

SECTION E

Developing cross-breeding programmes



Overview

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. producing cross-bred animals continuously), changing a local breed by upgrading or creating 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 multitier breeding structures. Figure 3 (in Section D) shows the general logic involved in the process of choosing 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 works.

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

In order to achieve the above objective, the following tasks need to be completed:

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 the delivery of cross-breeding services.
7. Improve the cross-breeding services and promote uptake.
8. Evaluate the cross-breeding programme for benefits and sustainability.
9. Report on progress.



Tasks and actions – phase I

Implementing an efficient cross-breeding programme will generally involve technical, operational or 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 three distinct phases: In Phase I breeding goals and allocating responsibilities are reviewed; Phase II establishes a simple breeding programme and a more advanced programme is established in Phase III. At the end of each phase, users should ensure that the elements required for the following phase are in place.

TASK 1: REVIEW THE BREEDING GOAL AND ALLOCATE RESPONSIBILITIES

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 alternative breeds (referred to below as breed A) as well as the locally available breed (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 (i.e. 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. These may require expertise in the following technical pursuits:

- 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);
- use of artificial breeding technologies (e.g. artificial insemination 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;



- collection and cryopreservation of semen or embryos, if the alternative breed is to be maintained as live animals and the preferred route for disseminating genetic material is via frozen semen or embryos; and
- 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.



Tasks and actions – 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 breeding nuclei in place whose sole purpose is to provide breeding stock to other livestock keepers?
- What are the ages 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;



BOX 35

The crucial role of women in Chiapas sheep breeding in Mexico

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 as well as 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 spoke only 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 – it was too short, too thin and broke easily. 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 women play 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, Mathias and Köhler-Rollefson (2002).

- animal recording services; and
- breeding (e.g. artificial insemination) 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 (Box 35). Note that situations exist in which female livestock keepers are not allowed to interact with male extension agents or artificial insemination staff.



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 mate: $2 \times 20 \div (0.8 \times 0.9) = 56$ cows 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.

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

Review the production systems 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, can 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, it 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 reproductive rate (Box 36). Specific technical advice should be sought on this matter.



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

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. Depending on the programme's scale, the following expertise should be available within or accessible to the programme structure:

- 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:

- Should a top tier be included in the breeding structure of the programme to produce 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 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.

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 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 (less upgraded) animals 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 that will be mated to sires of another breed to produce cross-bred progeny. The feasibility of such crossing schemes depends on how many males of the alternative breed are required for mating with the straight-bred population. For species that have low reproduction rates, it is particularly important to gather the following specific information:

- 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:

- 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).

The management requirements of the cross-bred stock also must be identified, 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 in which an introduced breed in the form of live animals is kept, 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



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 to keep a top tier of straight-bred alternative breed A animals or cross-bred animals? The answer will be no *only* if: (i) the ultimate objective is upgrading or sustained cross-breeding; *and* (ii) the genetic material of the alternative breed is both obtained and disseminated via artificial insemination. 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 the 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 then to backcross F1 females to A males. This will produce a breeding population that is 75 percent A to 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, which will produce a 50 percent A to 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 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 approach 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 to 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 by including 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, which is made up of breed A, 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? It may be possible to operate the intended cross-breeding programme without a nucleus by continual importation and distribution of semen. However, this will depend on the alternative breed A breeding goals being accepted in the 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, which in turn 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 breed B females in the production tier that will be used for crossing each year (c) and the success rate of artificial insemination (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.



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 required records. It is possible to start with simple, 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 a plan for which traits should be recorded on which animals is needed. Women, who often are the traditional record keepers of animal performance and pedigrees, 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-bred males will be continuously distributed. Under all circumstances, upgrading should be monitored to ensure that it is limited to the targeted livestock keepers, 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. Male and female breeding animals may be produced in separate units within the breeding tier and then brought together at farm level for mating. If the infrastructure needed to distribute the breeding stock is unavailable, sustained crossing systems are not recommended.

Action 7: Carry out a SWOT (strengths, weaknesses, opportunities, threats) analysis

