAMME

Action 1: Review the breeding goal and selection criteria

Traits to be considered for improvement (breeding goal traits) will have been derived from the LDOs with due consideration given to the opinion of all stakeholders concerned (Section C). The list of traits should be:

- as complete as possible – it should cover all the traits that are important to realizing the development objective;
- succinct – as few in number as possible without compromising the developmental objective (the more traits considered, the less the genetic improvement will be realized in each); and
- mutually exclusive.

Two pieces of information are needed to establish a sound programme to improve the breeding-goal traits. The first requirement is to have estimates of genetic and phenotypic parameters for the traits, i.e. heritabilities and genetic and phenotypic correlations. In many situations, these estimates will be unavailable or inaccurate at the initial stage. However, their precision will increase as the programme proceeds and more data become available. The second requirement is to establish the weight of each goal trait relative to the other goal traits, i.e. the goal trait values. In their simplest expression, goal trait values measure the increase in revenue associated with one unit increase in the trait in question. The calculation assumes that when the trait is increased by one unit other traits remain constant.

Goal trait values for trait measures can be estimated in two ways. The first method is simple subjective estimation; this is recommended at the beginning of the programme when few socio-economic data may be available. The second method is objective derivation based on concrete data on the socio-economic production environment and the use of advanced economic tools. Box 29 presents an example of how to derive goal trait values in a dairy improvement programme using the subjective method. This example can be easily adapted to other situations.

Breeding goal traits are not necessarily the same as the selection traits. In the example in Box 29, for instance, the goal trait is milk production. It is necessary to decide how this should be measured; i.e. what will be the selection traits? Options would include milk yield in 305 days or in 13 weeks. Costs and ease of measurement should be taken into consideration when choosing the selection criteria. When more than one trait is considered for selection, a means to aggregate them is needed. This is done using a selection index, which is a formula that combines all selection criteria into one figure, taking into account their heritabilities, their genetic and phenotypic relationships and their goal values.

Action 2: Allocate responsibilities for planning and implementing the straight-breeding programme

If a government decides to establish a straight-breeding programme, there is a need to decide which institution(s) will be charged with implementing the programme. The institutions concerned might be livestock-keeper cooperatives (possibly formed for the purpose), breeding companies, government farms, research institutes, breed societies or partnerships among such institutions. It must ensured that the programme is in line with current official regulations and legislation. If this is not the case, effort should be made to establish the regulations and legislation necessary for the smooth running of the programme. Section B provides more details on this.

The institution(s) implementing the programme will need:

- resources located sufficiently close to the bulk of the animal population targeted by the programme;
- an efficient management structure;
- expertise in quantitative genetics and data management;
- good knowledge of the management practices and requirements of the livestock keepers who raise the targeted animal population; and
- capability to develop a marketing profile for the programme.

Box 29. Calculating goal trait value – an example

The breeding goal traits for a dairy genetic improvement programme are: milk production (i.e. annual milk yield) and beef production (i.e. calf weaning weight).

One hundred points are divided between these two goal traits. This is done by experts, preferably in a panel, who are aware of the cost and return structure in the dairy operation.

Assume that the consensus was 60 points for milk production and 40 points for beef production. This means that milk production is 1.5 times as economically important to the producer as beef production. If milk production is further subdivided into milk yield and fat content expressed as a percentage, the 60 points for milk are also subdivided between the milk yield and the fat content (e.g. 50 points for the yield and 10 points for the fat content). The ratio becomes 50:10:40 for milk yield, fat percentage and calf weaning weight, respectively. These values must be inversely weighted by the additive genetic standard deviation σa (the square root of the numerator of the heritability) of each trait to standardize the units of measurement.

If σa for the traits are 260 kg, 0.8 percent and 10 kg, respectively, then the final breeding goal trait values would be 50/260 = 0.19, 10/0.8 = 12.5, and 40/10 = 4; or 1:66:21.

The lower value for milk production should not be interpreted as indicating that it is less important, as this value will be multiplied in the selection index by the much larger figure for annual milk production (in the thousands).

Objective but resource-demanding and sophisticated methods for deriving breeding goal trait values are explained in the following publications:

Sources: ICAR/FAO (2000d), FAO (1992).

B. PHASE II

TASK 2: ASSESS THE STATE OF CURRENT BREEDING PRACTICES, CAPACITY AND INFRASTRUCTURE

Action 1: Gather detailed information on breeding practices and structure

Answer the following questions:

- To what extent are breeding animals currently exchanged among livestock keepers? Do some livestock keepers sell animals to others specifically for breeding purposes? Are there breeding nuclei whose sole purpose is to provide breeding stock to other livestock keepers?
- What is the age of the breeding males and females and what is the mating structure (the number of females per male)? Note that while the practical reasons for a particular age and mating structure in a herd or flock may be unrelated to breeding (e.g. members of an extended family often pool their animals together for efficient management), this structure will nevertheless have a bearing on breeding. What are the lower limits to the age of breeding stock? Does the number of females per male vary with the age of the breeding male?
- When and where do livestock keepers choose their replacement stock? Are breeding males kept with the females all year round or only during a tightly controlled season? If the breeding is seasonal, what happens to the breeding stock outside the season? If they are obtained from outside the holding, where and in what season are they purchased?
- Are there breeding practices that will need to be changed within the top tier of the improvement programme?
- How do livestock keepers select animals for breeding?
- Is there an AI infrastructure?

Box 30. Cultural habits as ways to exchange germplasm – the example of the WoDaaBe of Niger

In livestock-keeping communities, social interactions often involve animals. Friendships are sealed with animal loans; marriages involve the payment of a bride price; animals are offered as wedding gifts; disputes and compensation claims are settled with animals. These and other traditional practices such as animal exchanges, herd splitting and herding contracts (known locally among the WoDaaBe of Niger as *mafisa*, *haBBana'e* and *bulisana*, respectively) entail numerous movements of animals. The animals in any herd or flock vary greatly in terms their origin and how they entered (this is often indicated by the animal's name). The animals' histories reflect the extent of a household's social network and family relations.

Cultural customs are therefore of direct relevance to animal breeding. While breeding is rarely the primary motivation for such customs, they influence breeding because any movement of animals from one herd or flock to another implies an exchange of genetic material. This also becomes apparent from the characteristics required of animals that are given away as presents or offered as a bride price or compensation. These animals must invariably be in their prime, of productive age, in good health, well built and whole (not castrated).

Through social networks, traditional livestock keepers have access to a wide pool of genetic resources, which they consciously exploit. The example below is taken from Saverio Krätli's description of Jiima, a WoDaaBe pastoralist in northern Niger.

Jiima's herd was about 35 head of cattle. From the perspective of selection, this would be a very small population. However, neither the quality nor the variety of genetic material to which Jiima had access was ever limited by the size of his own herd. This was due to the WoDaaBe breeding system, which relies on borrowing bulls from relatives and making long-term herding arrangements known as *haBBana'e*. Assuming that each herd from which Jiima

borrowed bulls is about the same size as his own, the cattle population involved in Jiima's cattle breeding over the last 20 years can be estimated at about 1 400 head. The potential gene pool network is many times larger. It includes a relatively stable set of herds belonging to Jiima's relatives (patrilateral, matrilateral and in-laws) as well a virtually endless set of additional herds available through friendships or at occasional meetings by wells and in the bush. Mobility is a crucial factor in expanding the gene pool network – moving from water point to water point increases access to genetic material.

Krätli concludes that cattle-breeding among the WoDaaBe is a social enterprise: the actual scale of the gene pools to which breeders have access is to be measured in terms of the extent of their networks.

Source: Krätli. (2007).

Box 31. How do livestock keepers select animals for breeding? The example of the Maasai communities in the United Republic of Tanzania

A recent study of two Maasai communities in the United Republic of Tanzania, sponsored by FAO within the framework of LinKS (Gender, Biodiversity and Local Knowledge Systems for Food Security), showed that these traditional livestock keepers have clear breeding goals, engage in purposeful and rational breeding, and use a variety of technologies to achieve their goals.

Maasai keep their animals under harsh conditions. They have to deal with periodic droughts, marginal soils and diminishing rangeland resources. To obtain the highest possible production in these circumstances, they manipulate the three main resources at their disposal – the environment, labour and animals. The Maasai try to make the best of the environment by operating a mobile grazing system. They use a system of labour division based on age and gender. Men, women and children have distinct responsibilities.

The Maasai try to get the best out of their animals by breeding for:

- **Adaptation to the environment:** hardiness, sturdiness (small size), disease tolerance or resistance (e.g. dark skin for protection against tsetse flies and skin diseases), drought resistance (the ability to go without water for several days), the ability to walk long distances (short legs).
- **Reliable production:** cows that easily become pregnant, calve regularly and without trouble, have steady milk production and well-formed udders. In the case of bulls for the market, there is a preference for larger animals with "much marrow in the bones". But for breeding bulls, family origin is rated higher than size; they will always prefer a bull whose mother was a good milker. Breeding bulls should be active and eager to mate.
- **Behaviour that facilitates milking, management and herding:** docility, obedience, good leadership qualities (positive influence in the herd). Cows with good mothering abilities are valued – animals that allow calves whose dams have no milk or have died to suckle and that have an "agreeable voice" with which to call their calves from a long distance.

Aesthetic factors, such as the size and shape of the horns and the hump and the colour of the coat, were also mentioned by the livestock keepers. However, when it comes to actual selection the aesthetic factors hardly play any role.

To implement their breeding strategy, pastoralists use a variety of measures, some aim to prevent mating (negative), while others aim to stimulate mating between selected animals (positive).

Positive measures include buying or borrowing animals with desirable traits, arranging a proper bull-to-cow ratio, timely detection of heat, "marrying" animals (once signs of oestrus are detected, the herder matches the cow with a particular breeding bull, either from within the herd or borrowed from another herder) and the use of fertility-enhancing medicines. Cross-breeding with animals of other breeds is always done in a controlled way. Cows from other breeds are usually welcome, provided they have some good qualities, but bulls are either immediately castrated or avoided altogether. Dowry animals are customarily female; in the case of males, they should be castrated.

Negative measures include castration, isolation, culling, use of aprons, sale, exchange and slaughter. Of all the bull calves born in a herd, some five to ten are earmarked for breeding, mainly on the basis of parental history in terms of milk production. The decision whether or not to castrate is made at the age of three to four years, when their potential can be properly evaluated.

There is overwhelming evidence that even in traditional livestock production systems, reproduction is not left to chance. Analysis of births in two sample herds over a 20-year period showed that 99 percent and 96 percent,

respectively, were the result of planned matching of sire and dam. Almost unfailingly, the owner of the dam remembered the circumstances in which the female animal was fertilized and the name of the owner of the sire. Only in a few cases had the name of the owner of the sire unknown or forgotten.

