Secondary Guidelines for Development of National Farm Animal Genetic Resources Management Plans

Animal Recording for Medium Input Production Environment

Food and Agriculture Organization of the United Nations

Organisation des Nations Unies pour l'alimentation et l'agriculture

Organización de las Naciones Unidas para la Agricultura y la Alimentación

Initiative for Domestic Animal Diversity

Initiative pour la Diversité des Animaux Domestiques

Iniciativa para la Diversidad de los Animales Domésticos
Table of Contents

Foreword 1

Section 1. Introduction 3

Section 2. Animal Recording in Development 7

2.1. What is “Animal Recording”? 7
  2.1.1. Objectivity and accurate data measurement and recording 7
  2.1.2. Utility of the data relative to the goals of the programme 8
  2.1.3. Use collected data to make management decisions 8

2.2. Reasons for Animal Recording 9
  2.2.1. Animal recording to establish baseline animal performance levels 9
  2.2.2. Animal recording to compare specific production system alternatives 12
  2.2.3. Animal recording for individual animal management 14
  2.2.4. Animal recording for genetic improvement 17

2.3. Animal Recording in Medium-Input Production Environments 22

2.4. Benefits and Beneficiaries of Animal Recording 24
  2.4.1. Consumers 24
  2.4.2. Farmers 27
    2.4.2.1 Direct payments. 27
    2.4.2.2 Increased production (i.e., greater production but requiring more inputs) or greater productivity (i.e., the same or greater production with fewer inputs). 29
  2.4.2.3 Increased product value through improved quality. 30
  2.4.2.4 Greater reliability of production. 30
  2.4.2.5 Better market access and marketing techniques. 30
  2.4.3. Rural communities 31
  2.4.4. Governments and the nation as a whole 33

2.5. Planning for Success—Ensuring the Long-Term Success of the Animal Recording Scheme 35
Section 3. Guidelines For Planning Animal Recording Schemes

3.1. Identify the Development Objective

3.2. Identify Anticipated Benefits and Beneficiaries of Animal Recording

3.3. Identify Potential Participants

3.4. Identify the Traits to be Measured

3.5. Animal Identification

3.6. Who will Measure the Animals and Record the Data?

3.7. Data Editing and Accreditation – Who will Vouch for the Data?

3.8. What Sort of Data Processing and Handling is required and how will it be accomplished?


3.10. Documentation of Benefits

3.11. Development of Farmer Participation in Establishing the Scheme

3.12. Institutional Support for Animal Recording

3.12.1. Field level technical support

3.12.2. Analytical support

3.12.3. Data management, processing, computing, and storage

3.12.4. Research

3.12.5. Training

3.12.6. Management of the animal recording scheme

3.12.7. Integration of programmes

3.14. Potential for Privatisation

3.14.2. Animal recording as a business 68
3.14.3. Long-term public involvement in animal recording 69

Section 4. The Conduct of Animal Recording

4.1. Getting Started: The Implementation of Animal Recording 71

4.1.1. Identification of the institutions that will provide support for animal recording, and of the responsibilities of each institution. 71
4.1.2. Employment of staff 73
4.1.3. Procurement of equipment to support field operations 73
4.1.4. Definition of operating procedures for field staff 73
4.1.5. Training of field staff, including both technical training and training in the objectives of the scheme 74
4.1.6. Identification of participating farmers 74
4.1.7. Schedule the flow of data to allow for timely transmission, processing, summarisation, and return of data 75
4.1.8. Animal identification 75

4.2. The First Cycle of Recording 75

4.3. Maintenance: Sustaining Enthusiasm and Commitment 76

4.4. Review 77

4.4.1. Annual review 77
4.4.2. Strategic review 78

4.5. Further Development 78

4.5.1. Enhancements to the recording process 78
4.5.2. Greater farmer responsibility for recording 79
4.5.3. New opportunities for benefit 79

4.6. Building Farmer Involvement 80
## Section 5. Animal Recording in Medium Input Production Environments—Special Operational Issues and Opportunities

### 5.1. What to Measure.  
- 5.1.1. Measurement of output  
- 5.1.2. Measurement of product quality  
- 5.1.3. Measurement of inputs  
- 5.1.4. Direct measures of productivity  
- 5.1.5. Measurement of life history traits  
  - 5.1.5.1. Reproductive traits.  
  - 5.1.5.2. Health-related traits.  
- 5.1.6. Measurement of adaptation  

### 5.2. When to Measure: The Scheduling of Animal Recording  
- 5.2.1. Milk recording  
- 5.2.2. Egg recording  
- 5.2.3. Meat recording  
  - 5.2.3.1. Effects of pattern of parturitions on animal recording.  
  - 5.2.3.2. Marketing patterns and animal recording.  
- 5.2.4. Fibre recording  
- 5.2.5. Draught recording  
- 5.2.6. Life history recording  

### 5.3. How to Measure: The Tools for Animal Recording  
- 5.3.1. Tools that reduce cost and complexity  
- 5.3.2. Tools that reduce complexity but increase costs  
- 5.3.3. Tools that increase complexity but reduce costs  
- 5.3.4. Tools that increase both complexity and cost  

### 5.4. Comparing Animals Born in Different Years and/or on Different Farms: The Contemporary Group
5.5. **The Prediction of Genetic Merit** 105

5.5.1. Use of information on relatives 107

5.5.2. Measurement of multiple traits and selection for a multi-trait development objective 108

5.5.3. Repeated records 109

5.5.4. Evaluation of animals in different contemporary groups 110
Foreword

These Guidelines

In recognition of the importance of animal genetic resources (AnGR) to sustaining and developing food and agriculture production, and of the sizeable portion of AnGR that is currently at risk of loss, and in keeping with FAO’s mandate and the Convention on Biological Diversity (CBD), the development of a strategic framework to assist countries in the Management of Farm Animal Genetic Resources was launched by FAO in 1992.

One of the constituents of this strategy is the development of Guidelines for country use.

Primary Guidelines, mainly targeted towards policy makers, serve as the ‘umbrella’ for Secondary Guidelines being developed for use in advancing each of the spectrum of areas involved in the sound management of AnGR.

The Primary Guidelines are designed to help countries get started to identify the main elements and objectives of an animal genetic resources management plan, and to outline the strategic policy directions required to fulfil these objectives.

The Secondary Guidelines are directed mainly at those who implement policy, administratively and technically.

This Secondary Guideline documentation concerns the Animal Recording area of sustainable use and development. Emphasis is on medium input production environments for, whilst most of the basic principles of animal recording apply irrespective of production environment, emphases in the planning of and operational approaches to animal recording schemes will often differ appreciably between high, medium and low input production environments.

These Secondary Guidelines have been developed to date using a process of seminal documentation concerning fundamental areas of animal recording, through a broad based workshop of 40 experts from all regions, conducted in collaboration with the International Committee on Animal Recording (ICAR) and the National Dairy Development Board (NDDB) of India; with all resulting material then being utilized to prepare the draft documentation which was then considered by the Informal Panel of Experts on the Development of the Global Strategy for the Management of AnGR. The seminal documents were prepared by Professor John
W James of the University of New South Wales, Australia, Dr Jean-Claude Flamant of Institut National de la Recherche Agronomique, France, Dr Geoffrey E Pollott of Wye College, United Kingdom, and Dr Robert Banks of the University of New England, Australia. Professor David R Notter, of the Virginia Polytechnic Institute and State University, worked tirelessly with FAO staff in drafting this Guideline documentation. Ir Wim M G Wismans, President of ICAR, of Regelgeving Veeverbetering, The Netherlands, Dr Kamlesh R Trivedi of NDDB, and Professor Jean Boyazoglu, Secretary General of ICAR particularly with the development of the workshop and the publication of its substantial proceedings.

Refinement of this Secondary Guideline documentation will continue with field use of the Guidelines, particularly with the assistance of the National Focal Points for AnGR and their country networks; and the documentation will be periodically reviewed incorporating the information and experience that accumulate.

The Guidelines focus on:

- The role of animal recording in development, with emphasis on the identification of beneficiaries and on the opportunities to use animal recording schemes as both a source of information to improve animal production and productivity and as a platform for rural economic development;
- The planning and conduct of animal recording schemes, providing step-wise and detailed guidance on institutional and operational organisation of such schemes; and
- Special issues involved in managing animal recording schemes and the utilisation of information resulting therefrom in medium-input production systems.

The Guidelines are available both as hard copy and in the Reference module of the Domestic Animal Diversity Information System (DAD-IS) both on the Internet and on CD-ROM.
Section 1. Introduction

The establishment of sustainable systems of food production to meet the needs of an expanding world population will be one of the great challenges of the next century. This challenge will be particularly acute for livestock production systems. Ample evidence now exists to demonstrate that global economic development is being accompanied by increased demand for meat, milk, eggs, and other animal products and more efficient use of scarce resources or inputs to the production system. Meeting these imperatives also raise important issues regarding alternative sources of livestock feed (forages and crop by-products versus cereal grains and oil seeds); management of grazing lands to avoid overexploitation and environmental degradation; disposal of wastes generated from the production and processing of animal products; and development of a transportation and market infrastructure that can support a vital rural economy while permitting efficient delivery of animal products to expanding urban centres.

Sustainable development of more productive and efficient livestock herds and flocks will be required to meet these challenges. This development will involve both identification of immediate tactical management activities to improve production and productivity (output per unit of input) of current herds and flocks as well as establishment of long-term strategic programmes for comparative evaluation and continued genetic improvement of livestock. In both cases, accurate and consistent decisions based on objective information and a thorough understanding of the key input-output relationships involved in animal production will be required. Recording of animal performance is required to provide information for sound decision-making and to establish key input-output relationships. It is also particularly important to provide the comprehensive and consistent information that is necessary to fairly compare native versus exotic germplasm and to support long-term genetic improvement toward an appropriate bioeconomic development objective.
Benefits of sustainable livestock development will accrue to farmers, through increased income, better management of risk and the maintenance of a vital, expanding rural economy; to consumers, through improvements in quantity and quality of animal products at affordable prices; and to governments through enhanced national food security, more favourable trade balances involving animal products and feed grains, and greater social and environmental stability.

The establishment of animal recording schemes in rural communities can serve as an important platform for economic and community development. The organisational structures required to support animal recording schemes provide important collateral opportunities for educational programmes; development of co-operative, value-based marketing schemes; and creation of a more informed and assertive rural population.

Methods and institutional mechanisms for animal recording are generally well established within the high-input production systems of the developed nations. Yet more than 75% of global animal production occurs within the developing nations, primarily under low- to medium-input production conditions. Further, the need for increases in both animal production (output) and animal productivity (output per unit input) is greatest within the developing nations.

Only recently have the long-term importance and unique aspects of animal production within medium- and low-input production systems been recognised. With this recognition has come the realisation that successful animal recording cannot be viewed as limited only to high-input production systems. Instead, animal recording procedures and institutional mechanisms must be adapted, or, when necessary, developed to involve farmers and enable them to collect appropriate information within existing medium-input production systems, and to interpret and act on the results.

This document will provide guidelines for the planning and conduct of animal recording schemes in medium-input production systems. Focus will be on:
• The role of animal recording in sustainable development, with emphasis on the identification of beneficiaries of animal recording and on the opportunities to use animal recording schemes as both a source of information to improve animal production and productivity and as a platform for rural economic development;

• The planning and conduct of animal recording schemes, providing detailed guidance on institutional and operational organisation of such schemes; and

• Special issues involved in managing animal recording schemes in low- to medium-input production systems.

As an input to this document, a workshop on animal recording in low-to-medium input production systems was held in India in October 1997 (Trivedi, 1998).

This document is a draft component of the FAO Guidelines for Development on National Farm Animal Genetic Resources Management Plans (Figure 1.1). In particular, the current document on Animal Recording is one of secondary technical documents that provide detailed guidance on the active use and development of farm animal genetic resources. Complementary secondary documentation is being developed covering the establishment of development objectives, the structuring of livestock breeding systems, genetic evaluation of livestock and costing breeding systems. This documentation is intended to provide comprehensive technical decision aids for sustainable livestock genetic resource development, for country use.

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Figure 1.1: Animal Recording in the Context of Farm AnGR Management Guidelines

- Agenda 21
- Convention on Biological Diversity
- FAO Global Strategy of Farm AnGR
  - Guidelines for the Management of AnGR
    - Primary Document
  - Secondary Documents
    - Characterization of AnGR
    - Livestock Production System Description
    - Active Breed Use and Development
    - Managing Populations of AnGR at Risk
      - Breeding Objectives
      - Animal Recording
      - Breeding Systems
Section 2. Animal Recording in Development

2.1. What is “Animal Recording”?

Animal recording involves the measurement of various indicators of animal performance and the use of that information in the decision-making process. Key elements of the animal recording process include:

- the measurement of performance or production system criteria
- the recording of the data
- the processing of that data to extract the desired information, and
- the use of the data to make management decisions.