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

Action 8: Obtain an investment appraisal

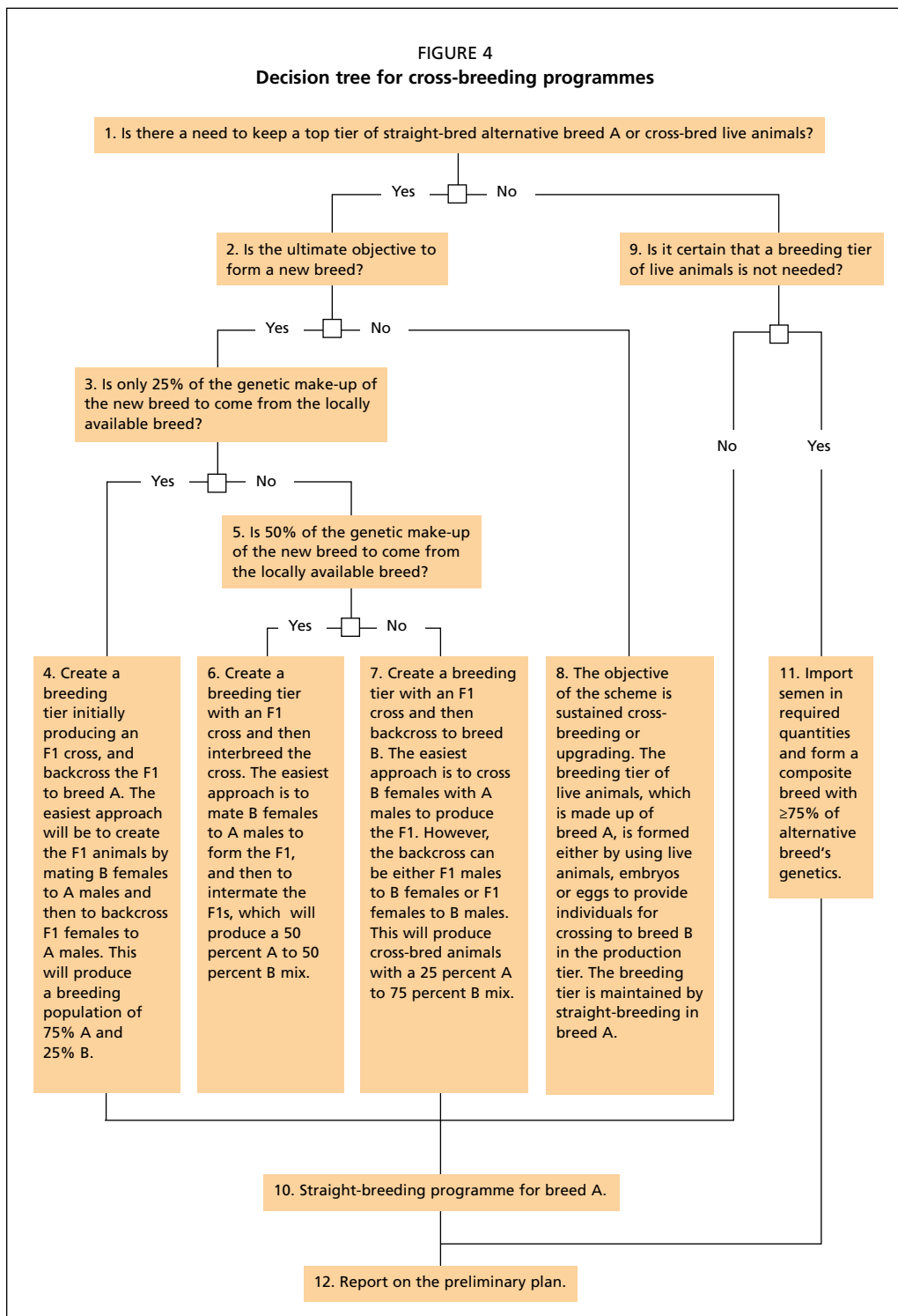
See details in Section F.

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.



FIGURE 4
Decision tree for cross-breeding programmes



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 technical cooperation programmes. In most developing countries, the government needs to play a significant role, at least at the start, so as to maximize the programme's chances of 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, artificial insemination equipment and identification tools).



Action 4: Strengthen contact with the extension service

Ask the extension service for feedback 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, compare the figures to the agreed targets and also include collated feedback from customers and extension services.

TASK 6: ORGANIZE THE DELIVERY OF CROSS-BREEDING SERVICES**Action 1: Improve the organization of the cross-breeding services**

Ensure that the following requirements are in place:

- a 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 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 also that they 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 (Box 38). Continually re-examine the system to ensure that the process is as simple and effective as possible.

Action 3: Consider using artificial insemination

Artificial insemination can significantly improve the delivery system. Its main benefits are:

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

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



BOX 38

Delivery of genetic material – a key to a successful 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, because 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 as 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.

The potential advantages of using artificial insemination 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;
- livestock keepers' acceptance of the concept of artificial insemination; and
- if frozen semen is used, regular supplies of liquid nitrogen and the capacity to use them.

Organization is also important (Box 39). To ensure effective operations at the village level, storage and transport of semen must be well timed. 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 schemes

The use of artificial insemination can facilitate wide and effective dissemination of male germplasm provided that the right dissemination services are available. In Malawi, the United Republic of Tanzania and Zambia, artificial insemination has been provided to cattle over the past three decades by governmental inseminators, who operate on farms, at roadside insemination points and artificial insemination centres. A steady increase in the use of artificial insemination has been observed. However, the increase is slow for a number of reasons. First, the reliability and availability of artificial insemination services have often been affected by transport-related problems, such as the long distances involved and a lack of vehicles and liquid nitrogen as well as by poor management at the artificial insemination centres. Second, conception rates have been low because farmers and farm workers 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 artificial insemination has not always met the appropriate superiority criteria established for selection of bulls.

Setting up a successful artificial insemination scheme thus requires efficient transportation between livestock keepers and artificial insemination centres, proficient management at the artificial insemination 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 should be considered in the following areas:

- 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 artificial insemination in local conditions.



Tasks and actions – 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. Improved health care (e.g. vaccinations) may also be needed and 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 individuals; if women are responsible for recording, ensure that they get the incentive.

If product quality is routinely measured, 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 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 artificial insemination 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 – often they will also 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, 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, more livestock keepers will be encouraged 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 an upgrading programme is implemented, then it may be necessary to introduce a basic pedigree recording scheme involving identification and recording of the sire. This would enable avoidance of matings between a sire and his female progeny, which would lead to inbreeding depression. It is recommended that existing oral recording systems be identified and that similarities with the required system be built upon.

TASK 8: EVALUATE 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. 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 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 reallocated 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. While the cross-bred stock included in the field assessment may be under different management conditions from the indigenous animals, it is helpful if the conditions are the same. Any differences should be documented. Differences between the local and the cross-bred stock, both in terms of 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 an assessment of genetic impact on the integrity of local breeds

Well-controlled cross-breeding programmes with efficient monitoring systems can be useful



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. It will appoint and, if necessary, contract a reputable animal scientist, group of animal scientists or animal science institution to carry out the study, after which the scientist(s) will 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. 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 should also be included in the report.

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).

for genetic improvement without negatively affecting the valuable genetic diversity that exists within and between 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).

TASK 9: REPORT ON PROGRESS

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