Action 2: Gather information on available human resources

Human resources to consider include the participation of the owners and keepers of the local breed in the programme and their knowledge of and agreement to the breeding goal.

Action 3: Assess the availability and suitability of technical support services

Resources to consider may include:

- the extension service;
- training support;
- research support;
- animal recording services; and
- artificial breeding (e.g. AI) services.

Capacity to deliver efficient services depends on human resources as well as on organizational matters. This includes gender-awareness among the staff (particularly in extension services and training institutes) and a gender-balanced workforce; there are situations in which women livestock keepers are not allowed to interact with male extension agents or AI staff.

Action 4: Assess current market signals for animals

Review the *Production systems assessment* (Section B) to recall how animals are traded and exchanged for production purposes. It is important to establish whether there are favourable market signals (e.g. price rewards) at the trading/exchange points that will provide benefits to livestock keepers in the production tier if they increase the quality or quantity of production as a result of the straight-breeding programme. This will promote livestock keepers' uptake of and involvement in the programme.

TASK 3: PREPARE THE *PLAN FOR THE START OF THE STRAIGHT-BREEDING PROGRAMME*

Action 1: Plan how to meet the requirements for personnel and a management structure

The type of personnel and management structure required will vary greatly depending on the scale of the programme. The following expertise should be available within or accessible to the programme structure, depending on its scale:

- a geneticist;
- a data and information manager;
- a veterinarian;
- a reproduction specialist;
- a farm manager;
- a technician to promote the programme among livestock keepers and advise on the use of improved stocks (gender expertise is necessary); and
- a financial manager.

Individuals may have multiple responsibilities, but responsibilities should not be shared.

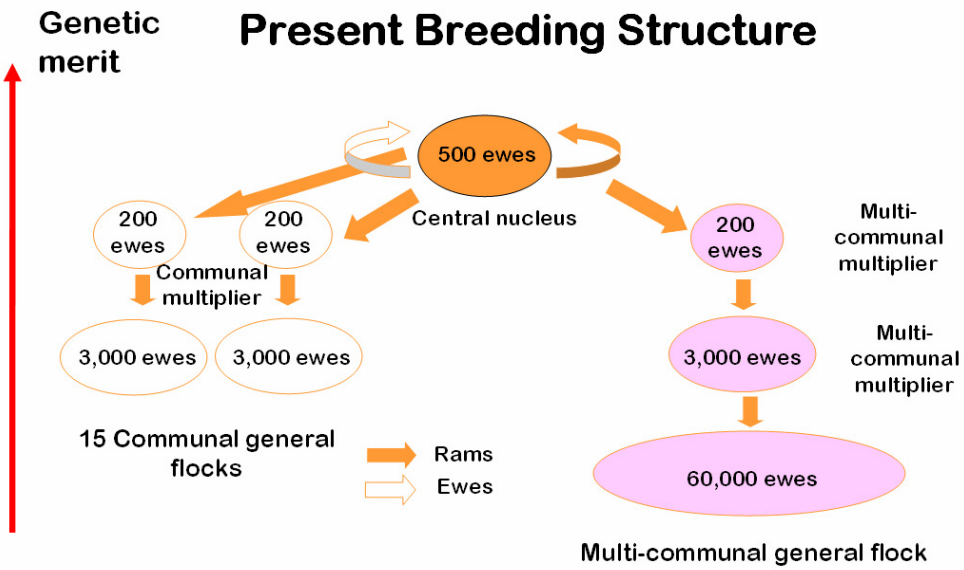
Action 2: Plan the establishment of a breeding nucleus

In a nucleus breeding scheme the genetic improvement takes place in a small segment (the nucleus) of the population and is then disseminated to the rest of the population directly or after improved animals have been multiplied in a multiplier structure to reduce costs. Nucleus breeding is utilized where recording at the grassroots level is not feasible. The smaller number of animals and the concentration of facilities in the nucleus mean that recording is easier. The nucleus can be "closed" (no new animals are allowed in) or "open" (superior animals from outside the nucleus are allowed in). The latter structure implies that some recording takes place in the rest of the population. After a few generations of nucleus breeding, the rate of the genetic improvement in the nucleus and in the breed population at large will be equal. The plan should address the following:

- the size of the nucleus (usually 5 to 10 percent of the size of the population it serves, including the multiplication units);
- whether there will be one nucleus or multiple nuclei;
- whether the nucleus will be centralized or dispersed (nucleus animals kept in the owners' herds or flocks) – a centralized nucleus is preferable for ease of transport and communication;
- the geographical location of the farm or farms that constitute the nucleus;
- how to choose the nucleus animals, i.e. how to screen owners' animals for possible inclusion in the nucleus.

Box 32. Open nucleus breeding – maximizing community involvement

In 1995, an agreement was signed between the University of La Molina and local sheep keepers in the Sierra Central in Peru to improve breeding efforts and produce superior rams. A year later, the Research and Training Centre for Rural Workers was established. A breeding structure was created based on an open nucleus with progeny-tested sires and 500 ewes. Two types of multiplication were established, the first involving a single tier of multipliers for single community flocks and the second involving two tiers for a general multicommunal flock.



Breeding structure based on an open nucleus and one- and two-tiered multiplying routes

In 1997, the villagers came together and defined the breeding goal. They allowed the 50 best ewes to be used in the open nucleus; 25 were returned to them when they were pregnant. Rams were selected from the best local and external sources. Performance is recorded in the nucleus, and sheep are visually appraised by the villagers.

This project shows that maximizing the involvement of livestock keepers in a breeding programme is a slow process, but pays off in the long term.

Provided by Joaquín Mueller.

Action 3: Plan the transport and communication infrastructure within the breeding nucleus

An effective straight-breeding programme requires good transport infrastructure and communication. The plan needs to consider how transport and communication requirements will be met.

Action 4: Plan recording policies within the nucleus

Recording is often one of the most expensive elements of a breeding strategy, so there is a need to be judicious and to take only the necessary records. It is possible to begin with simple low-cost recording (FAO, 1998b) and increase it as the programme proceeds (and possibly as revenues start to accrue). The traits to be recorded will have been chosen when the breeding goals and the selection criteria were identified. There is, however, a need to plan which traits will be recorded on which animals. Recording requires some form of animal identification; options include tattooing, branding, ear tags, ear notching, necklaces and electronic identification. In some situations, when mass selection[5] is practised for a simple trait such as body weight, animals may be selected as they are weighed.

Women are often the traditional record keepers of animal performance and pedigree, and are knowledgeable about these issues. It is therefore a sensible choice to involve them in record keeping. Literacy rates among women are usually lower than among men; however, this need not be a problem if recording methods are designed accordingly.

Box 33. Animal records and recording

Animal records taken in the nucleus will relate to:

- performance;
- pedigree; and
- management (e.g. health, feed consumption and reproduction).

Keep recording simple. For example, if lamb weight at weaning is a selection criterion, lambs can be weighed a number of days before weaning age and the weaning weight calculated by extrapolation. This approach will allow for the fact that weighing all the animals will take some time). In the case of cattle, if 13-week milk yield is the selection criterion, measure milk production for that period only.

For complete pedigree recording, the sire and the dam need to be known. Recording the sire requires AI, hand mating, separate mating pens during the mating season or close observation by the herder or caretaker. Recording dams is easier as the young stay with their dams for some time after birth.

Recording may become more sophisticated as the programme advances and more accurate genetic evaluation is required. For a thorough treatment of recording, consult ICAR (2006).

[5] Selection based on the phenotype of the individual animal.

Action 5: Plan the management of the stock within the nucleus

Basic parameters to consider include:

- ages at breeding and breeding lifetime (which will have great influence on the rate of genetic improvement);
- feeding of each management group (e.g. young males);
- housing of each management group; and
- locations of each management group.

There will also be a need to plan disease control and management, and to integrate the recording programme (including any performance tests) with the management of the stock. The selected animals are higher-producing animals and therefore have higher requirements in terms of feeding and husbandry.

Action 6: Plan the selection policies and selection targets within the nucleus

The selection policies will describe how replacements for breeding males and females in the improvement programme are to be chosen.

Action 7: Define the selection index

The selection index is defined in terms of the selection criteria and other parameters including heritabilities, and genetic and phenotypic correlations. In many cases, these parameters will not be available for the breed that is to be the subject of the breeding programme. In such cases it is possible to use the equivalent values for the same trait(s) in a production environment that is closely comparable to that in which the breeding programme is to be undertaken. At this point there is a need to establish a formal selection index, which will involve a combination of goal traits and/or non-goal traits (the latter provide information about the goal traits but are easier or less-costly to measure).

Action 8: Plan the genetic evaluation procedure

The following questions should be considered when planning the genetic evaluation procedure:

- How will the evaluation be made? Mass selection (selection based on the phenotype of the individual) is the form of evaluation that requires the least amount of recording. However, it is generally less accurate. Breeding value can also be estimated by progeny testing and best linear unbiased prediction (BLUP). This requires performance and pedigree data.
- Where are the evaluations to be done (e.g. at dispersed locations or at a centralized location)?
- How will the recorded data be transferred to where the evaluations are carried out?
- Will the data need to be entered into a computer before evaluation? If so, how will this be done?
- Are the available computing resources sufficient for the task?

- In the case of multiple nuclei, consideration should be given to whether they are genetically connected and whether a comparison between animals in the different nuclei can be made.
- How will the timing of the evaluations relate to that of the recording and the breeding schedule?
- How will the selection decisions be conveyed to the people concerned with managing the breeding stock?

Action 9: Plan the dissemination and marketing of improved stock

The plan for the dissemination of the improved germplasm should address the following questions:

- Will improved breeding stock be disseminated directly from the nucleus or via multiplier units?
- What germplasm will be disseminated – males, females or both?
- How will the germplasm be disseminated?
- How much improved germplasm will be available for dissemination?
- How will the improved germplasm be promoted?
- What are the targets for the use of improved germplasm by commercial livestock keepers?

Box 34. Niche markets and the need for a marketing plan – an example from France

An interesting example of niche marketing comes from the Bresse Region in France. Breeders undertook the protection of a local chicken breed that is associated with a tradition of quality products. To achieve their objectives, the breeders set up a genetic management programme for the breed and developed a marketing strategy to distinguish the "*Poulet de Bresse*" from fast-growing commercial broilers. Image is an important marketing point – the Bresse breed standard includes white plumage, blue shanks and traditionally red earlobes and comb. A better match with the national flag is hard to imagine.

The birds are raised under specific growing conditions, and are subject to a standard finishing period and regulated processing. The result is a unique product with a Protected Designation of Origin label. Revenues are often more than twice those obtainable with standard broilers. The *Poulet de Bresse* is sold almost exclusively via small retailers and restaurants and not via supermarkets. The *Poulet de Bresse* has thus managed to find a niche in a market dominated by large-scale poultry breeders.