These four steps are inherent in the animal recording process, but it is critical to recognise that it is the application of the process itself that is important, not the number, precision, or detail of the measurements taken or the sophistication of the data processing.

The most important aspects of animal recording are:

2.1.1. Objectivity and accurate data measurement and recording

Data recording procedures need not be complex or require sophisticated equipment, but must be accurate and objective. It is far better to accurately determine body size using heart girth or other simple measures than to attempt to record body weights using malfunctioning or improperly calibrated scales. Likewise, reliance on memory to ascertain animal birth dates in recording systems requiring birth dates cannot substitute for accurate records of parturitions.
2.1.2. Utility of the data relative to the goals of the programme

It is critical that the reasons for a particular animal recording activity be clearly stated and that the measurements taken be those that are necessary to support programme goals. Animal recording is time-consuming for both farmers and programme technicians. Collection of information that is not applicable to programme goals is inefficient and diverts attention from more important information. Farmers must readily experience the benefits of their involvement. One of the principles of conduct of animal recording schemes is to restrict the amount of data to be collected in the early stages of the programme to only the most important items, with expansion to more detailed data collection as the experience and enthusiasm of the participants increase.

2.1.3. Use collected data to make management decisions

The recording of animal performance is useless unless the data are subsequently used to improve production, productivity or product quality. Appropriate use of animal recording data relies upon:

- an understanding of the value and utility of the measurements taken;

- timely and appropriate processing of data to make it understandable and useful;

- technical support at the farm level to assist in interpretation of the processed data;

- feedback mechanisms to document the benefits gained from use of the data; and

- an organisational structure at the farmer level to provide for interaction among, and feedback from, programme participants.
2.2. Reasons for Animal Recording

There are a number of reasons for establishing animal recording schemes, and these serve to group schemes into four broad types. Key characteristics of these types of recording are summarized in Table 2.1. Common to all is the need for greater understanding of, and ability to control, the production process in order to increase production, enhance efficiency and sustainability of resource use, and identify opportunities to improve management. However, the beneficiaries, structural requirements, and organisational requirements of animal recording schemes will differ depending upon programme objectives. Reasons for animal recording include:

2.2.1. Animal recording to establish baseline animal performance levels

In any nation, there is a need to understand the current realised productive capacity of the main livestock types within each of the major production systems and ecological regions. This information is useful primarily to policymakers and agricultural planners as they develop strategies and programmes to enhance national food security and increase livestock productivity. Benefits of such schemes are to identify factors that limit animal production and to identify opportunities for research and development.

Characterisation of the productive capacity of native and exotic germplasm under various production conditions also facilitates better strategic planning with regard to farm animal genetic resources and identification of unique and endangered breeds of livestock.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Animal recording to establish baseline performance</th>
<th>Animal recording to compare production alternatives</th>
<th>Animal recording for animal management</th>
<th>Animal Recording for genetic improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main beneficiaries</strong></td>
<td>Government and the Nation.</td>
<td>All Farmers, consumers.</td>
<td>Participating farmers, consumers, rural communities.</td>
<td>Farmers, consumers, rural communities.</td>
</tr>
<tr>
<td><strong>Participants</strong></td>
<td>A broad sample of farmers.</td>
<td>A few carefully selected farmers.</td>
<td>Initially a few farmers; eventually, many farmers.</td>
<td>A nucleus of seedstock producers. Eventually, many commercial farmers to validate results.</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Short-term.</td>
<td>Usually a single production cycle.</td>
<td>Ongoing, across multiple production cycles.</td>
<td>Ongoing, across animal generations.</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Animal recording to establish baseline performance</td>
<td>Animal recording to compare production alternatives</td>
<td>Animal recording for animal management</td>
<td>Animal Recording for genetic improvement</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>---------------------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>Who will take the measurements?</td>
<td>Technical staff / Field technicians.</td>
<td>Technical staff / Field technicians.</td>
<td>Field technicians / Farmers.</td>
<td>Field technicians / Farmers.</td>
</tr>
<tr>
<td>Animal identification</td>
<td>None or temporary.</td>
<td>Temporary, usually for a single production cycle.</td>
<td>Usually requires permanent individual animal identification.</td>
<td>Permanent, unique identification; usually requires pedigree information.</td>
</tr>
<tr>
<td>Traits to be measured</td>
<td>Many simple measures.</td>
<td>Key measures of animal response to production alternatives.</td>
<td>Easily measured traits directly associated with individual animal profit or productivity.</td>
<td>Easily measured traits associated with genetic improvement in development objectives.</td>
</tr>
</tbody>
</table>
Animal recording schemes to establish baseline performance levels should be of eventual benefit to farmers, but are not likely to provide much immediate benefit through either increased production or reduced costs. The cost of these animal recording schemes must therefore usually be covered with public or institutional funds of some sort and may include payments or other incentives to participating farmers.

Animal recording schemes to establish baseline production levels have often been implemented as short-term (1 to 5 year) survey activities designed primarily to measure such things as net productivity (number of animals and weight of product marketed annually relative to total livestock inventory), reproductive capacity (number of offspring produced per breeding female per year), age and sex distribution within the population, major causes of mortality and morbidity, total population size, and gross production levels (liters of milk per d, weight of adults and offspring) of various genetic types under prevailing environmental and management conditions. This sort of baseline data on realised animal performance and on the main factors limiting animal performance can be particularly useful to developing countries seeking donor support for livestock development projects.

2.2.2. Animal recording to compare specific production system alternatives

Animal recording schemes may be designed to compare specific feeding strategies, health care options, germplasm sources, housing alternatives or other management variables. Traditionally, many of these comparisons were conducted on state farms or experiment stations, but today there is increasing interest in conducting these comparative trials on private farms. This trend has both positive and negative aspects. On the positive side, conduct of comparative studies on cooperating farms helps to ensure that experimental
conditions are similar to those that are likely to be encountered in the field and generally accelerates acceptance of results by participating farmers. On the negative side, levels of experimental control are reduced when comparative studies are done on farms instead of in public facilities, and the infrastructure for data collection is usually less well developed.

**Benefits from results of animal recording schemes to compare specific production alternatives generally accrue to the farming community as a whole, not just to the farmers who participate in the animal recording activity.** If effects of the treatments compared are large, meaningful benefits may also accrue to consumers. Thus, in common with animal recording schemes to establish baseline performance levels, costs of animal recording to compare production alternatives must usually be covered using public funds.

One important characteristic of animal recording schemes designed to compare specific management alternatives is that they generally do not require that information be accumulated beyond a single production cycle and do not require the maintenance of animal identification or pedigree information beyond the duration of a specific project. Thus, for example, the decision on whether or not to adopt a vaccine may involve evaluation of the cost and ease of administration; the efficacy in preventing overt disease symptoms, mortality, and morbidity; measuring changes in pertinent performance parameters; and assessing the net change in value of product marketed from a specified resource base. Yet once this information has been collected and a decision made regarding the value of the product, continued evaluation of performance is usually not necessary until or unless other changes in the production system require reevaluation of the efficacy of the intervention (e.g.,
if the disease is eradicated, vaccination may no longer be needed or cost-effective).

2.2.3. Animal recording for individual animal management

Animal recording for animal management involves monitoring of each animals’ performance and use of that information in normal, day-to-day farm management. It represents the integration of objective performance data into the farm management process and permits more effective decision making at the farm level and on an on-going basis.

Animal recording for animal management has a fundamentally different objective than animal recording to establish baseline performance levels or animal recording to compare specific management alternatives. The latter types of animal recording are essentially field survey or research activities designed to address specific questions over finite periods of time. They require recording of information on an appropriate sample of animals, but once the primary question is answered, continued animal recording is not necessarily needed. Their objectives are to collect general information, to identify meaningful trends and opportunities within the livestock sector, and to identify and quantify important input-output relationships within the production system.

In contrast, animal recording for animal management seeks to utilise objective performance data at the individual animal level to better manage reproduction, to customise health care and nutrition to individual animal needs, to cull animals which are likely to be comparatively costly to maintain, or to identify and make use of superior animals to produce herd replacements or offspring for sale as breeding animals. Decisions are based upon individual animal performance levels and are applied to individual animals within the herd or flock.
For example, in small ruminants, breeding performance is associated with body condition at the time the males are introduced; as body condition declines, fertility and twinning rates likewise decline. Body condition can be adequately evaluated by handling the animals, and animals from the flock can be divided into groups based on body condition. Depending upon the relative costs of feed and anticipated returns from the flock, animals in poor body condition can be either provided with supplemental feed to improve their body condition and enhance reproduction or can be sold because they are unlikely to conceive. Animals in good body condition, however, would not receive supplemental feed.

The immediate benefits of animal recording for animal management generally accrue to the farmers, although indirect benefits are also realized by consumers and the nation as a whole. Thus the planning, conduct, and funding of animal recording schemes for animal management must involve both the farmers and appropriate public institutions. However, it is of critical importance to recognise that the level of benefit realised by individual farmers from animal recording for animal management will be modest, especially in small herds and flocks, and in low- to medium-input production systems where changes in efficiency of production may be difficult to quantify and objectively demonstrate. Recording of litter size in pigs and retention of replacement females from the largest litters may increase litter size in the next generation by an average of perhaps 0.2 pigs per litter. For an individual farmer with one or two sows, it may be difficult to actually observe this increase or to realise value from recording litter size. But in a village with 5,000 sows, such a program would result in an additional 1,000 pigs per year.

Experience worldwide has clearly shown that active leadership of public institutions and significant public
funding are necessary to establish animal recording schemes for animal management. While it is important that farmers share in the funding of these programmes, the nation that will achieve significant benefits in terms of overall food security and development of the rural economy, and the nation must be prepared to contribute in order to receive these benefits. Experience has likewise shown that as the benefits to the farmers of animal recording are demonstrated, as the economic strength of farmers and their organisations increases, and as the farmers develop leadership of these programmes, the farmers can be expected to accept greater responsibility for their conduct and funding. But the time required for this to happen is substantial; a full human generation (20+ years) may be required to establish the necessary recognition of benefits and commitment to the animal recording programme. Failure of animal recording schemes for animal management can often be traced to failure to adequately provide for public support for the scheme during this critical establishment phase.

**Animal recording for animal management is a powerful tool for livestock system development.** Through its focus on key measures of performance, it provides perspective on opportunities for improving management and assists the farmer in identifying needs and opportunities in the livestock production enterprise. When animal recording efforts of this sort are properly coordinated and integrated with other educational activities, they also become a tool for rural community development by highlighting superior management practices within the farming community.

Animal recording schemes for animal management also provide a useful structure for associated programmes of animal recording to evaluate specific management alternatives. When an ongoing capacity for animal recording exists, it is easier to address new questions. Likewise, when
confidence exists among farmers in the value of animal recording for animal management, they will be more willing and open to involvement in other projects designed to answer specific management questions. Finally, the capacity to acquire baseline animal performance data may be important for decision-makers and planners for a variety of reasons, some of which may involve only limited immediate benefits to farmers. Yet the ability to collect such data depends importantly upon the cooperation and good will of participating farmers. Establishment of simple, useful, applied animal recording schemes with direct benefit to farmers will assist in creating a cooperative environment which will permit acquisition of other data as required.

2.2.4. Animal recording for genetic improvement

Animal recording for genetic improvement is specifically designed to acquire the information needed to permit sustained genetic change toward an objectively defined bioeconomic development goal. Animal recording for genetic improvement has much in common with animal recording for animal management, but there are a few key differences. First, the focus of animal recording for genetic improvement is the breed as a whole, whereas the focus of animal recording for animal management is more likely to be the individual herd. Second, there is a much greater need for maintenance of detailed records of parentage and of genetic relationships within the animals that are being recorded. And third is the requirement that the recording program must be sustained over time (animal generations) and maintained in a rigorously consistent manner in order to be effective.

Unless individual production units are very large, often disadvantageous for other reasons, animal recording schemes for genetic improvement will commonly be most effective when they involve a number of farms and when the participating farmers cooperate to achieve the goals of the programme. This cooperation includes a willingness to
attempt to identify the best animals from among all farm and to develop methods for comparative evaluation of these elite animals, generally by testing the animals themselves or their offspring under the same conditions. Mechanisms must also be developed to permit the best animals, once they have been identified, to be used widely by participating farmers so that all the participants may benefit from involvement in the animal recording scheme. These mechanisms must permit farmers who regularly breed superior animals to capture a financial premium for those animals, but they must also facilitate access to those elite animals or their offspring by other farmers at a fair price. In this way, the breed as a whole, as well as the individual breeders, will capture the benefits of genetic improvement.

The need for pedigree recording, on at least a limited basis and in many cases on an extensive, detailed basis, is one of the characteristics that distinguishes animal recording for genetic improvement from other sorts of animal recording. In choosing among candidates for selection, there are two particular areas where pedigree information is important. The first is in applying appropriate attention to life-cycle productivity which explicitly recognizes the long-term importance of reproductive, health-related, and maternal productivity traits to overall economic merit. These traits are tremendously important, especially in developing nations where the number of environmental stressors is often high, but can only be measured directly late in the animal’s life, and after initial selection decisions have been made. For these reasons, selection of young stock with high genetic merit for reproductive and other fitness traits usually must be based upon records of the dam and other female relatives that are already in production. This requires a mechanism to use the performance of adult females to predict genetic merit of their offspring.
Pedigree information is also needed to evaluate the performance of breeding stock, and particularly sires, within a breed. Sire selection accounts for a very high proportion of the genetic change which occurs within a breed, at least when matings are adequately controlled and males are allowed to service reasonably large numbers of females. The genetic value of a sire is ultimately defined by the value of his offspring and the evaluation of males requires measurements of their progeny.

The need for pedigree recording in an animal recording programme for breed improvement becomes absolutely critical when reproductive technologies such as artificial insemination (AI) and embryo transfer (ET) are used to permit widespread use of selected parents across many herds and, potentially, several production environments. These reproductive technologies create powerful opportunities for breed improvement by increasing intensity of selection through increases in the number of offspring produced by selected sires and by providing access to elite sires across many herds. Yet they also magnify risks associated with use of sires whose progeny are not adequately adapted to some or all of the production environments in which they may be used. Animal recording to objectively evaluate progeny of AI sires and ET matings across production environments is necessary to permit monitoring of results of such programs.

Consistency in recording and in decision-making are critical to animal recording for genetic improvement. Annual rates of genetic improvement in performance are usually modest (2 to 3% per year) in relation to those that can be achieved through a major management intervention such as a vaccine or nutritional supplement. It is the cumulative nature of genetic changes that makes it a powerful mechanism for livestock systems development; an increase in performance of 2% per year yield a cumulative increase of 22% after 10 years, which continues to be realized repeatedly.
into the future without further costs. However, this accumulated superiority can only be realised through rigorous selection based on appropriate and consistent measures of performance.

**Because of the level of detail required in animal recording schemes for genetic improvement, the proportion of farmers that fully participate in them has traditionally been relatively small.** In most cases, a nucleus of elite, progressive breeders emerges and is able to command premium prices for their animals based on their presumed genetic superiority. Purchase of breeding stock from these breeders by farmers outside the nucleus allows for distribution of genetically superior animals throughout the livestock sector and for benefits of genetic improvement to eventually be realised by consumers.

The importance of animal recording to this process is two-fold. First, use of animal records as a basis for genetic improvements adds objectivity to the selection process, can accelerate rates of genetic improvement in nucleus herds, and allows better documentation of the anticipated genetic merit of breeding stock being offered for sale. Second, if animal recording for animal management is widely practiced among farmers outside the nucleus, a mechanism is in place to validate the claims of the nucleus breeders regarding the genetic merit of their animals and to objectively compare breeding stock from different nucleus breeders. Thus in an ideal situation, animal recording schemes would both propel genetic improvement in nucleus herds and provide a powerful feedback mechanism between commercial farmers and nucleus breeders.

**Most of the marginal costs of the detailed recording required for genetic improvement and most of the immediate benefit from sales of breeding stock will flow to the farmers who participate in animal recording for**
genetic improvement. Yet even here, the immediate benefits achieved by farmers will likely not justify the full costs of animal recording for genetic improvement and some subsidisation of the animal recording process will be required, especially in regions without a tradition of animal recording.

In regions where a tradition of seedstock breeding and a nucleus of breeders already exists, care must be taken to avoid the appearance of outright subsidies to farmers who may already be viewed as affluent relative to their customers. Such a situation can generally be avoided by focusing public contributions to the animal recording scheme on technical and educational support, development of data processing procedures, and on use of animal recording for animal management on customers’ farms to document the value of breeding stock produced by the nucleus breeders. However, in regions where a nucleus of seedstock breeders does not already exist, there may be a need to encourage the establishment of such a nucleus.

In many ways, the procedures required to conduct a successful animal recording scheme for genetic improvement are logical extensions of those required for a successful animal recording scheme for animal management. Indeed, an animal recording scheme for genetic improvement can, and usually should, provide information for improved animal management. The most successful animal recording schemes for genetic improvement are usually those that also provide farmers with appropriate information for animal management.

The record-keeping requirements of animal recording for genetic improvement are more stringent than those required for animal management. Thus in regions where there is no tradition of animal recording, it may be wise to initially focus on animal recording for animal management,
even if the long-term goal is animal recording for genetic improvement. Such a strategy allows an evolutionary approach to the animal recording activity. Emphasis can initially be placed on the benefits which can be achieved through use of within-herd animal recording to improve animal management and on the identification of the most productive animals within each herd or flock. Such an approach builds familiarity and confidence in animal recording, allows for documentation of benefits, raises consciousness regarding the superiority of the best animals in the schemes, and permits identification of participants with the skills and attitude consistent with more detailed recording. From this beginning, a nucleus of breeders can be identified who are prepared to expand their recording procedures and interact in ways that will allow more rapid genetic improvement.

2.3. Animal Recording in Medium-Input Production Environments

Animal recording procedures are most highly developed for the high-input production systems, which may be defined as those in which individual animal inputs represent a large proportion of individual animal value. Individual animal output must, therefore, correspondingly be high in order to cover input costs, and monitoring of input-output relationships at the individual animal level is necessary to profitability. Animal recording is a recognised part of the production process in high-input systems.

For lower input production systems often key production inputs do not have well-defined financial costs. Production often depends upon opportunistic use of land and feedstuffs that may vary widely in quality and availability throughout the production cycle. At the extreme, production systems involve scavenging of feedstuffs that are not under the control of the animals’ owner is common. Investments in health care products, nutritional supplements, housing, etc. are usually minimal, and control of mating is commonly not practiced. Among grazing ruminants,
feedstuffs may be obtained through grazing of farmer-owned/leased land, from unregulated common lands, scavenging, or by utilizing opportunistic cut-and-carry systems. Among monogastrics, scavenging for feedstuffs or use of kitchen wastes are often involved. Lower input production systems are, by definition, characterized by being based in production environments where inputs are inherently scarce and perhaps also unreliable in supply and likely to remain so. Very large areas, estimated to be 75% of the food and agriculture producing land of the world, are characterized by such production systems. Two further key elements characterising lower input production systems would be difficulty in defining financial costs of production inputs plus output levels that provide minimal opportunity to assess or utilise individual-animal differences in productivity or value.

Between high- and low-input systems lies a range of medium-input production systems that are the main target of these guidelines. Characteristics of these systems include relatively low levels of financial inputs relative to product output and associated modest to low levels of output value per animal. Assignment of production costs to individual animals or identifiable groups of animals within the larger herd of flock is difficult (as for animals grazing common or public lands, or fed wastes or other feeds without explicit financial value). However, in contrast to low-input production systems, provision of health care, nutritional supplements, or other identifiable, costed inputs is possible in medium-input systems, and evaluation of such management interventions should be responsive to cost-benefit analyses. Some level of control of mating is usually possible, but may not be practiced. Some discrimination of individual animal value is likewise usually possible.

From these considerations, it is appropriate to note that many production systems that are traditionally considered to represent “low-input” systems meet or approach the criteria set out here for medium-input systems, and animal recording will be considered to have potential value and potential applicability to all but the most uncontrolled livestock production systems.
Note also that “medium-input” systems may be very diverse. Many range-oriented commercial ruminant production systems in developed nations would fall into the medium-input category, as would most smallholder production systems in developing nations. Rural development activities in developing nations would often involve transition from low (essentially unmanaged) to medium (strategically managed) production. However, establishment of high-input production systems should not be viewed as a logical progression of rural development because of issues of sustainability, best use of local by-product feed resources, concentration of animal production and associated wastes, and many others. In particular, for most grassland production systems worldwide, it is likely that most commercial production systems will remain at a “medium-input” level.

2.4. Benefits and Beneficiaries of Animal Recording

A clear understanding of anticipated benefits and beneficiaries of an animal recording scheme is essential in order to:

- plan key activities;
- develop mechanisms to document benefits;
- identify beneficiaries and ensure that those beneficiaries are consulted, informed, and appraised of the activities and benefits of the scheme; and
- properly apportion costs among the beneficiaries.

The primary beneficiaries and benefits of animal recording are diagrammed in Figure 2.1, and include:

2.4.1. Consumers

The nation’s consumer should be the ultimate beneficiaries of successful animal recording programmes. These benefits will be realized directly through:
• access to more plentiful food supplies;
• increased quality of animal products;
• reduced costs and a more reliable supply of animal products.

In addition, animal recording schemes facilitate greater organisation among participating farmers and an improved understanding of consumer needs and market opportunities. Resulting cooperatives and farmers’ organisations are much more sensitive to market needs than are individual farmers. Consumers will thus benefit indirectly from resulting improvements in organisation of production and marketing through:

• access to a greater diversity of animal products;
• reduced seasonality of production; and
• more efficient transportation and marketing, especially in supplying animal products to expanding urban centers.

The nation’s consumers thus have a very real long-term stake in the establishment of efficient, effective animal recording schemes, particularly in nations where food security is tenuous, and public support for animal recording schemes will often be justified based upon national consumer benefits.
Figure 2.1: Beneficiaries and Benefits of Animal Recording

ANIMAL RECORDING

CONSUMERS
- More animal product
- Better product quality
- Reduced food costs
- Greater product diversity
- Reduced seasonality
- More efficient markets

FARMERS
- Increased production
- Greater productivity
- Increased product value
- More reliable production
- Better marketing
- Direct payments

RURAL COMMUNITIES
- Rural development
- Educational opportunity
- Farmers’ organisations
- Marketing cooperatives
- Minority empowerment
- Women in development
- Youth programmes

GOVERNMENT AND THE NATION
- Sustainable development
- Environmental stability
- Enhanced food security
- Improved trade balances
- Enhanced research and development capacity
- Compliance with international agreements
- Greater social stability
2.4.2. Farmers

Participating farmers must benefit directly if animal recording schemes are to be successful. Otherwise, the farmers will not participate fully in the animal recording scheme and potential benefits will not be achieved. Farmers may benefit from participation in an animal recording scheme through:

2.4.2.1 Direct payments.

Direct payments to cover costs of animal recording and encourage participation in animal recording schemes have been widely used, but should only be implemented after careful consideration of the long-term goals and anticipated beneficiaries of the animal recording scheme. Paying farmers to collect data on their animals does little to build a sense of pride or ownership in the animal recording scheme, or to motivate farmers to make use of resulting information in management decisions. Also, it is difficult to convince farmers to continue participation in the scheme if payments are withdrawn.

However, direct payments for recording are justified when a large share of the benefits from the animal recording activity are expected to accrue to someone other than the participating farmers. Thus animal recording schemes to establish baseline performance levels or to compare specific production alternatives may provide little immediate benefit relative to participating farmers. These farmers must therefore be reimbursed or otherwise rewarded for their participation.

Animal recording for animal management or for genetic improvement, in contrast, is expected to confer direct benefits to participating farmers, and direct payments do little to facilitate the long-term success of the animal recording scheme. However, it is likewise critical to
recognise that the initial benefits of animal recording will often not be sufficient to motivate farmers to participate without some sort of subsidies. Even if benefits are sufficient to cover costs, farmers may be unprepared or otherwise unable to accept higher costs of production, or to recognise, quantify, or wait for anticipated benefits. This is especially true in medium- to low-input production systems where marketing is often seasonal and where cash inputs have traditionally been low. It is likewise true for animal recording schemes for genetic improvement because the benefits of such schemes rely in part on the ability of farmers to create, document, and successfully market superior breeding stock to other farms. The time required to accomplish these goals may create a substantial delay in the realisation of significant benefits from animal recording.

A better alternative to direct cash payments as an incentive to participate in animal recording schemes is the provision of subsidised labor, equipment, or other production inputs necessary to develop the animal recording activity. Such an approach places the benefit of animal recording in the context of the animal production enterprise rather than separating it from the production process. The benefits of the recording activity, if properly measured, can then be compared to the cost of the subsidised materials to demonstrate the value of the activity.

Examples of subsidies that may be necessary and appropriate at the farm level include:

- recording equipment such as recording forms, measuring tapes, containers, simple scales, etc.;
- labor to demonstrate how to take measurements and to assist in handling the animals;
- feed, health care products, semen for artificial inseminations, etc.;
• assistance in transporting and marketing animals or their products.

In all such cases, however, it is critical to begin immediately to document the value of the animal recording activity per se in a way that will justify and encourage its continuation if subsidies are withdrawn. It is also critical to recognise that long-term maintenance of some level of subsidies may, in some cases, be justified based on the contributions of the animal recording scheme to consumers and to the nation’s food security.

2.4.2.2 Increased production (i.e., greater production but requiring more inputs) or greater productivity (i.e., the same or greater production with fewer inputs).

Increases in production and/or productivity are a primary goal of most animal recording schemes, and are the preferred method of allowing farmers to realise benefits from animal recording. Documentation of increased production (amount of all products harvested/sold) may be easier than documentation of increased productivity, especially in medium- to low-input production systems where cash inputs are limited. However, productivity gains often contribute more to improving profitability and sustainability of production, particularly when herd and flock productivity is determined on an animal lifecycle basis.