It is apparent from the Bresse experience that it is possible to establish a niche market despite strong competition from highly selected breeds, provided that a good marketing strategy and a unified genetic management programme are agreed by the livestock keepers.

Provided by Michèle Tixier-Boichard.

Action 10: Carry out a SWOT analysis

Once the straight-breeding programme plan has been prepared, a SWOT analysis should be carried out. The results of the analysis should be used to fine-tune the programme plan.

Action 11: Obtain an investment appraisal

See details in Section F.

Action 12: Deliver the straight-breeding programme plan to the policy-makers and revise if necessary

When the straight-breeding programme plan is complete, deliver it to the policy-makers. Revisions may be required.

TASK 4: SET UP THE FINANCIAL AND ORGANIZATIONAL STRUCTURES

Action 1: Secure the necessary funding

Funding may come from the government, NGOs (including breed societies) or external funding (during the initial phase). In most developing countries, the government will need to play a significant role, at least at the start of the programme, so as to maximize the chances for its sustainability.

Action 2: Develop training programmes

Train extension service staff to show livestock keepers how to deal with the improved animals and meet their needs for housing, feed and veterinary care. Emphasis should be given to including women livestock keepers because of their important role in animal management. It is also necessary to train programme staff in all aspects of running the programme.

TASK 5: IMPLEMENT THE STRAIGHT-BREEDING PROGRAMME

Action 1: Manage the implementation of the development plan on a daily basis

Two areas require close attention – problems unforeseen at the planning stage and disputes over the demarcation of responsibilities. The latter are likely to occur during the recording procedures. The precise demarcation of responsibilities between the farm manager, the manager of the information system and the geneticist should be carefully re-assessed.

Action 2: Involve progressive and competent livestock owners

Such livestock owners should be identified. They will form the first group of customers for the straight-breeding programme. Ask for feedback from the livestock keepers. This should be collated and included in the progress report (Action 4) for consideration when the breeding goals are reviewed.

Action 3: Strengthen contact with the extension service

The extension service should explain to the livestock keepers that the improved animals, even though they are from local breeds, have higher requirements in terms of feeding and husbandry. Ask for feedback from the extension service concerning the performance of the improved animals in commercial conditions. This information should be collated and included in the progress report for consideration when the breeding goals are reviewed.

Action 4: Monitor and report on progress

Dissemination should be reviewed. Sales of the improved germplasm should be compared to the agreed targets. It should also include collated feedback from customers and the extension service. A genetic review should consider selection intensities, recording accuracies, generation intervals in males and females, and genetic gain.

C. PHASE III

TASK 6: OPEN THE NUCLEUS TO SUPERIOR GENETIC MERIT

Action 1: Carry out an empirical comparison of herds/flocks within and outside the improvement programme

If the nucleus of the improvement programme has had limited opportunity to select among its stocks or if selection has been based on poor information, this task may be extremely important. The improvement programme will benefit from obtaining replacements from among the superior animals in the superior herds or flocks that may be identified.

TASK 7: IMPROVE DISSEMINATION AND DISTRIBUTION

Action 1: Ensure that market signals promote the use of improved stock

There must be incentives for using the improved stock. These incentives will generally result from higher prices in the market. If incentives do not exist, then:

- lobby policy-makers for a change in the market structure;
- seek a marketing alliance further down the retail chain (branding); and
- seek ways to expand the market.

Action 2: Examine the case for improved dissemination methods

Reproductive technologies are continuously developing. Many can be used to expedite dissemination. In particular, the use of AI where it is technically feasible has proved very effective in disseminating genetic merit to commercial herds and flocks as it dramatically increases the male reproductive rate and avoids the need for multiplier herds or flocks.

TASK 8: IMPROVE RECORDING AND EVALUATION

Action 1: Consider introducing pedigree recording (if this has not already been done)

It is possible to proceed with the breeding programme without pedigree recording, but developments in Phase III are easier if pedigrees are routinely recorded within the programme or at least in the nucleus. Seek expert advice if required. If pedigree recording is already being implemented, review the procedures and amend them if necessary; set targets for reducing errors in the pedigrees.

Action 2: Consider the need for more structured recording

More structured recording implies taking more, and possibly more sophisticated, records. Examples include performance testing of animals or their progeny, and measuring traits that are not among the goal traits, but are included in the selection index because of their high correlations with the goal traits. The potential benefits achievable through the introduction of more structured recording should be reviewed. The review should address the following questions:

- Will more structured recording produce significant genetic benefits?
- Will additional holdings need to be included?

- What other developments are required (e.g. additional housing for mature males during a progeny test)?
- What are the total additional costs likely to be?

Action 3: Consider the use of best linear unbiased prediction (BLUP) for breeding value evaluation

If full pedigree recording has been introduced, then it is possible to improve genetic evaluation by using BLUP. If only partial pedigree records (through sire or through dam only) are available, BLUP can still be performed, but it will be less accurate.

If there are multiple nuclei in the straight-breeding programme, effort should be made to have sires that are used across the nuclei in order to provide the genetic connectedness required for accurate evaluation of breeding values.

TASK 9: OPTIMIZE THE SELECTION INTENSITY AND THE GENERATION INTERVAL

Action 1: Review selection and mating structure

The number of individuals selected as replacements within each age group affects both the selection intensity and the generation interval. A balance must be struck between the two. Generation intervals can be shortened by breeding animals at younger ages, keeping parents for fewer years and avoiding reproductive failures. Selection can be intensified by increasing the reproductive rate, reducing mortality among the young and by keeping animals for longer. The latter, however, option leads to longer generation intervals.

Action 2: Consider how to increase the female reproductive rate through improved management

One way of increasing selection intensity is to increase reproductive capacity. Review management procedures to determine how reproductive rates might be improved. Discuss the required measures with the persons who are responsible for managing the animals.

Action 3: Consider how to increase reproductive rates through the use of reproductive technology

Reproductive rates can be increased through the use of reproductive technologies. Consider whether there is a case for using these technologies.

Action 4: Review the adequacy of the genetic links between dispersed locations

Without adequate genetic links, the relative merits of herds or flocks in dispersed locations are difficult to estimate. The genetic links between the herds or flocks that make up the selection nucleus should be reviewed. If they are found to be weaker than is desirable, measures should be taken to strengthen them.

Action 5: Improve selection across age groups and locations

If BLUP evaluation is introduced, selection should take place across age groups and locations.

TASK 10: ENSURE THAT THE PROGRAMME IS DELIVERING AS EXPECTED

Action 1: Estimate the effective population size and consider ways to ensure that it is sufficiently large (more than 50)

The effective population size determines the rate of loss of genetic variation from the breeding programme. It is distinct from the actual population size. It depends on the number of both male and female animals used as parents, the selection intensity, the variation in litter size and the method of evaluation and selection. The effective population size and how it can best be managed should be reviewed.

Action 2: Consider the potential effects of differences between management in the top tier of the breeding programme and that in production tier

If the herds or flocks within the top tier are managed differently from those in the production tier, genotype by environment interactions may mean that the animals best suited to one system are not best suited to the other. The possibility of such effects should be explored during the early stages of the programme. This will help ensure that the breeding programme delivers benefits to the whole population. As the programme develops further, checking for such effects is a means by which to identify whether there is a need to reconsider the breeding goal or provide advice to livestock keepers in the production tier on how to improve their management so that they obtain greater benefit from the improved stock.

SECTION E: DEVELOPING CROSS-BREEDING PROGRAMMES

RATIONALE

This and the previous section both deal with the genetic improvement of breeds and therefore have much in common. It is, however, intended that each should be able to stand alone. Reading them in sequence will involve some unavoidable redundancy.

Cross-breeding is an alternative method for genetically improving a breed. There may be major advantages to be gained from cross-breeding rather than straight-breeding, and progress is generally obtained within a shorter time period. Cross-breeding can be used for sustained crossing (i.e. to continuously produce cross-bred animals), to change a local breed by upgrading or to create a new (synthetic) breed that combines desirable traits from two or more breeds.

A cross-breeding programme can be a complex operation. Implementing such a programme requires efficient organization and may require stratification of the breeds involved into multi-tier breeding structures. Figure 3 (in Section D) shows the general logic involved the process of deciding between a cross-breeding and a straight-breeding programme. The planning and implementation of the cross-breeding programme is described in this section.

OBJECTIVES

Develop a cross-breeding programme that makes use of the genetic variation among the breeds with which the programme is working.

INPUTS

The main inputs are the breed(s) that are the focus of the programme (identified by implementing Section C); the LDOs (Section B) and the overall breeding goal (Section C).

OUTPUT

The outputs will be a well-planned cross-breeding programme with a detailed list of tasks and actions to be undertaken at each stage and a description of the roles that the various actors involved will play in all aspects of the programme.

TASKS

The following tasks need to be completed in order to achieve the above objective:

1. Review the breeding goal and allocate responsibilities for planning and implementing the programme
2. Assess the current state of breeding practices, capacity and infrastructure
3. Prepare the *Plan for the start of the cross-breeding programme*
4. Set up the financial and organizational structures
5. Implement the *Cross-breeding programme plan*
6. Organize and implement the cross-breeding services
7. Promote the uptake of the cross-breeding services
8. Evaluate the cross-breeding programme for benefits and sustainability
9. Report on progress

TASKS AND ASSOCIATED ACTIONS

Implementing an efficient programme will generally involve technical, operational or policy-oriented tasks. The cross-breeding programme needs to be operationally effective in each of its constituent actions and effective in coordinating these actions.

Tasks are divided into distinct phases: Phase 1 reviewing breeding goals and allocating responsibilities; Phase 2 establishing a simple breeding programme: Phase 3 establishing a more advanced programme. At the end of each phase, users should ensure that the elements required for the following phase are in place.

A. PHASE I

TASK 1: REVIEW THE BREEDING GOAL AND ALLOCATE RESPONSIBILITIES FOR PLANNING AND IMPLEMENTING THE PROGRAMME

Action 1: Review the broad objectives of the cross-breeding programme

General breeding goals will have been derived with the active involvement of end-users (Section C). At this stage, they will need to be reviewed. Less detail is required than for building the selection index for a straight-breeding programme. However, the broad objectives of the cross-breeding programme should be identified. For example, the objective might be to increase milk yield, with meat production as a secondary objective. Once a breed has been created through cross-breeding, it can then be improved through a straight-breeding programme in the manner described in Section D.