Animal recording may also improve productivity by allowing better allocation of inputs such as feed, health care, and other management inputs to animals who can benefit most from them. In low- to medium-input systems, these discretionary inputs are often in short supply, difficult to obtain, or expensive. Their use must therefore be restricted to animals who are most capable of using them in a profitable manner.
2.4.2.3 Increased product value through improved quality.

Increases in product quality may lead to benefit through higher prices or through access to new markets. However, realisation of benefits from improved product quality assumes that existing markets adequately discriminate between inferior and superior products. A number of development projects have successfully reduced fibre diameter in wool, mohair, or cashmere, but been unable to benefit from these improvements in existing markets. Increasing leanness of meat products may or may not increase value, depending upon preferences in local markets or upon the ability of the farmers to reach new markets. Thus an important aspect of animal recording schemes to improve product quality may be to identify and gain access to markets that will provide a premium price for those products.

2.4.2.4 Greater reliability of production.

In many nations, extreme climatic conditions, and in particular periodic drought, lead to major fluctuations in animal numbers and productivity. The ability to maintain production under difficult conditions and to quickly reestablish previous production levels when conditions improve is a critical consideration. Animal recording provides for both the opportunity to determine the relationships necessary to decide how to respond to climatic extremes (which animals to sell, which to keep, whether or not to provide supplemental feed) and the information to make decisions about individual animals based on these relationships.

2.4.2.5 Better market access and marketing techniques.

The organisational structures required for conduct of an effective animal recording scheme also provide opportunities for cooperative marketing activities including market development, cooperative price negotiation, pooling of animals or animal products for delivery to more distant
markets, further processing of animal products, value-based marketing, and forward pricing. If successful, these various marketing enhancements may generate direct and immediate financial benefits through higher prices for animal products. One of the main problems facing livestock producers worldwide, and particularly the small producers of developing nations, is inability to successfully negotiate prices for their products. Thus the integration of marketing cooperatives with animal recording schemes may provide a way to achieve immediate benefits and farmer loyalty through better marketing while simultaneously establishing the animal recording procedures needed for sustained improvements in production efficiency.

2.4.3. Rural communities

Animal recording schemes can be an important force for rural community development. Rural agricultural communities often receive little benefit from national development programs because of their distances from centers of power and commerce, the limited educational opportunities commonly afforded to rural youth, and the more visible, pressing needs of expanding urban centers. Yet the need to strengthen rural agricultural communities and involve them fully in the national food production enterprise is critical to maintaining and enhancing food security. Recent trends toward peri-urban animal production in large production units have been justified as necessary in order to serve the demands of urban populations, but the associated problems of pollution and of disenfranchisement of traditional agriculturalists are significant and will likely become acute in the future. Development of structures to increase production and efficient delivery of high-quality animal products to increasingly concentrated markets is thus a priority in rural development.

Animal recording schemes, if combined with proper educational support, organisational structures, and
marketing assistance can aid in empowering rural peoples to take a greater responsibility for the animal production enterprise. These schemes focus on exerting control over the production enterprise and on understanding and manipulation of the elements of production. They generate pride and recognition among the best producers, and encourage others to follow their example. Likewise, the organisational structures required for effective animal recording also provides a structure for community development and a voice for participating farmers.

Animal recording schemes may also aid in expanding opportunities for minority or otherwise disenfranchised groups. In many places, minority ethnic communities are often involved in traditional agricultural or pastoral activities which have exacerbated their isolation from national affairs. Establishment of farmers’ organisations for animal recording can aid in strengthening these ethnic communities and assist them in marketing their animal products.

Similarly, in many nations the women are the primary animal caretakers. The role of women in animal production is also increasing as more men commute to urban jobs, leaving their wives and daughters to maintain the small farm. The recognition accorded the owners of high-producing or otherwise outstanding animals reflects well on these women, is a source of pride and confidence, and can more actively involve women in the development process. Research evidence also indicates that women can be superior to men in the recording of animal data and in the maintenance of recorded information.

Youth programs are likewise an important component of animal recording schemes. In many places, adult literacy is low in rural areas, which makes both the recording of performance and the use of written material to provide instructions, summarise results and provide
recommendations difficult. Rural youth, however, generally have better prospects for attaining a basic level of literacy, if properly motivated to continue their studies and may contribute to family well-being by aiding in participation in animal recording schemes. Recognition of the significance of those contributions by organisers of the scheme can support the value of continued education.

Two conditions are essential in order to realise a significant impact of animal recording schemes on rural community development. First, as discussed above, the farmers must achieve a real and visible benefit from the recording activity in order to motivate them to be involved in the full range of activities associated with the recording activity. And, second, the individuals involved in the planning and conduct of the schemes must have the broad welfare of the participants and of their community as a priority. Animal recording must be viewed by all concerned as both a mechanism for improving animal productivity and a broad platform for sustainable community development.

2.4.4. Governments and the nation as a whole

One important role of government is to allocate scarce public resources to areas of greatest potential benefit. This role can be fulfilled effectively only if adequate information is available to support the decision-making process. Animal recording schemes are an important source of information about the livestock sector of the nation and can identify areas of greatest opportunity within that sector.

The information obtained from well-designed animal recording schemes can be extremely useful in meeting the responsibilities of various international agreements and in obtaining collaborative development assistance from international donor agencies. For example, the Convention on Biological Diversity mandates that each signatory nation
conduct an assessment of its biological diversity, including agricultural biodiversity, and develop a plan to manage that biological diversity. Effective animal recording schemes will be required to catalog and describe the nation’s livestock genetic resources, to provide a comparative evaluation of available breeds, and to identify possible contributions of those breeds to the livestock sector of the nation.

Throughout the developing world, funding from various international collaborative agencies is critical to support a wide range of agricultural development activities, including animal recording. Access to objective, persuasive information to justify support of these various development activities is likewise critical to obtaining necessary funding. Effective animal recording programs are a key source of such information.

Increasing recognition worldwide of the importance of identifying and implementing sustainable agricultural practices and of the importance of sustainable agricultural practices to realizing food security and maintaining environmental integrity provides additional motivation for animal recording. It is essential that all nations achieve a balance between sustainable livestock development which encompasses environmental protection. Meeting the demands of increasing animal production while maintaining environmental integrity requires information on the interrelationships involved in animal production and quantification of how livestock production impacts the environment. Animal recording can provide such information and allows agricultural agencies to take leadership in developing livestock production systems that are productive, environmentally responsible and sustainable.

Animal recording data and results also provide additional opportunities for enhancing research and development capacity, frequently raising important practical questions to
be researched, often contributing data for study of farm community development, crystalising development issues and contributing information for monitoring the progress of development.

2.5. Planning for Success—Ensuring the Long-Term Success of the Animal Recording Scheme

One of the main challenges in establishing an animal recording scheme is to ensure the continuity of support required to allow the scheme to become a recognized, accepted, and integral part of the livestock sector of the nation. As mentioned before, in areas where a tradition of animal recording has not already been established, a human generation (20 years or more) may be necessary to gain full acceptance of animal recording as an essential part of livestock production. In the high-input production systems of developed nations, animal recording is well established, but that goal was achieved only through sustained public-sector assistance over periods of 10 to 20 years. Privitisation of animal recording schemes has succeeded in some developed nations primarily because of the development over time of strong farmers’ organisations with commitment to, and communal resources to support, animal recording. Again, however, evolution of these farmers’ groups was aided by long periods of public support. And finally, even those animal recording schemes that have been successfully “privatised” still often receive important levels of public support for research and development.

The early, and more easily obtained, benefits of an animal recording scheme will in greater measure be societal, and therefore more easily justified in terms of public investment. In addition, many of these early benefits will be collateral to the animal recording scheme itself, encompassing rural community development, youth and adult education, formation of farmers’ organization and cooperatives, etc.

The model that emerges is thus one of initial investment in the rural society and the food producing capacity of the nation. If successful, the infrastructure that results empowers the rural community.
Concurrently, the data collected should relatively quickly identify the major constraints and opportunities to increasing animal productivity and, when these constraints are relieved and opportunities are seized, the result can be a significant enhancement in the food security of the nation. These benefits may be difficult to quantify, but nevertheless if achieved in reasonable measure can do much to justify the initial costs of establishing the animal recording scheme.

The scheme then enters a phase where the main benefits become those directly associated with the animal recording activity per se. These include the greater efficiencies of production through better animal management and genetic improvement. The most cost-effective management changes have been made and a nucleus organisation of participating farmers has been established. Yet this is also the time when the scheme is most vulnerable to premature attempts at complete privitisation. Management changes, even if cost-effective, have not yet become integral parts of the production system. Farmers’ organisations may exist but still lack the maturity to manage recording schemes on their own, and societal gains in both rural community development and food security are tenuous. It is in this phase that schemes such as this are most often charged with “subsidising” the farmers when, in fact, commitment to program continuity is now most necessary to consolidate the societal gains and to place the recording scheme on a solid footing.

Planning for the long-term success of an animal recording scheme thus becomes a key consideration in all other activities involved in the scheme. Some general principles in planning for success include:

- Make the success of the animal recording scheme a national priority. While donor funds may be necessary to initiate programmes and may provide key supplemental funding, the importance of animal recording programmes to national food security and rural development dictates that base funding for such schemes should be a part of the nation’s development budget.
• **Involve farmers** fully in the planning and conduct of the animal recording scheme. The full support of participating farmers will aid in maintaining support for use of public funds as well as in convincing the farmers to contribute to the programme. Make sure farmers feel a sense of pride, loyalty, and ownership towards both the animal recording scheme itself and the institutions that support it. Develop leadership among the farmers and effective farmers’ organisations.

• **Make documentation of benefits an integral part** of the animal recording scheme, using all available mechanisms (reports, farm visits, fairs, competitions, awards, comparisons with nonparticipating farms and regions).

• **Focus on key goals necessary for success**, and avoid unnecessary or less-productive activities. Separate key activities necessary for functioning of the scheme from those that are optional based on availability of funds. Avoid activities that do not contribute directly to programme goals.

• ** Recognise collateral benefits** involving education, rural community development, market development, social and environmental stability, and national food security. Document these benefits.
Section 3. Guidelines For Planning Animal Recording Schemes

A number of tasks must be accomplished in order to successfully establish an animal recording scheme. These activities will define the overall structure of the scheme and do much to define its long-term success or failure. Specific tasks are diagrammed in Figure 3.1, and include:

3.1. Identify the Development Objective

Specify reasons for implementing an animal recording scheme. Identify how the scheme is expected to contribute to the nation’s economy and food security. Place the opportunities for sustainable development through animal recording in the context of existing production resources, markets, social structures, and human resources. Identify the constraints to improved animal production and productivity that may be identified and/or relieved through animal recording. Define how removal of these constraints would benefit the nation’s farmers and consumers.

3.2. Identify Anticipated Benefits and Beneficiaries of Animal Recording

Define how the animal recording scheme will contribute to the development objective. Specify who is expected to benefit from the animal recording activities and how those benefits will be realised. Whenever possible, identify ways to measure and quantify those benefits, preferably in economic terms. Project both short-term and long-term cost—benefit relationships; in both cases, continue to focus on how benefits will be measured.
Figure 3.1: The Planning of Animal Recording Systems
(Numbered boxes correspond to material addressed in sections 3.1 through 3.11.)

1. Define the development objective
2. Identify beneficiaries
   - Consumers
   - Farmers
   - Rural communities
   - Government & the nation
3. Identify participating farmers
4. Traits to measure
   - Output
   - Product value
   - Input
   - Productivity
   - Life-history traits
   - Adaptation indicators
5. Animal identification
6. Measurement by:
   - Technicians
   - Private contractors
   - Farmers
7. Data recording
8. Data processing
   - On-farm
   - Local institutions
   - Central institutions
9. Data interpretation and recommendations
10. Measurable benefits
11. Farmer participation & rural community development
   - Farmers organisations
   - Cooperatives
   - Marketing schemes
   - Educational programmes

(Numbers correspond to material addressed in sections 3.1 through 3.11.)
Identify both primary benefits and beneficiaries (i.e., those who will realise direct measurable benefits through increased production, reduced costs, or lower food prices) and indirect benefits (i.e., reduced environmental degradation, rural community development) and identify ways to quantify indirect benefits.

Clearly identify how participating farmers are expected to benefit from the animal recording scheme. Recognise that some sort of immediate benefit will be required to entice participation. If anticipated benefits are primary medium- to long-term, identify ways to also generate short-term benefits, using such things as production subsidies, cooperative marketing opportunities, or access to better germplasm.

If animal recording is implemented primarily for the benefit of government (such as animal recording to establish baseline performance levels or to catalog and characterise farm animal genetic resources) or for the benefit of the livestock sector as a whole (such as animal recording to compare specific production alternatives), then payments to participating farmers may be warranted because benefits will accrue to others besides the immediate participants. In contrast, when animal recording is implemented for animal management or for genetic improvement, emphasis should be placed upon realisation of benefits within the context of the production and marketing system and use of cash payments should be minimised.

Do not expect farmers to acknowledge or realise subjective benefits from the knowledge obtained from animal recording or to apply that knowledge without assistance. In particular, recognise situations where structural changes in the livestock sector may be required in order for farmers to realise benefits of animal recording and be prepared to support such changes. Examples would include changes in pricing structures to reward improvement in product quality and development of markets for breeding stock to cover the greater costs of animal recording for genetic improvement.
3.3. Identify Potential Participants

Who should participate in the animal recording scheme? Different levels of participation are required for different types of animal recording.

Animal recording to establish baseline performance levels generally requires either short-term screening of animals from a number of farms to attain a broad sample of all farms in a region or a more in-depth recording scheme involving a limited number of carefully selected farms. In the latter case, care should be taken to ensure that the chosen farms are representative of the region as a whole. In particular, reliance on larger, “elite” farms should be avoided, even though these farms are often easier to work with.

Animal recording to compare specific production alternatives likewise should involve only a limited number of farms in the region. Since this type of recording is essentially a form of on-farm research, farms should be carefully chosen to maximise the anticipated attention to detail in recording and quality of resulting data. Again, however, the chosen farms must be representative of others in the region.

In animal recording for animal management, realised benefits on a national level are generally proportional to the number of farms and animals involved in the scheme. Widespread participation is thus the eventual goal. However, it will likely be necessary to limit the initial number of participating farms, and these initial participants should, to the extent possible, include influential and progressive farmers to maximise opportunities for success and to aid in developing support and recognition within the communities. It is likewise better to identify groups of participants from a single area than to choose participants in different villages or areas. In this way, the farmers can help and support one another and develop a sense of community pride in their accomplishments.

Animal recording schemes for genetic improvement generally require a substantial commitment of resources to the animal recording activity in order to be effective, and may additionally require sales of breeding stock.
at premium prices to capture full benefits of detailed recording procedures. Thus in evaluating the benefits and beneficiaries of animal recording for genetic improvement, two elements must be considered:

- benefits realised by all farmers and consumers through genetic improvement of commercial animals, and;

- benefits which accrue to a more restricted group of elite seedstock breeders, and which may be necessary to capture the more general benefits within the commercial sector.

At issue is the way in which superior genetic material will be identified, comparatively evaluated, multiplied, and distributed to farmers, and the benefit structure that will support this process. The initial step, the identification of superior animals, can occur within any type of animal recording schemes, and the identification of elite animals should be recognized as an important component of animal recording.

**The benefit structure required to support animal recording for genetic improvement will depend upon the breeding structure of the industry.** If a subsector of seedstock breeders already exists, the most likely model will involve relatively detailed recording of animals on these farms to identify genetically superior individuals, public support to further compare elite animals under comparable conditions and to document their genetic superiority, demonstration and quantification of the value of that genetic superiority to other farmers, and documentation of genetic superiority under commercial conditions, usually as a part of an animal recording scheme for animal management. In this way:

- progressive seedstock breeders who most effectively use animal recording as a tool for genetic improvement will create genetically superior animals;

- the animal recording scheme will aid in recognising that genetic superiority and in demonstrating its potential value to commercial farmers;
• the seedstock breeders will be able to ask and receive higher prices for their animals, as required to cover their higher costs of animal recording;

• the commercial farmers will benefit from the greater production and productivity of the genetically superior animals; and

• the animal recording scheme will document these benefits to the commercial farmers, justifying the higher prices that must be paid for improved breeding stock.

If a nucleus of seedstock breeders does not exist within the livestock sector, then some other structure must be developed to play that role. Options include:

• use of public institutions to generate and distribute improved germplasm;

• cooperative arrangements within the commercial farms to identify, evaluate, propagate, and distribute improved germplasm. In essence, the commercial farmers would form their own breeding nucleus, either independently or cooperatively with some public institution; or

• development of a subsector of nucleus breeders from within the commercial farmers.

Use of public institutions to generate and distribute improved germplasm has been a popular model, especially in developing nations where most farmers do not have the number of animals, physical and financial resources, and technical skills to manage the genetic improvement and marketing of germplasm without assistance. Advantages include the ability to use public resources to screen existing farms to identify animals with the most favorable production characteristics, to purchase such animals, and to collect them in a single location for comparative evaluation. Public institutions also can better justify purchases of both the equipment required for animal recording. Public institutions are also often better prepared to use advanced
Guidelines for Planning Animal Recording Schemes

reproductive technologies such as artificial insemination, both as a part of the improvement program and as a way to distribute improved germplasm.

However, the use of public institutions as centers for genetic improvement has often been strikingly unsuccessful. In order to be effective, it is essential that the public institution establish and maintain a strong interactive relationship with local farmers. An animal recording scheme must be established among local farmers to provide a mechanism to demonstrate the benefits to be gained from use of improved germplasm, and the public institutions involved must deliver documentably superior breeding stock. Farmers must be provided with a mechanism to have input into the management and the breeding policies of the public institution. Farmers must see the institution as a unique source of genetically superior animals and must be willing to pay fair prices for that material. If these things do not occur, then a different model of animal recording for genetic improvement is needed.

Cooperative development of genetic improvement schemes by local farmers can be successful, but generally requires strong, well targeted contributions from public institutions, farmers’ organisations, or cooperatives to provide necessary structure and coordination. Such programs usually grow out of successful programs of animal recording for animal management as the sophistication of participating farmers and their organisations develops to a point that will permit the program to become actively involved in genetic improvement. Benefit to participating farmers under this scenario comes primarily from increased production and productivity in their own herd, but if the coordinating institution or organisation can establish a successful program for marketing breeding stock to nonparticipants, additional benefits can be captured.

The development of a nucleus of seedstock producing farmers within the broader animal recording scheme is a long-term endeavor, but may nonetheless be the most appropriate strategy for capturing the full benefits of animal recording. Such development usually must occur in an evolutionary way, with emergence of the most capable and progressive
farmers as candidates to implement the more detailed and necessarily cooperative animal recording needed for genetic improvement. Once such a nucleus is established, it may serve as a source of germplasm for others, providing optimum benefit to both seedstock breeders and commercial farmers. As in all such cases, however, the animal recording scheme must provide for documentation of quantifiable benefits from use of improved germplasm. Otherwise, the newly established seedstock breeders will be unable to establish the markets necessary for them to be successful.

3.4. Identify the Traits to be Measured

The choice of traits to measure will be dictated by two main considerations:

- the importance of the trait to the breeding objective, and
- the feasibility of measuring the trait on participating farms.

The traits that will actually be measured in an animal recording scheme usually will not correspond exactly to the traits in the development objective. That situation occurs because many of the traits that affect life-cycle productivity and profitability as well as the sustainability of the livestock enterprise are not easily measured, either because it is difficult to make the measurement or because the character is only expressed late in life or in the presence of a stressor. For example, length of productive life may be an important component of the development objective, but cannot be directly measured until the animal dies or is culled, at which time there is no longer an opportunity to use that animal in genetic improvement. Similarly, resistance to infectious diseases may be important but can only be measured objectively by exposing all animals to the disease.

Most animals recording systems in both developed and developing nations instead rely on relatively easily measured indicator traits that provide less expensive or more timely information on the traits in the
breeding objective. Improvement of these indicator traits is expected to lead to improvement in the characters in the development objective.

In deciding what to measure, the following questions should be addressed:

- What biological characters should be improved in order to move toward the development objective?
- Which of these can be measured directly on the farm, including considerations of cost, time, farmer skills and attitudes, and access to skilled technicians, equipment, and laboratory facilities? Which others cannot reasonably be measured directly? It is important that this question be addressed realistically.
- What alternative characters can be reasonably measured and are expected to provide indirect information on the traits in the development objective? What classes of animals can they be measured on?
- For traits in the development objective that cannot be measured and for which there are no obvious indicator traits, what options are available for eventual assessment of these traits? What equipment, technical skills, organisation, laboratory facilities, etc., could be developed that might permit cost-effective recording of these traits? How can the animal recording scheme evolve to encourage eventual capture of this information through demonstrations of benefit, provision of technical support or equipment, or integration with other animal recording activities? What is a reasonable time scale for this evolution?
- What measures need to be taken to determine relationships between potential indicator traits and the traits in the development objective? Where (on farms, on research stations, in university herds, etc.) can the necessary data be obtained, and who will pay for its collection?
3.5. Animal Identification

The identification of individual animals is a necessary component of an animal recording scheme. However, the specific requirements for animal identification and the means used for animal identification can vary widely among schemes and must be tailored to match the specific objectives of the animal recording scheme.

Specific issues include:

- Must each animal have its own unique identification, or is it sufficient to simply distinguish among groups of animals? For example, it is sufficient to identify animals only with respect to their sire? Or only with respect to the management they receive (e.g., vaccinated or not vaccinated; provided with supplements or not)? Or with respect to birth year to allow identification of animals by age?

- For how long must the animal be identified? Is identification required only for the current production cycle (e.g., a lactation) or must identification be maintained across multiple production cycles (e.g., several lactations)?

- Is unique animal identification required for animals on different farms, or is unique identification required only for animals on the same farm?

- When must the animals be identified: at birth, at weaning, at breeding, at the start of a production cycle (e.g., shearing or the start of lactation)?

- Are identification “devices” (ear tags, neck chains, leg bands, tatoos, brands) required? If individual farmers own only a few animals (perhaps not more than 10), the farmer may be quite capable of distinguishing among the animals. Some sort of animal identification number normally will be required for processing records and summarising performance but an identification device may not be required.
• What sort of identification devices are appropriate to the species, breed and production system?

• Can key indicators of performance be physically attached to the animal using, for example, a system of ear notches? Such an approach allows animals to “carry their records with them” where they are readily available to the farmer. For example, if the ears of single ewe lambs or doe kids are notched at birth, these animals can be distinguished from twins later in life and, if appropriate, not kept as replacements. Breeding females can have an ear notched for each time they fail to produce offspring. If a system of notches in the other ear identifies the birth year, it becomes easy to identify and cull infertile females, or to preferentially keep offspring of highly fertile females as breeding stock.

• Does the farmer choose how the animal will be identified or are identification numbers assigned as a part of the recording scheme?

• Must the animal’s identification also allow for identification of the animal’s parents? Is identification of both parents required? How important are detailed pedigrees? Is single-sire mating to establish paternity required?

The system of animal identification must be consistent with the goals and objectives of the animal recording scheme. Thus when animal recording is used to establish baseline performance levels or to compare specific management alternatives, temporary identification is often sufficient. If animals are measured only once to establish performance levels (e.g., screening of animals to determine litter sizes), no identification may be required. However, some sort of temporary identification is required if the scheme dictates returning to the farm to acquire additional data (e.g., weaning weights of animals born in litters of different sizes).

In animal recording to compare management alternative, it is often sufficient to only identify animals with regard to the treatment received
Identification is likewise often required only for a single production cycle. However, if the management alternatives being tested have potential effects on future health, fertility or other life history traits, data collection and identification may have to be maintained across multiple production cycles.

Animal recording for animal management generally requires that animals be uniquely identified for at least a full production cycle, and permanent identification is often required. Animal recording for animal management has as its goal the evaluation and use of individual animal differences. Also, in most cases the development objective will involve several traits, including life history traits expressed at different ages. For these reasons, some form of permanent identification is generally desired. However, in some cases this requirement can be met using simple systems of ear notches to identify key performance differences. Identification of parentage may or may not be required in animal recording for animal management, but is necessary if selection of replacement animals is to be based in part on the past performance of parents.

In animal recording for genetic improvement, identification and use in breeding of superior individuals is a specific goal. Attainment of this goal will usually require unique, permanent, individual identification of animals, although in some cases group identification (e.g., identification of daughters of a specific sire) may be sufficient. Control of paternity and accurate birth records are often required. Modern statistical procedures for prediction of genetic merit can use performance records of related animals to increase accuracy of the genetic evaluation if relationships are known.

Even if individual animal identification is not absolutely required to meet the goals of the animal recording scheme, accurate animal identification can enhance the value of the collected data. One of the uses of animal recording is to define key production relationships. Study of such relationships is often possible only when records taken on the same animal at different times can be identified. Examples would include
use of animal recording data to evaluate if traits measured early in life can predict later productive or life history traits.

3.6. Who will Measure the Animals and Record the Data?

The actual measurement of animal performance may be done by the farmers themselves or by field technicians employed by the animal recording scheme. In newly established animal recording schemes, it will usually be necessary to have technicians make most of the animal measurements, at least for the first few years of operation of the scheme. This approach enhances both accuracy and consistency of measures and, especially, of recording. Equally important, it provides for regular close interactions between farmers and technicians. These interactions provide opportunity for instruction of farmers in the reasons for animal recording, the technique used to accurately evaluate the animals, and the interpretation and use of data following processing. The importance of these interactions should be emphasized in selection and training of technicians.