Action 2: Allocate responsibilities for planning and implementing the cross-breeding programme

It is important to allocate the responsibilities for planning and implementing the cross-breeding programme. There will be a need to manage one (or more than one) alternative breed(s) (referred to below as breed A) and the locally available breed (referred to below as breed B) with the main objective of producing males from breed A to cross with females from breed B. The exact requirements will depend in part on the ultimate objective of the cross-breeding programme (sustained cross-breeding, developing a new breed or upgrading). The institutions charged with the management of the alternative breed(s) and the development of the programme may be livestock keepers, breeders' associations, breeding companies, breeding-service companies, government farms, research and development institutions or a combination of these. The institution(s) involved may require the following technical skills:

- expertise in designing, planning the operations of and managing a breeding scheme(high levels of skill are required if the ultimate objective is to develop a new breed);
- expertise in the use of artificial breeding technologies (e.g. AI or embryo transfer), if the initial access to the alternative breed is by semen or embryos and/or the preferred route for disseminating genetic material is via fresh or frozen semen or embryos;
- expertise in collecting and cryopreserving semen or embryos, if the alternative breed is to be maintained as live animals and the preferred route for disseminating genetic material is to be via frozen semen or embryos; and
- expertise in the management practices required to maintain the straight-bred animals of the alternative breed.

Resources will need to be located sufficiently close to the local population to allow effective dissemination; this is particularly important when dissemination involves live animals or fresh semen. A marketing profile for the cross-breeding programme will need to be developed in order to encourage participation in the scheme.

B. PHASE II

TASK 2: ASSESS THE CURRENT STATE OF BREEDING PRACTICES, CAPACITY AND INFRASTRUCTURE

Action 1: Gather detailed information on breeding practices and structure

Consider the following:

- What is the extent of current exchange of breeding individuals among livestock keepers (see Box 30)? Do some livestock keepers sell animals to others specifically for breeding purposes? Are there breeding nuclei whose sole purpose is to provide breeding stock to other livestock keepers?
- What is the age of the breeding males and females and what is the mating structure (the number of females per male)? Note that while the practical reasons for a particular age and mating structure in a herd or flock may be unrelated to breeding (e.g. members of an extended family often pool their animals together for efficient management), the structure will nevertheless have a bearing on breeding. What are the lower limits to the age of breeding stock? Does the number of females per male vary with the age of the breeding male?
- When and where do livestock keepers choose their replacement stock? Are breeding males run with the females all year round or only during a tightly controlled season? If the breeding is seasonal, what happens to the breeding stock outside the season? If they are obtained from outside the holding, where and in what season are they purchased?
- Are there breeding practices that will need to be changed within the top tier of the improvement programme where breed A is maintained?
- Is there a need to change breeding practices in breed B?
- How do livestock keepers select animals for breeding (see Box 31)?
- Is there an artificial insemination infrastructure?

Action 2: Gather information on available human resources

Human resources to consider include the keepers of the local breed(s) and their knowledge of and agreement to the breeding goal. Due consideration should be given to relevant indigenous knowledge.

Action 3: Assess the availability and suitability of technical support services

The resources to be considered might include:

- the extension service;
- training support;
- research support;
- animal recording services; and
- breeding (e.g. AI) services.

The capacity to deliver efficient services depends on human resources, organization, gender-awareness among staff (particularly in the extension service and training institutes) and a gender-balanced workforce (there are situations where female livestock keepers are not allowed to interact with male extension agents or AI staff).

Box 35. The crucial role of women in Chiapas sheep breeding

Since 1973, several attempts have been made to use cross-breeding to improve the wool production of the Chiapas sheep kept by the Tzotzil people of southern Mexico. The third attempt initiated in 1981 involved a large number of Romney Marsh sheep, yet by 1990 the project had been abandoned. While part of the failure can be attributed to an incompatibility between the breeding seasons of the two breeds and reduced wool production caused by the poor adaptation of the Romney Marsh sheep to the new environment, the best explanation for the failure is probably the project's lack of understanding of responsibilities in the Tzotzil household. Women are entirely responsible for herding the sheep.

The Tzotzil women did not accept the improved sheep for several reasons. First, the extension workers (mostly men) communicated solely with the men in Spanish, rather than with the women, who only spoke their native language. Second, sheep husbandry is an individualistic business – each shepherdess takes care of a few sheep and gives each one a different name. The women only accept a new animal when it has the right "feeling" and "soul". They are not used to a collective approach to sheep breeding. Third, rams of the improved breed did not obey the women like the Chiapas or "real" breed did. Fourth, the new wool was unsuitable for hand weaving – too short, too thin and easily breakable. Finally, the wool was not as colourful as that of the traditional Chiapas breed and thus less fit for making the woollen clothes and garments that protect the Tzotzil people from the cold climate and distinguish them from other indigenous groups.

In 1985, the key role of women in Chiapas sheep breeding was recognized by the Institute of Indigenous Studies of the University of Chiapas. In the early 1990s, the institute started a genetic improvement programme for Chiapas sheep based on the women's criteria. By fully involving the women, significant increases in wool quantity and quality have been achieved.

Source: Geerlings *et al*. (2007).

Action 4: Assess current market signals for cross-bred animals

Review the *Productions system assessment* (see Section B) to identify the ways in which animals within the production tier are traded or exchanged. It is important to establish whether there are market signals (e.g. price rewards) that will provide benefits to livestock keepers in the production tier if they increase the quality or quantity of production. This is likely to influence levels of livestock keeper uptake and involvement in the breeding programme. Predicting the size of the market will make it easier to estimate the number of animals that will need to be produced in the various tiers of the programme.

Action 5: Assess the possible extent of existing cross-breeding

Many breeds, especially of cattle, are exposed to crossing with other local or exotic breeds. This may be done intentionally as part of a defined plan or (as is often the case) be indiscriminate. The latter may be detrimental to the local breed that is to be an element of the proposed cross-breeding scheme. Livestock keepers may already be cross-breeding for various reasons related to performance, adaptation or workability in the field. This may lead them to breed in a way that is not in line with the agreed programme. It is important to be aware of these practices. If the envisaged programme involves sustained cross-breeding, the programme should ensure the availability of a population of the local breed. The proportion of animals that a livestock keeper can cross while still maintaining the size of the local breed population with security depends on the herd/flock size and the reproductive rate (Box 36). Specific technical advice should be sought on this matter.

Box 36. Impact of herd size on breed security – an example calculation

Assume that breed A is renowned for its high milk yield and was brought in to improve the milk production of local breed B by producing F1 cows. If fertility in breed B is 80 percent, mortality to breeding age is 90 percent and 20 percent of cows are replaced every year, then in a 100-cow herd it is necessary to have: 2*20/ (0.8*0.9) = 56 cows mated to a bull from breed B to produce the straight-bred females required to secure the pure breed (assuming a 1:1 sex ratio). Thus, only 44 cows can be mated to bulls from breed A to produce F1 cows for increased milk production.

To sustain the security of breed B, F1 males should ideally not engage in mating, i.e. should be castrated or slaughtered. It is obvious that such a calculation will be influenced by fertility, mortality and herd size, especially in the case of small herd size.

The top tier of the breeding scheme would always produce breed A bulls or their semen (or import semen) to service local cows of breed B.

TASK 3: PREPARE THE *PLAN FOR THE START OF THE CROSS-BREEDING PROGRAMME PLAN*

Action 1: Plan the requirements for personnel and management structure

The type of human resources and management structure required will vary greatly depending on the scale of the cross-breeding programme. The following expertise should be available within or accessible to the programme structure, depending on its scale:

- a geneticist;
- a data and information manager;
- a veterinarian;
- a reproduction specialist;
- a farm manager
- a technician to promote the programme among livestock keepers and advise on the use of cross-bred stocks (gender expertise is necessary); and
- a financial officer.

Individuals may have multiple responsibilities, but responsibilities should not be shared.

Action 2: Plan the establishment of the cross-breeding programme

Make a plan of the steps required in the cross-breeding programme. Address the following issues:

- whether there should be a top tier in the breeding structure of the programme producing straight-bred breeding animals, mainly sires (this tier may develop into a straight-breeding scheme);
- what crosses need to be produced over time;
- if there is a breeding tier, what animals will be required for breeding replacements within this tier and what animals will be available for dissemination to the production tier?

It is also necessary to ensure that correct decisions are taken regarding the number, sex, genotype and genetic lines of breeding stock required over a period of at least three generations.

Follow the decision tree set out in Box 37 and summarized in Figure 4. Seek genetic expertise. The decision tree is based on the assumption that only one alternative breed is required. If more than one alternative breed is to be used, the group of alternative breed males used for the F1 and the backcross

should be made up of the appropriate proportions of each breed. It is also assumed that only mixes based on 25 percent, 50 percent and 75 percent genetics from the locally available breed are initially considered.

Box 37. Decision tree for a cross-breeding programme

For the purposes of this decision tree, the alternative (introduced) breed is referred to as breed A and the locally available breed with which it is to be crossed is referred to as breed B.

1. *Is there a need for a top tier of straight-bred breed An animals or cross-bred animals to be kept?* The answer will be no ***only*** if: (I) the ultimate objective is upgrading or sustained cross-breeding ***and*** (ii) the genetic material of alternative breed is both obtained and disseminated via AI. If **yes**, go to **2**; if **no**, go to **9**.

2. Is the ultimate objective to form a new breed? If **yes**, go to **3**; if **no**, go to **8**.

3. Is only 25 percent of genetic make-up of the new breed to come from the locally available breed? If **yes**, go to **4**; if **no**, go to **5**.

4. Create a breeding tier initially producing an F1 cross, and backcross the F1 to breed A. The easiest approach will be to create the F1 animals by mating B females to A males and to backcross F1 females to A males. This will produce a breeding population that is 75 percent A: 25 percent B. Once this 75:25 breeding population is established, the breeding tier can proceed with straight-breeding (see Section D). Estimate the numbers of breeding animals required for three generations.

Minor adjustments to breed percentages can be made by either including a proportion of additional F1 males or breed A males in the population once the nucleus is being straight-bred.

Avoid mating F1 females of one alternative breed back to the males of the same breed, and try to mix the breed combinations. However, once straight-breeding starts, concentrate on using the best individual animals rather than focusing too closely on maintaining breed proportions.

During this process, A males (and F1 cross males) can be disseminated more widely and mated with females within the production tier, provided an effective dissemination scheme is in place. Upgrading the production tier to the new breed formed in the breeding tier will then make further progress. Go to **10**.

5. Is 50 percent of the genetic make-up of the new breed to come from the locally available breed? If **yes**, go to **6**; if **no**, go to **7**.

6. Create a breeding tier with an F1 cross and then interbreed the cross. The easiest approach is to mate B females to A males to form the F1. The F1 animals can then be intermated. This will produce a 50 percent A: 50 percent B mix. Once the 50:50 breeding population is established, the breeding tier can proceed with straight-breeding (see Section D). Estimate the numbers of breeding animals required for three generations.

Minor adjustments to breed percentages can be achieved by including a proportion of additional A or B males when the F1 crosses are interbred.