Technicians should be physically located in close proximity to participating farms and should be assigned a regular list of farmers to serve. If possible, technicians may be chosen from the local community, but they must also be thoroughly indoctrinated in the goals and objectives of the animal recording scheme. In this way, rapport and confidence between farmer and technician can be maximised.

As discussed further in Section 3.10.1. below, technicians should be assigned some sort of local institutional affiliation to provide support and communications services and to strengthen their sense of involvement with the animal recording scheme.

Even if technicians take the actual measurements, the farmers should be actively involved in the measurement process because in most cases it is desirable to eventually shift much of the responsibility for measurement and recording to the farmers themselves. An important task for the technician is to prepare farmers to accept this responsibility, and to
encourage them to become actively and critically involved in the animal recording scheme.

If farmers are to make the measurements and do the recording, there are several critical issues to consider. These include:

- Do the farmers have a clear understanding of why each measurement is being taken, how to make the measurement, and what use will be made of the measurement?
- Do the farmers possess the necessary equipment, and do they understand how to maintain that equipment?
- What is the literacy rate among the farmers? Can they deal with written instructions and reports? Do they have the skills to accurately record data?
- How will the farmers be instructed in animal recording methods? Equally important, who will help them interpret results of the animal recording activity and provide advice on how to use those results to improve animal management?
- What sort of convenient support system can be set up to answer questions and address problems? How will enthusiasm for the animal recording activity be maintained?

Each of these questions must be addressed before farmers can be expected to take over responsibility for animal measurement and recording.

3.7. Data Editing and Accreditation – Who will Vouch for the Data?

Data editing and accreditation are designed to identify erroneous or fabricated data. Data editing is an important component of any animal recording scheme and involves identification of errors in the data, usually arising from misunderstanding of measurement and recording procedures, improper training of farmers and/or technicians, or recording errors. A principal: the closer editing is to the data source,
the better. When farmers do the recording, an initial inspection of the data should be made when it is picked up or delivered to the processing center. Subsequently, data processing procedures should include checks for reasonableness and consistency of reported data. Methods should also be put in place to quickly address apparent errors without compromising timely processing of data and return of results to the farmer.

Data accreditation involves certification that the data is correct and accurate as reported and is designed to identify both erroneous and fabricated data. Among existing animal recording schemes, the importance and effort attached to data accreditation varies widely. In some schemes, data accreditation is considered to be a critical step and is cited as one of the major reasons for using technicians instead of farmers for recording. In others, farmers are given primary responsibility for accurate data reporting under the assumption that benefit will be realised from an animal recording scheme only if proper data reporting is practiced.

In animal recording for animal management, problems of data accreditation can generally be minimised by ensuring that benefits of the recording activity are captured primarily in the context of the production and marketing system rather than through cash payments or other subsidies not tied to animal productivity. In this way, farmers must collect and use animal data to capture benefits, and the accuracy of collected data is directly related to the size of the anticipated benefit. So, when all farmers involved understand the value to them of reliable data, separate accreditation will commonly not be seen as particularly important to the scheme’s success.

Data accreditation can be particularly challenging in animal recording for genetic improvement because such schemes normally seek to identify the best animals and to obtain sale premiums for these animals and their offspring. Some form of data accreditation may be necessary in such programmes, perhaps involving independent confirmation of reported production levels before animals are sold. Also, if the animal recording scheme is set up to validate claims of genetic superiority through
Guidelines for Planning Animal Recording Schemes

measurement of performance on cooperating commercial farms, fraudulent claims of exceptional performance are readily identified.

3.8. What Sort of Data Processing and Handling is required and how will it be accomplished?

“Data processing” involves the computations and data organisation that are required to make the recorded data useful as a management and/or genetic selection tool. Requirements for data processing can vary widely among animal recording schemes, depending upon the kind of traits being measured and the objectives of the scheme. However, in most cases data processing should be no more complicated or time-consuming than absolutely necessary. In some schemes data processing may comprise only data inspections and calculations by the farmer or a field technician whilst visiting the farm; whilst at the other extreme complex, centralized time series analyses may be done utilizing all available data for the breed.

The speed with which data can be processed beyond the farm and returned to the farmer for use is a critical issue in designing successful animal recording schemes. It is absolutely necessary that the processed, summarised data be returned in time to be used to make management decisions. Failure to process and return data in a timely manner is one of the main reasons for failure of animal recording schemes.

In many cases, data can be processed directly on the farm at the time of collection using simple tables or other decision aids, permitting its immediate use in the decision-making process. For example, feeding limited amounts of grain to a dairy animal may be economically advantageous so long as daily production remains above some critical level. Weekly milk recording can allow the farmer to immediately adjust the feeding level of individual animals. In selecting replacement ewe lambs or doe kids, animals can be weighed or measured to determine body size, and, if the twins were identified at birth using ear notches, the heaviest twins can easily be identified as replacement females.
When further processing is required, technicians may be equipped with portable computers or the facilities of local institutions may be used. For example, milk samples may be evaluated for fat and protein or fibre samples may be evaluated for fineness in local village collection points and prices received may be determined immediately based upon these values.

Processing of data at a central (farm community, regional or national) level may be required in some cases, but raises major challenges in terms of timely return of results to the farmers. Use of a central processing site is most often required when data from many farms are to be processed together, and must be accumulated from the various locations before processing. This is a particular concern in setting up comprehensive, breed-wide animal recording schemes for genetic improvement. These schemes may require sophisticated processing of large amounts of data to be effective. In designing such schemes, the organisers must consider whether or not the communications system can support central processing of large amounts of data from many farms.

Even if data can be processed locally for use by the farmers, a central data storage and analysis capability will usually also be required. Accumulation of data in a central institution permits the higher-level analyses required for research, for documentation of benefits across the entire scheme, and for national planning and monitoring activities. Thus provision should be made for accumulation of data in a uniform format and for storage of that data at a central location. Large, well-managed, well-documented, and comprehensive data sets describing livestock performance are an important and valuable resource, and should be treated as such.

Ownership of data collected in animal recording schemes is an issue which should be addressed when the scheme is established. Data from animal recording schemes are a valuable resource, at the farm, farm community, regional and national levels. They originate with the farmers, who in most cases should be considered to be the owners of the data. Access to data from animal recording schemes should be managed to ensure that farmers have full access and opportunity to benefit from
results before they are provided to other users. Regulations on use of data should be configured to permit relatively unrestricted use of records for valid research and educational activities, for monitoring of performance levels at the regional or scheme-wide levels, or for descriptive analyses. However, when recording involves individual-animal evaluations, as it must when used for breed improvement, care must be taken to ensure that the owners of the animals in question possess full information on the estimated genetic merit of their animals before that information is considered for release to a wider audience.

### 3.9. Putting Data to Work: Using Results of Animal Recording for Animal Management and Genetic Improvement

A major challenge in designing animal recording schemes is to develop procedures that will encourage farmers to use results of animal recording to enhance animal management and generate genetic improvement. In order for this to happen:

- **results of animal recording must be returned to the farmers quickly.** In many cases, decisions regarding the sale or management of the animals in question will be made at the time data is recorded, or very soon thereafter. Farmers must have access to necessary results in time to make management decisions.

- **farmers should have a clear idea of the anticipated benefits of the animal recording scheme.** They need to be clearly told what actions they must take to acquire these benefits. It is naïve to anticipate that farmers will see subjective benefits from the knowledge obtained through animal recording.

- **results must be presented in a form that the farmers can understand.** It is not enough to simply return lists of adjusted measurements or average performance levels. Instead, results should be placed in the context of recommendations for management and/or selection decisions. Presentation of
results should take into account the level of literacy and education among the farmers.

- **assistance must be available to help farmers interpret and apply results.** Someone must be available to explain results, answer questions, and direct farmers in making appropriate management decisions. Ideally, that person will visit the farms on a regular basis and will often be the same person who helps with data recording.

The process of animal recording is a cycle, as depicted in Figure 3.1. Data is recorded and processed. Results are returned, interpreted and used to make management decisions. The outcome of those management decisions are then measured in the next cycle of recording. The technical staff of the animal recording scheme must work with participating farmers at each step in the cycle to ensure the success of the scheme.

3.10. Documentation of Benefits

A structure for documenting benefits of animal recording should be an integral part of the animal recording scheme. This can be done, in part, by choosing traits to measure that are directly associated with farm profitability and by documenting positive changes in these traits over time. However, results of monitoring of production, by itself, are often not enough to convince farmers of the benefits of animal recording.

Instead, the monitoring of production should be designed to specifically include measures related to the well-being of participating farmers and their families. These measures should be financial, if possible, and explicitly monitor increases sales, reduced costs, better use of limited resources, etc. This is one reason why cooperative marketing schemes are often a part of the animal recording scheme. In this way, marketing information is available to compare prices received and amount of product marketed by participants of the scheme to those of nonparticipants. When one of the benefits of the animal recording is improved product quality, cooperative marketing schemes may be
particularly useful to document improved quality and receive appropriate prices.

**Documentation of indirect benefits accruing to the families of participants and to their community should be included in the documentation process.** While more difficult to quantify, some important activities to support and document might include:

- setting up of farmers’ organisations
- conduct of village or regional educational programs
- youth recognition programs, scholarships, involvement of young people in animal recording
- recognitions of outstanding producers, of the owners of the best animals, and of the leaders of the animal recording scheme
- cooperative marketing ventures, expanded market access, better marketing strategies
- sponsorship of fairs and sales of breeding stock that highlight the genetic merit of animals as indicated from their performance and progeny records.

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### 3.11. Development of Farmer Participation in Establishing the Scheme

**Farmer involvement and participation in the planning and implementation of the scheme is critical to its long-term success.** This statement is true of any animal recording scheme, but is particularly critical for animal recording for breed improvement because of the need for consistent, long-term application of animal recording results in order to achieve meaningful genetic change. The achievement of breed improvement on participating farms absolutely requires a commitment to the program from the farmers. Otherwise, data may be collected and
analysed with great sophistication, but will languish in folders and record books.

Experience in developed countries has shown that it is not critical that all farmers embrace an identical development objective, at least early in the life of the recording scheme. It is far better that the farmers be permitted and encouraged to identify the characteristics that they recognise as key to their own well being and be assisted in determining what to measure in order to improve those characteristics. Formal attention to definition of the development objective is an essential exercise in animal improvement, but once defined initially it functions best as an educational tool to assist farmers in trait selection. The organisations involved in directing animal recording schemes would do well to strive for progress toward convergence of farmers’ goals and the goals of the objectively defined development objective. Indeed, farmers’ goals, while sometimes vaguely stated and defended, generally have strong pragmatic bases that may be most consistent with the true limiting factors within the environment and their consideration is important to configuration of both the development objective and the recording scheme.

Within any agricultural community, a leadership structure exists. That structure may be formal, involving farmers’ organisations, village cooperatives, social organisations or other entities, or may be informal, involving respected individuals or groups. The animal recording scheme should actively involve that leadership structure in configuring the scheme. If no formal organisations exist, new organisations may need to be created around influential, interested farmers.

Also, within any agricultural community, individuals and groups will exist that are essentially traditional and conservative in outlook versus those that are essentially innovative and opportunistic. Perhaps one of the key indicators regarding the challenges that are likely to be faced in implementing animal recording schemes will be the determination of whether the existing leadership structure is essentially conservative or essentially innovative. While agricultural leadership is often portrayed as conservative and traditional, groups of commercial or subsistence
farmers can often be surprisingly innovative if provided with clear evidence of real, sustained benefit from the innovation.

**Farmers’ ideas on what constitutes genetic improvement within the production system and on how to achieve that improvement will need to be acknowledged in order to develop a workable, effective animal recording scheme.** Technical personnel at all levels need to be involved in this process. Higher level technical inputs of theorists, geneticists and analysts need to be filtered through on-site technical personnel to facilitate attainment of rapport across all levels of the scheme.

When the objective of the animal recording scheme is breed improvement, consideration must also be given to identification and involvement as appropriate of existing producers of seedstock or germplasm. It does little good to institute an animal recording scheme among small farmers if they continue to purchase breeding males from nonparticipating breeders. It likewise does little good to institute detailed animal recording and breed improvement programs on state farms if no mechanism exists to demonstrate the value of the improved germplasm to farmers and to motivate them to use it at mutually acceptable prices. Thus those that participate in animal recording for breed improvement must be encouraged and assisted to develop a vision of how the anticipated breed improvement will be marketed to assure an adequate return on the farmers’ investment.

### 3.12. Institutional Support for Animal Recording

Successful animal recording schemes require institutional support in several different areas. Some of these areas are best addressed by central technical institutions, but many others can only be effectively addressed at the local level. The involvement of local institutions, or local offices of a larger central institution, with good farmer involvement, is therefore critical to the success of the animal recording scheme, diagrammed very generally in Figure 3.2.
An important part of planning for animal recording is the identification of the institution(s) that will provide the various essential support services. These services include:

3.12.1. Field level technical support

On-farm technical support is required to implement, and in some cases to maintain, effective animal recording procedures. At a minimum, technicians must be available to:

- demonstrate data collection methods;
- familiarise farmers with the tools to be used in animal recording (scales, tape measures, graduated containers, etc.); and
- familiarise farmers with the record-keeping requirements of the animal recording scheme.