Avoid mating F1 females of one alternative breed back to males of the same breed, and try to mix the breed combinations. However, once straight-breeding starts, concentrate on using the best individual animals, rather than focusing too closely on maintaining breed proportions.

During this process, A males (and F1 cross males) can be disseminated more widely and mated with females within the production tier, provided there an effective dissemination scheme is in place. Upgrading the production tier to the new breed formed in the breeding tier will then make further progress. Go to **10**.

7. The new breed is 75 percent breed B. Create a breeding tier with an F1 cross and then backcross to breed B. The easiest is to cross B females with A males to produce the F1. However, the backcross can be either F1 males to B females or F1 females to B males. This will produce cross-bred animals with a 25 percent A: 75 percent B mix. Once the 25:75 breeding population is established, the breeding tier can proceed with straight-breeding (see Section D). Estimate the numbers of breeding animals required for three generations.

Minor adjustments to breed percentages can be achieved either by including a proportion of F1s mated *inter se* (to increase A), instead of backcrossing all F1s to B, or additional B males or B females in the nucleus.

However, once straight-breeding starts, concentrate on using the best individual animals, rather than focusing too closely on maintaining breed proportions.

During this process, F1 males (and possibly A males, **depending on F1 performance** in the production system) can be disseminated more widely and mated with females within the production tier, provided an effective dissemination scheme is in place. Upgrading the production tier to the new breed formed in the breeding tier will then make further progress. Go to **10**.

8. The objective of the scheme is sustained cross-breeding or upgrading. The breeding tier of live animals is made up of breed A. This is formed either by using live animals, embryos or eggs to provide individuals for crossing to breed B in the production tier. The breeding tier is maintained by straight-breeding in breed A. Go to **10**.

9. *Is it certain that a breeding tier of live animals is not needed?* The intended cross-breeding programme can be operated without a nucleus by continual importation and distribution of semen. However, this will depend on the breeding goals for the alternative breed A being accepted in its location and production system of origin. Another point to consider is that setting up a breeding tier of straight-bred animals of breed A would provide a kick-start for a straight-breeding programme. If it is decided that a breeding tier should be included, go to **10**. If the answer is still **no**, go to **11**.

10. The size of the nucleus will depend on the number of breeding males needed for crossing to breed B. This will depend on the method of dissemination. As the nucleus may evolve to become part of a straight-breeding programme for breed A, the size should eventually be large enough to allow for this role to develop (see Section D).

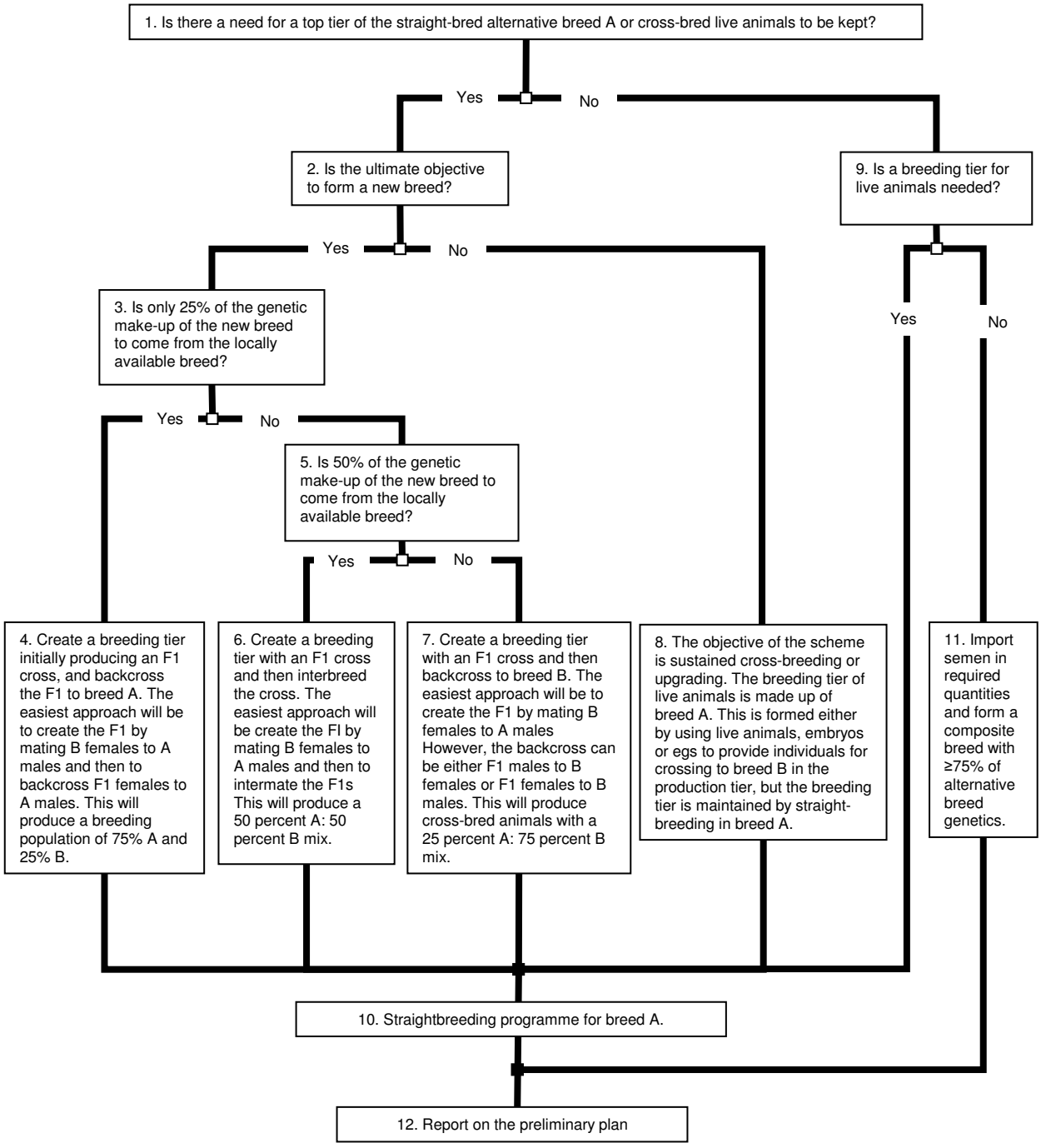
It may be important to introduce controlled mating within the nucleus to distinguish the various crosses, particularly if there are no unambiguous visual indicators (e.g. coat colour, plumage). Individual identification may become important as the nucleus evolves into a straight-breeding programme. Go to **12**.

11. Given that there is no breeding tier, this part of the design is relatively straightforward. The amount of semen required depends on the number of breeding females of breed B in the production tier that will be used for crossing each year (c) and the success rate of AI (p pregnancies per insemination). The number of semen doses required is then c/p per year.

If upgrading is the ultimate objective, a straight-breeding programme could be developed from the indigenous population when it is 75 percent or more upgraded to the alternative breed (see Section D). Go to **12**.

12. Report on the preliminary plan.

Figure 4. Decision tree for cross-breeding programmes



Creating a new breed. When the cross-breeding programme aims to create a new breed, the plan must:

- include an empirical or experimental estimate of the appropriate composition (local and introduced genetics) of the intended breed; and
- establish the number of animals required from both the local and the introduced breeds, the sources from which they will be obtained, and whether the introduced breeds will be brought in as live animals or in the form of semen or another cryopreserved material.

Upgrading. Upgrading is continuous backcrossing to one parental breed or cross. The number of upgraded animals should be large enough to allow for culling undesirable animals that show poor performance, reproductive failures or lack of adaptation. Upgrading can be accelerated by culling older animals (which are also less upgraded) at earlier ages. Culling large animals may not be an easy operation in developing countries; coordination with the livestock keeper or the community is required, and their particular needs and circumstances must be taken into account.

Sustained crossing. Sustained cross-breeding implies that the crossing programme involves a group of livestock keepers who produce females of a specific breed or breed combination which will be mated to sires of another breed to produce cross-bred progeny. In such crossing schemes, feasibility of running such schemes depends on how many males of the alternative breed are required for mating with the straight-bred population. The following specific information is particularly important for species that have low reproduction rates:

- total numbers of straight-bred animals by age;
- reproductive rate for each group by sex;
- survival rate per breeding cycle for each group by sex;
- desired mate type for each group;
- identification of local-breed females to use as replacements;
- number of females in the next cycle for each group; and
- number of males (or semen doses in the case of an alternative breed) required by each group.

Action 3: Plan the transport and communication infrastructure

An effective cross-breeding programme requires good transport infrastructure and communication. The plan needs to consider how transport and communication requirements will be met.

Action 4: Identify the requirements of the alternative breed that is to be used in the cross-breeding programme

The requirements of the alternative breed with respect to its adaptability to the target production environment, level of feeding, quality of feed, health care and level of management need to be identified in order to ensure that it receives proper care. This may require attention to be given to:

- lifetime management of the straight-bred alternative breed in the nucleus; and
- management of the breeding males during the breeding period (possibly by livestock keepers outside the nucleus).

There is also a need to identify the management requirements of the cross-bred stock, so that the extension service is able to communicate these requirements to the owners and keepers.

Action 5: Plan recording policies within the different tiers of the programme

If a decision has been made to establish a top tier keeping an introduced breed in the form of live animals, records corresponding to those described in Box 32 for straight-breeding programmes should be taken. Additional tiers within the programme will have their own recording requirements. For example, if there is a tier that produces cross-bred males for distribution to communities for crossing with the local breed, then these males must be tested for reproduction and semen quality in addition to their performance traits.

Because recording is often one of the most expensive elements of a breeding strategy, it is necessary to be judicious and take only the records that are necessary. It is possible to start with simple and relatively inexpensive recording and increase it as the programme proceeds (and possibly as revenues start to

accrue). The traits to be recorded will have been decided upon during the consideration of the breeding goals, but at this point there is a need to plan which traits should to be recorded on which animals. Women are often the traditional record keepers of animal performance and pedigrees and are knowledgeable about these issues. It is therefore a sensible choice to involve them in record keeping. Literacy rates among women are usually lower than among men; however, this need not be a problem if methods of recording that do not require the recorder to be literate are designed.

Action 6: Plan the distribution of improved genetic materials

The nature of arrangements for distributing genetic material will depend on the aim of the cross-breeding programme. If a new breed is to be developed, once it has been created and tested it will be subject to a straight-breeding programme (see Section D). If, however, the programme aims to upgrade to a ceiling of 50 percent exotic genetics, then F1 males or their semen will need to be continuously distributed to service local females or their crosses. If 75 percent is the required upgrade, then three-quarter cross-bed males will be continuously distributed. Under all circumstances, upgrading should be monitored to ensure that it is limited to the targeted livestock keepers and to ensure that the rest of the breed population remains in its straight-bred state and that its genetic integrity is not undermined. This is simply stated, but may not be easy to achieve in low-input systems in developing countries. Sustained cross-breeding needs a sophisticated stock distribution system, and may require stratifying the breeding stocks so that one tier of the structure produces males and another produces females, while mating takes place at the farm level. Sustained crossing systems are not recommended unless there is adequate infrastructure.