Recording of animal performance will often be done by local technicians who visit participating farms on a regular basis. These technicians must be located in close proximity to the participating farms, both to control costs of travel by the technicians and to permit development of a close working relationship between technicians and farmers. Whenever possible, field-level staff should be associated with existing local institutions. This arrangement allows the technicians to take advantage of both the physical facilities and the credibility within the community of that local institution. Development of new institutional structures should be avoided if possible.
Figure 3.2: Country Institutional Structures for Animal Recording

Research Institutes

Country-wide Focal Group(s) for Animal Recording

Universities

Local Institutions

Data

Interpretative summaries

Data

Interpretative summaries

Data

Interpretative summaries

Data

Interpretative summaries

Data

Interpretative summaries
3.12.2. Analytical support

In some cases, simple analytical procedures may be required as a part of the animal recording scheme, and may have to be done off the farm. Examples would be milk testing for protein and fat content, or assessment of fibre quality characteristics of wool, mohair, or cashmere. Unless a very reliable system exists within the nation for transporting samples to analytical facilities and for communicating results back to farmers, these analytical facilities must be established at the local level, preferably in association with existing institutions. If appropriate analytical facilities cannot be established in close proximity to participating farms, use of simpler alternative measures should be strongly considered.

3.12.3. Data management, processing, computing, and storage

Institutional responsibilities for data handling can vary considerably depending upon the overall structure of the animal recording scheme (see Section 3.8.). Initial processing of data through a local institution is generally advantageous to allow errors or omissions to be promptly addressed at the local level. Institutional requirements for further processing of data and for production of data summaries, reports, and recommendations will depend upon the technical sophistication (in terms of both personnel and equipment) required. Whenever possible, data processing should occur at the local level. If appropriate computing facilities and personnel are available, local institutions may also take responsibility for summarising collected data from all participating farms and producing summaries and comparative reports.

3.12.4. Research

The capacity to use the data collected in an animal recording scheme to address pertinent research issues is important and identification of institutional support for continuing research and development activities is an important consideration.
Mechanisms need to be established to allow farmers and local technicians to voice concerns and to translate those concerns into specific research questions. Local institutions, by virtue of their more direct interactions with participating farmers, thus have an important role to play in the identification of research priorities. The actual conduct of developmental research, however, generally requires access to higher-level technical expertise characteristic of central institutions. These central institutions may accomplish needed research activities, either directly or through contracts or cooperative agreements with research institutes or universities.

3.12.5. Training

Training activities at different levels are required to establish effective animal recording schemes. Each of the institutions involved in the animal recording scheme must possess appropriately trained personnel to fulfill its specific mission. A part of that mission will involve the training of farmers, technicians, and intermediate-level professionals at various other institutions.

In planning an animal recording scheme, appropriate training responsibilities must be allocated to each institution involved with the scheme. The objective of that training is to develop appropriate skills at each level of the animal recording scheme. An important secondary objective is to build rapport and confidence among all support personnel in the scheme. While training of farmers by field technicians and of field technicians at local institutions will be most common, involvement of personnel from local institutions directly in farmer training and of technical staff from central institutions in training of field staff and farmers is also valuable and serves to develop a feeling of connectedness among staff and participants.
3.12.6. Management of the animal recording scheme

Overall management of the animal recording scheme will generally be assigned to a single central institution in a local area or country-wide. That institution, in consultation with other local institutions, farmers’ organisations, and other stakeholders, will define the objectives and the scope of the animal recording activity. Operational management of the scheme, including the identification and recruitment of potential participants, will be shared among the central institution and the various local institutions, including farmers’ organisations, if they exist. Local institutions, including farmers’ organisations and cooperatives, will provide mechanisms for farmer input into the operation of the scheme through regular meetings, seminars, fairs, and other events.

3.12.7. Integration of programmes

Requests and opportunities for animal recording often arise in several agencies and organisations within the same region or country. While these requests may all be valid and may lead to collection of useful data, animal recording activities should be integrated under a single institutional structure whenever possible. This often does not happen, as various agencies involving farm planning, veterinary services, breed improvement, etc., with different administrative structures and funding sources all too often end up approaching the same group(s) of farmers to implement specific animal recording schemes. The result of such a piecemeal approach is to unnecessarily complicate the farmers’ management as different agencies attempt to impose different schedules, use different personnel, and utilise different methodologies.

It is far better if animal recording efforts can be integrated under a single organisational and institutional structure, a very general schematic being given in Figure 3.2. While it would be naïve to minimise the challenges inherent in integrating recording activities across agencies and institutions, the advantages of clear lines of responsibility and
accountability, nonambiguous direction, and consistent methodologies argue strongly for integration of animal recording activities within each region and(or) production system.


Evidence from successful animal recording schemes is overwhelming that adequate external funding is necessary to implement an animal recording scheme. The source(s) of funding may be government, various international agencies, nongovernmental organisations, or other private sources, but clearly neither the farmers themselves, their organisations, nor the consumers of the nation have shown the willingness and foresight to support the initial establishment of animal recording schemes. However, the evidence is likewise very strong that successful animal recording schemes also involve at least some significant contribution by participating farmers toward covering the operating costs of the scheme.

Animal recording is expensive. The actual costs of data collection on the farms is only a small part of the total cost of animal recording. Even the most efficient animal recording schemes still require coordination, technical inputs to design and monitor data collection and storage procedures, an analytical capacity, an educational and farmer liaison capacity, data processing and storage facilities, and equipment for data collection, management, analysis and storage, and distribution of results. These costs of establishment of the animal recording scheme must be borne by government or other funding agencies. Farmers will not recognise levels of benefit sufficient to justify the initial investment that is required, and, in fact, are unlikely to receive initial benefits sufficient to cover establishment costs. Thus the nation must recognise that these schemes will have diffuse benefits to consumers, farmers, and the rural economy as a whole which justify the use of public funds in their establishment and initial conduct.
It is equally important, however, that the participating farmers provide some level of financial support for operation of the animal recording scheme. Without such a commitment, the farmers have no stake in the operation of the scheme, have little power to influence its operation, and have little motivation to provide accurate, timely data. In many cases, the farmers’ initial contributions will be minimal, involving little more than the time and effort required to provide access to the animals and to assist in data collection.

Successful establishment of an animal recording scheme should therefore involve financial contributions from:

- Government, to provide baseline funding necessary for operation of the scheme over the period of 10 to 20 years which may be required to establish animal recording as an integral component of livestock management. If this baseline public funding is not available, then organisers of the scheme will be challenged to:
  - maintain funding from other external sources (donor agencies, nongovernmental organisations, private sources, etc.) for comparable periods of time, or
  - accelerate farmer willingness to accept more responsibility for funding the scheme, which will require the scheme to generate and document an exceptional level of benefit.

- Public and private donors and funding agencies, which may play a major role in initial establishment of the infrastructure required for animal recording (facilities, equipment, data processing and storage capability). These funding sources may also contribute to important enhancements in the activities of the scheme by providing for research, educational programs and materials, key supplemental equipment, etc. However, funds of this sort often are provided for relatively short periods of time (5 or, rarely, 10 years). These periods are often too short to allow an animal recording scheme to mature to a point where it can be self-supporting. Thus the need for continued baseline funding from government.
• Farmers and their organisation, who should be assigned a part of the cost of animal recording from the beginning, even if those costs are initially waived and are subsidised for some additional period.

A financial structure for collecting funds to support animal recording is required. Charges can be assessed on a per animal measured basis, a per farm basis, in proportion to farm production, or some combination of the above. It is often advantageous for contributions of farmers to the animal recording scheme to be made through some farmers’ organisation to provide for greater accountability to farmers and a greater sense of control. If no such organisation exists, its establishment should be encouraged. Fees can be assessed by the farmers’ organisation and then used to cover costs of recording. If benefits of animal recording are being captured through organised marketing of greater amount of products or higher prices received, some sort of assessment at marketing by the farmers’ organisation or cooperative may be used as a source of farmer funding.

3.14. Potential for Privatisation

3.14.1. Planning for privatisation

Under the economic conditions which prevail worldwide today, governments and other funding organisations have become increasingly reluctant to assume on-going responsibility for programmes such as animal recording, even when those programmes may produce clear benefits to the nation as a whole (such as a more plentiful, higher quality, and less seasonal food supply). Instead, the prevalent model today involves a finite investment in both funds and time toward establishment of a programme, with eventual withdrawal of those funds under the assumption that if the programme is successful, it will be maintained by its beneficiaries. While it has already been noted that the
duration of funding is often far too short to establish a working animal recording scheme, the fact remains that a part of the planning for such a scheme must include provision for it to eventually become substantially, if not completely, self-supporting.

Assumptions necessary to permit consideration of privatisation are:

- that the recording scheme has generated, and is continuing to generate, genuine benefits for farmers, that those benefits have been documented and quantified, and that the farmers recognise and accept that the animal recording scheme is the source of those benefits;

- that an organisation has been established within the rural community that can manage the operations of the animal recording scheme and that is committed to the overall goals of the scheme;

- that the benefits of the scheme are, in fact, sufficient to at least cover the operating costs of the scheme.

- when breed improvement is one of the goals of the scheme, privitisation also requires that a breeding structure has evolved within the community that permits identification and marketing of genetically superior animals generated within the animal recording scheme at premium prices consistent with that genetic superiority.

3.14.2. Animal recording as a business

Privatisation is most commonly taken to mean the assumption of the responsibilities of the animal recording scheme by farmers through their organisations, but the establishment of independent private businesses to provide animal recording services to farmers is another alternative. Models of privitising animal recording as a business are expanding throughout both the developed and developing
nations. An important advantage of such a structure is the high level of accountability placed on the independent providers who must serve their clients well to retain their business. A potential disadvantage is that competition among potential service providers may lead to inconsistent procedures and offerings. This is a particularly serious problem in animal recording for breed improvement where consistency of methodologies and objectives is particularly important. However, if animal recording is primarily for animal management with little need for long-term maintenance of records, pedigree recording, or accumulation of data across management units, private animal recording schemes may be quite effective. On the other hand, when neither public agencies nor farmers’ organisations are the primary managers of the animal recording activity, correspondingly less attention is given to the important collateral goals of rural development and national food security.

3.14.3. Long-term public involvement in animal recording

Strong arguments can be made for ongoing participation in, and contributions to, animal recording schemes by public or quasi-public agencies. Particularly important roles that are unlikely to be taken on by individual service providers or breeders’ organisations, particularly within developing nations, include the development and standardisation of recording methodology, development and implementation of analytical methodology, long-term maintenance of data, and the conduct of comprehensive multi-farm or multiregional analyses. Much of this can be achieved within central institutions through appropriate agreements with private sector service providers and breeders’ organisations. Higher level organisations (“organisations of organisations”) may also play at least some of the coordinating roles, as the International Committee for Animal Recording (ICAR) currently does within the developed nations and is beginning to do within the developing nations.
Public involvement in animal recording schemes also permits easier public access to the participants, resources, and information generated by the scheme when needed for planning activities or when questions or issues arise that need to be addressed by a specific animal recording activity (e.g., evaluation of a new vaccine, assessment of environmental impacts, etc.). Public involvement also facilitates greater attention within the scheme to issues of public good such as education, rural development, and national food security. Continued provision of limited public funds and of access to technical personnel on long-term basis is justified in order to capture these benefits.
Section 4. The Conduct of Animal Recording

Certain additional guidelines are required for the conduct of the animal recording scheme. These guidelines are summarized in Table 4.1 and relate primarily to interactions between the staff of the scheme and the participating farmers. In all cases, conduct of the scheme should be designed to encourage the farmers to actively participate in the scheme, to become involved in its planning and management, and to integrate results from the scheme into livestock management plans.

4.1. Getting Started: The Implementation of Animal Recording

Before the beginning of the animal recording process itself, several activities must be completed in order to lay the ground work for future success. These include:

4.1.1. Identification of the institutions that will provide support for animal recording, and of the responsibilities of each institution.