Action 7: Carry out a SWOT analysis

Once the plan has been drafted, a SWOT analysis should be carried out and the results used to adapt plan.

Action 8: Obtain an investment appraisal

See details in Section F.

Action 9: Deliver the draft development plan to the policy-makers and revise as needed

When the draft development plan is complete, deliver it to the policy-makers. Revisions may be required.

TASK 4: SET UP THE FINANCIAL AND ORGANIZATIONAL STRUCTURES

Action 1: Secure the necessary funding and organizational framework

Funding may come from the government, NGOs (including breeders associations or breed societies) or from technical cooperation programmes. In most developing countries, the government needs to play a significant role at least at the start of the programme, so as to maximize the chances of its sustainability. The organizational framework should include all relevant stakeholders.

Action 2: Develop training programmes

Train extension service staff to show livestock keepers how to deal with the cross-bred animals and meet their extra needs for housing, feed and veterinary care. Emphasize the inclusion of women livestock keepers in the training because of their important role in animal management. Train programme staff on all aspects of running the programme.

TASK 5: IMPLEMENT THE CROSS-BREEDING PROGRAMME PLAN

Action 1: Manage the implementation of the plan on a daily basis

Close attention should be paid to problems that were not foreseen during the planning and to disputes over the demarcation of responsibilities. The latter are likely to arise during the recording procedures. The precise demarcation of responsibilities among the farm manager, the manager of the information system and the geneticist should be carefully reassessed.

Action 2: Involve progressive and competent livestock owners/keepers

Progressive and open-minded livestock keepers should be identified. These people will form the first group of customers for the cross-breeding programme.

Ask for feedback from the livestock keepers. This information should be collated and included in the progress report (Action 5) for consideration when the breeding goals are reviewed.

Action 3: Develop solutions to the management constraints faced by the livestock keepers

The assessment of the current situation in the production system will have identified management practices that may hinder the implementation of a cross-breeding programme. Solutions to the problems identified will need to be developed in consultation with livestock owners and keepers and the extension services. For example, where males of the indigenous breed are allowed to mate freely, there may be a need to introduce pens or a castration programme.

Develop the facilities needed to operate the cross-breeding scheme (e.g. animal housing, AI equipment and identification tools).

Add Asko's comment here

Action 4: Strengthen contact with the extension service

Ask for feedback from the extension services on the performance of the cross-bred animals under field conditions. This information should be collated and included in the progress report (see next action) for consideration when the breeding goals are reviewed.

Action 5: Monitor and report on progress

A review of dissemination should be undertaken. It should document the sales of the improved germplasm and compare the figures to the agreed targets. It should also include collated feedback from customers and extension services.

TASK 6. ORGANIZE AND IMPLEMENT THE DELIVERY SERVICES

Action 1: Improve the organization of the cross-breeding services

Ensure that the following requirements are met:

- solid infrastructure that allows animals and data to be made available in the right place at the right time;
- a good communication system that allows all those involved to know where animals and data should be, when they should be there and what should be done with them;

- training for the field staff and supervision to ensure that they perform their tasks fully;
- clear allocation of responsibilities; and
- defined targets for operational efficiency.

When setting targets, make sure that they are measurable (clear criteria for success or failure) and achievable, but that they also represent a challenge. Achieving progressively more challenging targets provides positive feedback to the people in the field, whereas continually failing to achieve unreasonable targets provides negative feedback and jeopardizes the system.

Action 2: Establish efficient delivery systems for genetic material

An efficient delivery system for the germplasm from the cross-breeding programme is needed in order to guarantee supply at the right time and at convenient locations close to the livestock to be targeted. The degree of complexity involved will vary according to the system followed – the simpler the system, the greater the chances of success. Continually re-examine the system to ensure that the process is as simple and effective as possible.

Box 38. Delivery of genetic material – one of the keys to success in a breeding programme

During the late 1970s, a breeding programme for D'man sheep was initiated in Morocco with the aim of both conserving and improving the breed based on an open nucleus scheme. The breeding goal entailed retaining the high fertility of the ewes while upgrading the growth rate of the lambs. However, due to the lack of a sound animal dissemination strategy – approximately 90 percent of the smallholders were not included – only a few livestock keepers were able to take advantage of the improved animals provided by the multipliers. It also proved impossible to further advance the breeding scheme as the flow of animals from multipliers to smallholders was not monitored.

The breeding scheme was also hindered by the particular location and production environment in which the D'man nucleus and the base population were situated. The breed is mainly bred in oases. Other breeds are less common in these remote areas because they are not so well adapted to the extreme environment. Despite the higher commercial value of the D'man, the absence of other breeds and the limited numbers of animals in the base population sometimes forced breeders to slaughter superior sheep for consumption or religious purposes (*Aïd el Idhaa*).

Planning efficient delivery of improved genetic material to livestock keepers is thus crucial for the success of a breeding scheme.

Provided by Ismail Boujenane.

Action 3: Consider using AI

AI can be a means to significantly improve the delivery system. The main benefits of AI are:

- elimination of the need to distribute large numbers of breeding males; and
- a higher reproduction rate per male, enabling much wider use of superior and proven sires than is possible using natural service.

If the number of alternative-breed sires that are available for use is relatively small, the need for AI is much greater. The most effective means to address this need is by using frozen semen.

The potential advantaged of using AI will only be realized if the following prerequisites are in place:

- insemination equipment and consumables;
- trained personnel to carry out inseminations;
- ability to detect heat early and accurately;
- acceptance of the concept of AI on the part of the livestock keepers; and

- (if frozen semen is used) regular supplies of liquid nitrogen and the capacity to these supplies.

Organization is also important – there is a need to ensure that storage and transport of semen is sufficiently well timed to ensure effective operations at village level. When organizing delivery systems for genetic material, it is imperative that gender issues be taken into account.

Box 39. The infrastructure needed for artificial insemination (AI) schemes

The use of AI can facilitate wide and effective dissemination of male germplasm provided the right dissemination services are available. In Malawi, the United Republic of Tanzania and Zambia, AI has been provided to cattle over the past three decades by governmental inseminators who operate on farms, at road-side insemination points and at AI centres. A steady increase in the use of AI has been observed. However, the increase is slow for a number of reasons. First, the reliability and availability of AI services have often been affected by transport-related problems, such as the long distances involved and a lack of cars and liquid nitrogen, as well as by poor management at the AI centres. Second, conception rates have been low because farmers and stock persons lack training in detecting when cows are in heat. The principle reason for this is the generally low level of financial support for extension services and training programmes. Finally, the semen used for AI has not always met the appropriate superiority criteria for bulls.

Setting up a successful AI scheme thus requires efficient transportation between livestock keepers and AI centres, proficient management at the AI centres, adequate funding for extension services to deliver effective training programmes, and efficient performance or progeny-testing schemes to ensure the use of genetically superior or suitable individuals.

Source: Mpofu (2002).

Action 4: Develop research proposals for improving the germplasm delivery systems

A key limitation to the effectiveness of a cross-breeding programme is the delivery of males or semen for servicing the females of the indigenous breed. Research proposals in the following areas should be considered:

- improving the supply of males for crossing at the right time and in the right place;
- controlling the reproduction of indigenous males so that the crossing is better targeted; and
- developing the use of AI in local conditions.

C. PHASE III

TASK 7: IMPROVE THE CROSS-BREEDING SERVICES AND PROMOTE UPTAKE

Action 1: Consider incentives to improve the uptake of the cross-breeding services

Capital items such as shelters for livestock may need to be provided as an incentive for uptake of the service. There may also be a need for improved health care (e.g. vaccinations) which could be the subject of start-up subsidies. There may be a need to provide incentives to encourage recording. These incentives should go to the right person; if women are responsible for recording, ensure that they get the incentive.

If there is routine measurement of product quality and if it can be linked to the livestock keeper, there is an opportunity to create a quality award scheme for livestock keepers. This could be associated with premium payments for quality and merit awards that the livestock keeper can use to advertise.

Action 2: Consider branding cross-breeding services

If the cross-breeding services become successful, it may become necessary to mark or "brand" the service in some way. This may be particularly important when AI is used for dissemination, as there will be a need to differentiate between semen from the cross-breeding scheme and semen of poorer quality sold by other suppliers. Marking or "branding" the semen with a protected trademark will reassure the livestock keepers that the semen is actually from the cross-breeding scheme.

Action 3: Communicate knowledge of cross-bred animals

Cross-bred animals are expected to perform differently from their local counterparts – they will also often look different. Livestock keepers should be helped to familiarize themselves with these new animals, their behaviour and their adaptability to the local production environment. Efficient extension services are important in ensuring that livestock keepers are adequately informed about the cross-bred animals and their husbandry and management.

Action 4: Establish a performance recording system

Recording production traits in both local and cross-bred animals (at least for one complete life cycle) will allow a comparison between the production performances of the two groups. If the crosses have superior performance to the straight-bred animals, this will encourage more livestock keepers to participate in the cross-breeding programme. If the performance of crosses does not meet expectations, reasons can be identified at an early stage; if performance continues to be inadequate, the cross-breeding programme may need to be stopped.

Action 5: Consider establishing a basic pedigree recording system

If the cross-breeding programme is an upgrading programme, then it may be necessary to introduce a basic pedigree recording scheme involving identification and recording of the sire. This would allow matings between a sire and his female progeny (which would lead to inbreeding depression) to be avoided. It is recommended that existing oral recording systems be identified and that similarities with the required system be built upon.

TASK 8: ORGANIZE AN EVALUATION OF THE CROSS-BREEDING PROGRAMME FOR BENEFITS AND SUSTAINABILITY

Action 1: Provide funds and expertise for an objective evaluation

The cross-breeding programme should be subject to an evaluation of whether it is achieving its objectives. This requires a field assessment of performance. It may be necessary to procure or provide additional funds for the evaluation. After the assessment, a cost–benefit analysis can be conducted.

Action 2: Evaluate whether a long-term strategy for cross-breeding is in place

A cross-breeding programme requires a long-term strategy. Consider the results of the field assessment and, if appropriate, re-evaluate the cross-breeding programme to improve its efficiency and examine opportunities to include new breeds in the cross-breeding programme. This may involve developing an effective straight-breeding programme to complement the cross-breeding programme.

Action 3: Conduct a field assessment of the cross-bred stock

Differences between local and cross-bred stock in terms of the inputs and outputs should be assessed. The performance outputs considered should include production, disease resistance and reproductive

success (irrelevant for terminal crosses). Inputs considered should include feed, veterinary products such as vaccines and any other management inputs including labour. Additional capital investments, such as improved shelter or land re-allotted for growing fodder crops, should also be noted.

Specialized assistance may be necessary to provide a good statistical design for the assessment, and to analyse and interpret the data. The design should compare contemporary indigenous and cross-bred stock. The cross-bred stock included in the field assessment may be under different management conditions from the indigenous animals; however, it is helpful if the conditions are the same. Any differences should be documented. Differences between the local and the cross-bred stock in terms of both inputs and outputs should be analysed for all aspects of performance relevant to overall profitability.

If the results of the analysis suggest that the cross-breeds provide little benefit, consider whether changes in management are necessary and practicable or whether the AnGR used needs to be reconsidered. Advise the policy-makers of the results.

Action 4: Carry out a assessment of genetic impact on the integrity of local breeds

Cross-breeding programmes that are well controlled and have efficient monitoring systems can be a useful tool for genetic improvement without negatively affecting the valuable within- and between-breed genetic diversity that exists in local breeds. However, if adequate controls and checks are not put in place, indiscriminate crossing will take place and the genetic integrity of local breeds will be damaged. A genetic impact assessment of the introduction of exotic genetics must be made and measures taken to prevent indiscriminate crossing.

Box 40. Impact assessment studies for the management of risks associated with the introduction of exotic breeds

In South Africa, the Department of Agriculture (DoA) has developed specific guidelines for impact assessment studies to be conducted prior to the introduction of an exotic breed into the country. A reputable animal scientist, group of animal scientists or animal science institution should be appointed, and if necessary contracted, to carry out the study. The scientist(s) will conduct the study and present a report to the DoA. The report should include a description of the exotic breed, its normal production environment and production system, and the management it requires. It should also include details of which breeds in South Africa are similar to the exotic breed, the exotic breed's potential impact on the indigenous livestock resources of South Africa and what impact it has had in other countries.

Once an authorization has been granted, all animals and progeny must be recorded in the Integrated Registration and Genetic Information System, the national database. When deemed necessary by the DoA, on-site evaluation is carried out. While the breed is under evaluation, no animals or genetic material may be disposed of in any way without the permission of the DoA.

Source: Pilling (2007).

TASK 9: REPORT ON PROGRESS

Reports should be submitted at the end of each phase and annually thereafter.

SECTION F: EVALUATING INVESTMENT DECISIONS

RATIONALE

Without an evaluation and clear indicators, it will be difficult for policy-makers to make an objective decision regarding opportunities to invest in animal breeding programmes, and investors will not be encouraged to invest. Opportunity will be lost and this will negatively affect the outputs of the country's AnGR.

OBJECTIVE

Provide the investor (government or private) with a clear indication of the benefit of investing in animal breeding programmes.

INPUTS

In order to evaluate the benefit of a given breeding programme, tangible and non-tangible inputs and outputs need to be considered, including non-monetary and non-quantifiable benefits.

OUTPUT

The output of this section is an objective evaluation of the economic benefit and other impacts of a given breeding programme.

TASKS

The following tasks need to be undertaken in order to achieve the above objective:

1. Identify the perspectives and evaluation criteria
2. Identify and derive cost and returns
3. Analyse cost–benefit
4. Evaluate the benefit and decide on the investment

TASKS AND ASSOCIATED ACTIONS

TASK 1: IDENTIFY THE PERSPECTIVES AND EVALUATE THE CRITERIA

Action 1: Decide on evaluation criteria

Breeding plans may be developed at various levels – national, regional, cooperative, company or community. They need to be evaluated in a way that is appropriate to the level in question. There may be important differences between the evaluation criteria that are relevant at each level. While strict economic criteria (profit, return on investment) will be important from the perspective of a company, broader socio-economic criteria will be important from a community perspective. From a national perspective, a range of policy criteria will probably need to be taken into account.

Ideally, all criteria should be described and analysed in economic terms, i.e. on the basis of cost–benefit analyses. However, this may not always be possible because of the nature of the inputs and outputs involved, the difficulty of collecting the relevant information or a lack of expertise to perform the analyses. Therefore, depending on the perspective and objective, breeding plans will need to be evaluated not only in terms of formal economic indicators, but also in terms of additional criteria that allow consideration to be given to the less tangible inputs and outputs (e.g. impacts on malnutrition or on gender roles). The weight given to the various criteria will need to be agreed upon by the working group.

Action 2: Decide on the perspectives for the evaluation

The outcomes of the evaluation will depend on the perspectives taken. The perspectives considered in the following discussion are: (i) national, regional and sectoral, cooperative, company and community levels; and (ii) retrospective and prospective.

The main differences among the perspectives listed under (i) relate to the inputs and outputs that are taken into consideration, the planning horizon and the discount factor applied (Box 41). For example, a company-based breeding plan will normally include only measurable costs and revenues. It will have a short planning horizon and apply a large discount factor. Conversely, a community-based breeding plan will consider additional inputs and outputs, have a longer planning horizon and apply a smaller discount factor. A particular breeder may have a planning horizon related to his or her personal family business expectations.

The difference between a retrospective and a prospective analysis is that the former is based historical data on performance, prices and returns while the latter uses predictions of genetic gains and prices. Less tangible inputs and outputs will be evaluated on the basis of previous experience or probable outcomes, respectively.

Box 41. Planning time horizons and discount factors

The planning horizon h describes the period of time over which costs and returns will be considered and summarized. The discount factor d is a number between 0 and 1 (usually between 0 and 0.1). It is used to discount a profit of x monetary units next year to a current value of $y = x/(1+d)$; x monetary units in t years' time is worth $y = x/(1+d)^t$ at current value. The use of a discount factor can be justified in a variety of ways. For example, if the interest rate is $100d$ percent, then it would be possible to obtain the same profit by investing y in a bank today. High values of d indicate short time horizons, as profits obtained in the more distant future are given considerably less weight. Conversely, if values of d are low, future profits are given more weight. It must be recalled that the discount factor does not take inflation into account. Economic expertise may be required to help define what values of h and d are appropriate.

Action 3: Decide how economic returns should be presented

The operational actions in the later tasks will derive the costs and returns for each year of the planning period. There are at least two options for combining these in order to evaluate investment: (i) maximize revenues minus cost (i.e. maximize profit); (ii) maximize revenues per unit of cost (i.e. maximize return on investment). Livestock keepers and cooperatives may relate more easily to maximizing profit. An investor in a breeding company will require a measure of the return on investment. The decision as to which option is most appropriate should be taken by the policy-makers for whom the evaluation is being performed.

TASK 2: IDENTIFY AND DERIVE COST AND RETURNS

Action 1: Identify major components of the animal breeding programme

The major components of the animal breeding programme will have been identified when describing the production system, identifying the LDOs and developing the straight-breeding and/or cross-breeding programme. Items to be considered include the following:

- inputs per animal (e.g. feed, vaccines and other veterinary treatments);
- outputs per animal (e.g. market and non-market products);
- inputs per holding (e.g. housing, labour by gender and age, machinery, extension advice, credit, recording costs);
- outputs per holding (e.g. biogas, draught power, social networks);
- inputs per sector (e.g. genetic evaluation, marketing organizations);
- outputs per sector (e.g. food security, nutritional objectives);
- inputs per country (e.g. subsidies, grants, enterprise schemes, start-up schemes);
- outputs per country (e.g. employment, exports and foreign exchange, fulfilling the objectives of rural policies).

Note that the level at which particular inputs or outputs should be considered will not necessarily correspond to the level at which they appear in the above list. For example, genetic evaluations could in some scenarios be considered farm-level rather than sector-level inputs.

The importance given to the different items in the evaluation process will depend on the perspective of the policy-makers and the type of breeding programme.

Action 2: Wherever possible, identify the costs of inputs and returns on outputs

The approach taken to identifying costs and returns will depend on whether the perspective is prospective or retrospective. In the former case, the costs and returns will have been forecast when identifying the LDO (Section B); in the latter case, the costs and returns will be a matter of historical record.

Identification of costs and returns can be done by appropriately trained staff within research institutions, universities, the relevant government ministry or private companies. Although some of the items identified during the previous action will not be easy to cost, they may be very important components of the programme. The evaluation of such items will be dealt with in Action 4 of Task 4.

TASK 3: ANALYSE COST–BENEFIT

Action 1: Determine costs and revenues in each planning term period, for each stakeholder

Action 2 of Task 2 involved listing the inputs and outputs of the breeding programme. For the inputs and outputs to which monetary values can be attached, costs and revenues need to be calculated for each period of the planning term.

At this point, it is important to recall the outputs of Actions 1 and 2 of Task 1 (criteria and perspectives for the evaluation), because this will indicate which stakeholders should be considered in the cost and revenue calculations. From a national perspective and considering the inputs and outputs that have monetary values, the costs incurred and revenues received must be calculated for each stakeholder. For the evaluation of an investment made by a single livestock keeper, only the individual's own costs and revenues need to be considered. A simplified example is presented in Table 8.

Calculating genetic outputs involves considering the flow of genes through the population over time and the accumulation of genetic gain over all age groups in every period. This can be done on via the following steps:

- Calculate the genetic value for each trait in each age group for each period (genetic value is the starting genetic value plus the genetic gain achieved).
- Calculate the costs of animal inputs for each age group, for each period and for each stakeholder (a livestock keeper, for example, will incur feed intake and veterinary costs, – take into account the input provided all household members). Be sure to include only costs that are additional to those associated with the normal breeding activities.
- Based on the genetic values, calculate the value of sales and home use of produce for each age group, for each period and for each stakeholder. For example, milk will be sold to the retailer by the livestock keeper, and the retailer will sell products to the public.
- Add additional costs and revenues not related to the animal inputs and outputs considered in the two previous steps. Add the costs and revenues to the period in which they were incurred. Use the list of costs and revenues as a checklist (Action 1).
- For each period and for each stakeholder, add up the costs and the revenues separately.

Table 8. Investment evaluation for a simplified sheep breeding programme

Tier	Feature	Year since birth of first improved progeny in the nucleus															
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Nucleus	Average fibre diameter[1]	19	18.8	18.6	18.3	18	17.6	17.3	17	16.7	16.4	16.1	15.8	15.5	15.1	14.8	14.5
Nucleus	Annual income[2]	0	540	1 080	1 754	2 564	3 542	4 183	4 934	5 710	6 505	7 292	8 032	8 809	9 584	10 359	11 128
Nucleus	Annual discounted income[3]	0	504	943	1 432	1 956	2 526	2 788	3073	3 323	3 538	3 707	3 816	3 911	3 977	4 017	4033
Nucleus	Annual costs[4]	6 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800	1 800
Nucleus	Annual discounted cost[3]	6 800	1 682	1 572	1 469	1 373	1 283	1 199	1 121	1 048	979	915	855	799	747	698	652
Base	Average fibre diameter[5]	20	19.9	19.8	19.6	19.4	19.1	18.9	18.6	18.4	18.1	17.8	17.5	17.2	16.9	16.6	16.3
Base	Annual income[2]	0	2 236	4 471	8 201	1 3424	19 418	24 436	30 607	36 746	4 2678	49 029	55 471	62 103	68 647	75 232	81 969
Base	Annual discounted income[3]	0	2 089	3 905	6 694	10 241	13 845	16 283	19 061	21 387	23 214	24 924	26 354	27 575	28 486	29 176	29 709
Total	Annual discounted profit[6]	-6 800	912	3 276	6 657	10 824	15 087	17 871	21 012	23 662	25 773	27 715	29 315	30 687	31 716	32 495	33 090
Total	Accumulated discounted profit[7]	-6 800	-5 888	-2 612	4 045	14 869	29 956	47 827	68 839	92 502	118 275	145 991	175 305	205 992	237 708	270 203	303 294

Description of the programme: A livestock-keeping community with 3 000 ewes decides to select the best 300 ewes for a ram-producing nucleus, where replacements are selected on the basis of reduced fibre diameter. The best rams are used in the nucleus and average rams are used in the base. Flock statistics are: 80 percent weaning rate, no mortality, 5 ewe age groups (5 lambings, 6 shearings), 2 ram age groups.

Notes:

[1] Average fibre diameter, measured in microns (mic), refers to the average of all shorn female age groups. Initial nucleus fibre diameter is 19 mic. Breeding value of new progeny is calculated by adding the averaged male and female replacement selection differentials to the mean of parents. Required assumptions are: fleece weight = 3 kg; CV [coefficient of variation] of fibre diameter = 0.08; heritability of fibre diameter = 0.5.

[2] The extra income is due to higher wool price, as fibre diameter decreases, with a premium of US$1.5 per mic for each kg wool.

[3] Calculated by applying a discount factor of 0.07.

[4] Annual costs are: ear tags $US1 each; fleece analyses, US$4 each, extra labour US$600. One time only costs are a scale and fencing, totalling US$5 000.

5 Average fibre diameter (mic) refers to the average of all shorn female age groups. Initial base fibre diameter is 20 mic. Breeding value of new progeny is the average of base ewes and average of nucleus rams (these being the average of two age classes).

[6] Annual discounted profit is the discounted difference between annual income in nucleus and base, and annual costs incurred in the nucleus.

[7] The accumulated discounted profit indicates the profit of the programme at the respective year (revenue - costs).

Interpretation: It can be seen that costs start early and revenues build up late. However, by Year 3 the programme is already profitable. With a planning horizon of 15 years the profit (revenue - costs) of the programme (nucleus + base) is US$303 294 and the return on investment (revenue/costs) is US$14 to US$1.

Action 2: Use the agreed discount factor to convert costs and revenues to net present value

The policy-makers will have decided on the discount factor to be used. If the value is zero, then the costs and revenues calculated in the previous action will be left unchanged. If the discount factor is greater than zero, the costs and revenues for each stakeholder and period need to be converted to a net present value equivalent to $x/(1+d)^t$ where x is the cost or revenue, d is the discount factor and t is the time since the start of the planning term.

Action 3: Calculate benefit according to the desired profit function

For each stakeholder, sum the net present values of costs over all periods in the planning term (denote this total C) and sum the net present values of revenues over all periods in the planning term (denote this total R). If the objective is to calculate profit, calculate R minus C for each stakeholder. If the objective function is return on investment, calculate R divided by C for each stakeholder. For the overall scheme, add up the C-values and R-values over all stakeholders, and calculate either profit (R - C) or return on investment (R/C) based on the totals.

Action 4: Where appropriate, test the sensitivity of the cost–benefit analysis

If the investment decision is prospective, the key assumptions on which the model is based will involve a degree of uncertainty. The sensitivity of the results should be tested by varying the future commodity prices and the anticipated genetic gains used in the calculation.

The cost–benefit analysis should be repeated with both pessimistic and optimistic assumptions of prices and anticipated genetic gain. Break-even points can be investigated – for example, what proportion of the anticipated genetic gain has to be realized for the additional revenues of the breeding scheme to be equal to the additional costs?

Action 5: Report results of the cost–benefit analysis to the policy-makers

The results of the analysis should be summarized and given to the policy-makers. Ensure that the outcomes for different stakeholders are described in the report.

TASK 4: EVALUATE THE BENEFIT AND DECIDE ON INVESTMENTS

Action 1: Consider the outcome of the cost–benefit analysis

The cost–benefit report should be carefully reviewed. Consider whether all identifiable costs been taken into account and whether the assumptions are reasonable. If there are deficiencies that can be rectified, the analysis should be repeated.

If the analysis is considered adequate and the perspective is purely economic, then the decision can be made relatively easily. For other perspectives, however, outputs of the programme that are difficult to quantify and have been omitted from the cost–benefit analysis may need to be carefully considered before the final decision is made (see Action 4).

Action 2: Consider whether benefits are equitably shared among stakeholders

The cost–benefit analysis identifies costs and benefits that accrue to various stakeholders (Box 42). There is a need to consider whether the benefits are shared equitably (or in line with a particular distributive policy objective). If benefits are not equitably shared, consider whether there is a case for redistributing costs. For example, if breeders have a favourable cost–benefit compared to the

government, yet the government pays for the genetic evaluations, then there is a case for breeders to take on the costs of the evaluation.

Box 42. Example of return on investment in a genetic evaluation scheme considering various stakeholders

LAMBPLAN is the Australian sheep genetic evaluation scheme. Both retrospective and prospective cost–benefit analyses of the breeding programme to improve meat quality have been conducted. The table below shows the prospective cost–benefit analysis. Costs and benefits are distinguished according to the stakeholder. The stakeholders considered are breeders (the generators of the genetic progress who contribute funds to and receive services from LAMBPLAN), levy payers (commercial sheep and beef producers who pay up to 2 percent of gross value to Meat and Livestock Australia, a livestock keeper-owned corporation, and who pay breeders for improved rams), the government (which matches funds provided by the levy payers for research and development in sheep genetics) and processors and retailers (who buy the carcasses from the levy payers at prices matched to the quality of the product and sell them in export or domestic markets).

Return on investment in LAMBPLAN (in million $A) 1998–2002.

	Breeders	**Commercial producers (levy payers)**	**Government**	**Processors and retailers**	**Total**
Genetics research and development		-1.0	-1.0		-2.0
LAMBPLAN delivery	-0.6	-0.3	-0.3		-1.2
Breeders cost/return	+37.3	-37.3			
Producer cost/return		+73.0		-73.0	
Cost/return to others				+263.4	+263.4
Net benefits	+36.7	+34.4	-1.3	+190.4	+260.4
% of the benefit by sector	14.1	13.2		73.1	100
Benefit-to-cost ratio	62:1	1.9:1		3.6:1	85:1

Source: ICAR/FAO (2000b).

Action 3: Consider the national impact

The breeding programme will do more than achieving genetic improvement; it will create a dynamic in the livestock sector that will have an effect at different levels (farm, research station or imports of germplasm). It is, therefore, essential that the evaluation takes these broader perspectives into consideration. Consider the impact that the new information generated will have in terms of for improving livestock management and the effects of creating common goals among livestock keepers. A country with national breeding programmes for its animal resources strengthens its food security policy and provides job opportunities.

Action 4: Consider impacts not included in the cost–benefit analysis

A number of components of livestock breeding programmes will be difficult to include explicitly in the cost–benefit analysis, but may have important effects. The following components may need to be considered (potential methods to quantify some of them are described in Section B):

- use of livestock for socio-economic, social and cultural purposes (Box 5);

- food and livelihood security for the human population, and degree of dependence on others (e.g. other countries) to feed the human population;
- improvement to human nutrition;
- output of animal products additional to those included in the cost–benefit analysis;
- environmental impact of the breeding programme;
- impact of importing food on the national balance of trade;
- rural policy goals; and
- gender policy goals.

Box 43. Checklist of additional impacts of a breeding programme

- Do the improved livestock have a cultural or social value?
- What is the importance of the new or improved products for food diversity and local food availability?
- Do the new or improved products contribute to overcoming current nutritional deficiencies?
- Have products additional to those included in the cost–benefit analyses been considered (e.g. manure, fuel and draught power)?
- Does the breeding programme reduce or increase the stocking rate, demand for water and feed, soil compaction, pesticide requirements or energy requirements?
- Do the new or improved products substitute imports or expand markets?
- Does the breeding programme favour rural development objectives, rural employment or livestock keeper organization?
- What impact does the breeding programme have on women's incomes particularly if they are required to supply additional input?

The livestock breeding programme may affect several or all of these components. For example, for a product in a *saturated market*, increasing production per animal may reduce the number of animals and hence the number of owners (note that this may in fact occur at a slower rate than would have happened had there been no investment in the sector and a consequent loss of competitiveness). Management may need to change to make the most of the opportunities associated with the improved stock. Use of the improved stock, may increase the profitability of the remaining enterprises and thus drive a significant downstream economy. All this will affect the social roles of livestock, gender relations, rural employment, poverty alleviation and possibly the environment. The effects on the environment may be negative (e.g. if intensification of production gives rise to more harmful wastes) or positive (e.g. if stocking rates can be reduced while maintaining or improving production).

Such consequences are hard to incorporate objectively into a cost–benefit analysis, although they may be open to subjective assessment. Some attempt should be made to bring them into the investment decision. For example, it may be useful to assess the impact of these components (categorizing them as positive, negative or neutral). This may be done with the assistance of experts and based on the opinions of key stakeholders. Results should be presented together with the formal cost–benefit analysis and weighted according to the policy-makers objectives.

Action 5: Consider a no-investment scenario

Given that competitiveness in markets for agricultural products is likely to increase, it is useful to repeat the cost–benefit analysis based on the assumption that no investment occurs. This may be particularly informative where the perspective is national, sectoral or cooperative. This comparison of *investment versus no investment* gives an alternative perspective on the decision to be made.

Action 6: Decide on investment and future evaluation policy

Evaluation of investments in animal breeding programmes has shown them to be effective in providing high benefit-to-cost ratios. This is largely because genetic improvement is permanent and cumulative – one round of selection confers improvement on all subsequent generations (while vaccination, for example, needs to be applied to each new group of animals). Subsequent rounds of selection build on improvements already made. If the evaluation of breeding programmes were carried out more regularly their cost–effectiveness of would more widely recognized and they would probably be included more often within development strategies.

The results of the cost–benefit analyses and the assessment of non-measurable benefits should be supplied to the policy-makers who will take the decisions regarding investments in the programme.

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Boxes

Tables

Figures