Including:

- commitments of space and facilities,

- procurement, delivery, and installation of laboratory, clerical, and data processing equipment,

- specification of responsibilities of each institution, of lines of communication among institutions, and of the administrative structure that will govern interactions among institutions

- budgets for each institution for the animal recording scheme including sources and amounts of funds and specification of fiscal responsibilities for operations, equipment, salaries, etc.
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<td>• Institutional commitments of space and facilities.</td>
<td>• Employ staff: - Administrative, - Technical, - Field staff.</td>
<td>• Public meetings: – community groups, – farmers’ organisations, – potential participants.</td>
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<tr>
<td>• Procure equipment.</td>
<td>• Procure supplies and equipment.</td>
<td>• Identify participants.</td>
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<tr>
<td>• Develop and define administrative structure.</td>
<td>• Define expectations of field staff.</td>
<td>• Meetings with participants.</td>
</tr>
<tr>
<td>• Develop budgets.</td>
<td>• Train staff.</td>
<td>• Specify essential arrangements.</td>
</tr>
<tr>
<td>• Minimise data processing time.</td>
<td>• Build linkages among staff.</td>
<td>• Define responsibilities.</td>
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<tr>
<td>• Respond to farmers’ concerns.</td>
<td></td>
<td>• Preliminary visits by field staff: – train farmers, – define who will do the recording, – identify animals.</td>
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<tr>
<td>• Identify and publicise benefits.</td>
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<td>• Provide clear and reliable schedules and expectations.</td>
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<tr>
<td>• Conduct annual and strategic reviews.</td>
<td></td>
<td>• Create opportunities for feedback.</td>
</tr>
<tr>
<td>• Develop facilities and equipment.</td>
<td></td>
<td>• Schedule regular farmer meeting.</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td></td>
<td>• Accept increasing levels of responsibility for recording and for funding.</td>
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</table>
4.1.2. Employment of staff

Including:

• administrative staff with appropriate support

• technical staff, either directly employed by the animal recording scheme or under contracts from other research, technical, or educational agencies

• field staff, located appropriately to serve the farmers

4.1.3 Procurement of equipment to support field operations

Initially the animal recording scheme should be prepared to supply all equipment and supplies needed for the scheme including measuring tools, recording supplies and forms, mailers, educational material, decision aids, and animal identification supplies.

4.1.4 Definition of operating procedures for field staff

Including:

• expectations for number of farms to be served by each technician and the distribution of these farms. How many farms will be served, and will they be in a single village or more widely distributed?

• assign each technician to a specific group of farms

• define expected duties of technicians in terms of animal measurement and recording, farmer education, monitoring of the scheme, and advice. Define a schedule for the number of times each farm is to be visited and the activities at each visit.

• define how transportation and communication support will be provided for technicians
• define how technicians will be employed and paid. Technicians might be either full-time employees of the scheme or part-time contractors hired from local communities. If technicians are contractors, they will likely be paid based on performance (farms served, animals recorded, etc.). Define these arrangements.

4.1.5. Training of field staff, including both technical training and training in the objectives of the scheme

Opportunity should be provided for interactions among field technicians and between technicians and upper level staff.

4.1.6. Identification of participating farmers

Including:

• preliminary public meetings to inform farmers of opportunities to participation, to get feedback from farmers, to build community enthusiasm, and to allow farmers to get to know staff and technical personnel. Emphasis in these meetings should be on specific benefits expected from the scheme and on the expectations of participants

• meetings with pertinent farmers’ organisations, when they exist, to obtain support and feedback

• identification of the actual participants, followed by several small group meetings to define expectations, requirements, and services to be provided

• specification of all financial arrangements involving participants, including clear statements of all fees and payments involved and scheduling of these fees and payments. Clearly distinguish short-term financial arrangements (e.g., initial waiver of fees or outright payments to farmers) from anticipated long-term arrangements (e.g., eventual farmer fees).
• specification of responsibilities of farmers (short- and long-term) versus responsibilities of technicians

• preliminary farm visits by field staff

4.1.7. Schedule the flow of data to allow for timely transmission, processing, summarisation, and return of data

4.1.8. Animal identification

Specify how animals will be identified and acquire the necessary supplies. Animals must be identified either before recording begins or on the first recording date.

4.2. The First Cycle of Recording

The first cycle of animal recording includes the initial measurement and recording of data, the initial processing of that data, its return to the farmers in summarised and interpreted form, the use of the data to make management/selection decisions, and the documentation of the outcomes of those decisions. It is critical that all steps in the first cycle be carried out in accordance with the plans and commitments made during planning of the scheme. Experiences by the farmers during this first cycle will do much to define future performance and expectations. Specific considerations include:

• Scheduling. Farmers must be clearly informed about when technicians will visit the farms and those schedules must be met.

• Expectations. Farmers must be clearly informed about what is expected of them prior to, or at the time of, the technician’s visit. If farmers are doing some or all of the measurements, the timing and nature of those measurements must be clear, and initial compliance should be closely monitored.

• Initial feedback. On-farm training and education regarding measurement procedures, recording, and anticipated results
The Conduct of Animal Recording

should be a major task at the initial farm visit. This visit should be used as an opportunity to plan future visits and applications of results.

- On-going feedback must continue throughout the cycle. Opportunities to communicate with farmers during this first cycle should be maximised to maintain enthusiasm and support applications. Particular attention should be paid to documenting results of data-based management decisions.

- Provide a support system for programme technicians. Technicians who visit the farms during this initial cycle of recording will encounter particular challenges. Provide a way for technicians to get help and advice from higher-level staff as needed. Aid technicians in establishing credibility with farmers.

- At the end of the first cycle of recording, meetings between participating farmers and staff should be scheduled to allow discussions among farmers regarding experiences and problems. Key problems should be identified and promptly addressed. Positive results of the first cycle of recording should be highlighted.

4.3. Maintenance: Sustaining Enthusiasm and Commitment

Operating guidelines applied during the first cycle of recording must be sustained and updated as needed as the scheme continues. Key points are:

- Scheduling. Schedules must be tightly maintained, both in terms of technician visits and timely reporting of data. Avoid complacency.

- Promote farmer involvement, training, and responsibility. Each interaction between farmers and technicians is an opportunity to encourage farmers to become more involved in the recording process. Use these opportunities to support
development of farmers’ measurement skills and understanding of animal recording.

- Advice and education. Maintain an active program of helping farmers to interpret and apply results of animal recording.

- Listen to, and react to, farmer concerns. Technicians and administrative staff should meet periodically to identify these concerns.

- Maintain an absolute commitment to timely processing and return of summarised and interpreted data.

- Make recording and documenting of benefits an integral part of the recording scheme. Include both direct benefits (increased profits, production, productivity) and indirect benefits (community development).

4.4. Review

4.4.1. Annual review

Establish an efficient, concise annual review procedure, including:

- Documentation of animal recording activities including numbers of participating farms, numbers of animals recorded, numbers of records processed, educational materials and decision aids developed and distributed.

- A one- or two-day meeting of the staff of the scheme including field technicians to review progress, concerns, and opportunities. This is also an opportunity to build enthusiasm and consensus among field staff.

- A field day or similar program should be scheduled to highlight accomplishments to the farmers. Focus on educational activities, recognition of participants, and
summaries of benefits. Invite both participating and nonparticipating farmers.

- Provide an annual report to appropriate administrative and government agencies (including local and village governments) and to funding bodies.

### 4.4.2. Strategic review

A detailed strategic review should be conducted every 5 years or so. Particular objectives of this review should be:

- External evaluation. Experts from outside the scheme should be involved to provide a neutral perspective.

- Detailed assessment of benefits. A comprehensive and detailed listing of the benefits of the scheme should be compiled and critically evaluated.

- Identification of needs and opportunities to enhance operational procedures and benefits. Identify key successes and limitations. Assess progress and opportunities for improvement.

- Evaluate opportunities to expand the number of participants.

- Revise operating procedures as necessary.

### 4.5. Further Development

#### 4.5.1. Enhancements to the recording process

At implementation, it is important that the animal recording scheme be kept as simple and straightforward as possible. The traits to be measured should be those that are most directly related to the development objective and are most easily measured on participating farms.
However, one of the development goals for an animal recording scheme will be to expand the number and/or detail of the measurements recorded to provide better information to the farmers. This can only occur as farmers see benefits from animal recording and become willing to do more to obtain potentially more benefits. Thus a part of the conduct of the animal recording scheme is to assist farmers to better appreciate opportunities for additional benefits from additional measurements. A part of the development process can be to identify subsets of participants who will demonstrate new recording opportunities. These more progressive farmers can encourage others to adopt more comprehensive recording procedures.

4.5.2. Greater farmer responsibility for recording

In most cases, one of the long-term (10- to 20-year) goals of an animal recording scheme is to shift responsibility for measuring and recording from technicians to farmers. Expanded farmer involvement in conduct of the scheme is also desired. Provision to shift more responsibility to farmers should exist, but can only be achieved on a gradual basis. Substantial early investments in farmer training and education will be required.

4.5.3. New opportunities for benefit

Development of strong farmers’ organisations is desirable to support animal recording schemes. These organisations should be helped and encouraged to become involved in a broad range of activities to develop the rural economy. Development of cooperative marketing or purchasing programmes, educational programmes, or community-based resource management programmes are examples. Scheme managers should be alert to opportunities for new ways for farmers to benefit, either directly from the animal recording activity or indirectly through better organisation.
4.6. Building Farmer Involvement

A sense of ownership of the animal recording scheme should be developed among participating farmers. Thus the scheme should focus on the needs and desires of these farmers. Activities that can increase participation of farmers in the conduct of animal recording include:

- Better communication among participating farmers and between farmers and staff members (both field and technical). Field days, farmer meetings, and educational events provide opportunities for such communications.

- Identification of successful farmers and their use as advocates for animal recording. Also identify community leaders and enlist their support.

- Enlist involvement of existing farmers’ organisations and cooperatives in the management of the scheme. If such organisations do not exist, encourage their formations. Be sure that they have a voice in the operations of the scheme. Farmers’ groups may be especially effective at collecting and managing farmers’ contributions to funding the scheme. When farmers’ organisations contribute to the costs of the scheme, try to identify areas that are both important to the scheme and of high priority to farmers, and focus use of farmers’ funds in these areas.

- Involve the animal recording scheme, either directly or indirectly, in youth education and improving the quality of rural life.

- Build markets for animal products. In particular, when animal recording is for genetic improvement, provide assistance in market of breeding stock at premium prices through sponsored auctions or contract sales to other farmers.
Section 5. Animal Recording in Medium Input Production Environments—Special Operational Issues and Opportunities

This section of these guidelines will address specific issues involved in animal recording in medium-input production systems. Whereas Sections 3 and 4 dealt primarily with the planning and conduct of animal recording schemes, Section 5 will focus on the animal recording activity itself in terms of unique considerations in medium-input production environments.

Animal recording in developed nations has, over time, become a relatively standardised process. Use of standardised methodologies enhances communications, permits greater comparability of results, and has aided in development of international genetic evaluation procedures. Organisations such as the International Committee on Animal Recording (ICAR) have evolved to extend the concept of standardised animal recording procedures across national boundaries and have played a strong facilitative role in globalisation of animal recording and genetic evaluation for some important species. Recent commitments from ICAR to extend its activities into the medium- to low-input production systems of the developing world bode well for the establishment of scientifically-based, cost-effective and suitable standardised and sustainable recording procedures in these critical regions of the world.

In establishing animal recording programs in both developing countries and in the medium-input systems of the developed nations, it is not appropriate to simply apply the same techniques used for animal recording in high-input production systems. Instead, existing methodologies must be critically evaluated and adapted to fit these less structured, lower cost production systems; and possibilities for the use of indigenous production system technologies should also be examined. The goals of animal recording should not, however, be compromised; the rigorous, objective characterisation of animal performance with the subsequent use of that data to enhance the well-being of farmers, consumers, and their communities remains a priority.
Issues to be addressed in carrying out an effective animal recording scheme include:

5.1. What to Measure.

Traits to measure may be categorized into six groups: Output, product quality, input, productivity, life history, and adaptation traits. Characteristics of these groups are summarized in Table 5.1.

5.1.1. Measurement of output

Animal production levels are an important component of overall animal merit, although, as discussed below, not necessarily the most important component in low- to medium-input production environments. Thus recording of the main output variables is indicated. In dairy production, this involves recording of milk production levels at various points during lactation and of the duration of lactation. Such a set of measurements allows estimation of total milk production. Changes in total milk production over time (years) also provide an indication of benefits from the scheme and, if a sizable proportion of the milk is marketed, of gross farm income.
Table 5.1: Animal Recording – What to Measure?

<table>
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<tr>
<th>Trait Category</th>
<th>Characteristics</th>
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| Outputs              | • Relatively easy to measure  
                      • Directly related to production and income  
                      • May not be directly related to productivity and profit                                                                                     |
| Product Quality      | • Usually relatively easy to measure  
                      • May require simple equipment to measure (milk composition; fibre quality)  
                      • Important only if the markets reward quality                                                                                               |
| Inputs               | • Have a great impact on productivity and profit  
                      • Difficult to measure directly  
                      • Emphasise indicator traits                                                                                                                  |
| Productivity         | • Composite indicators of net merit may be relatively simple to measure but can be complex to interpret  
                      • Not necessarily ideal for use in genetic improvement programmes                                                                               |
| Life History Traits  | • Involve reproductive and health-related measures  
                      • High economic importance  
                      • Important to maintain a favourable age structure  
                      • Requires careful recording                                                                                                                   |
| Adaptation           | • Key trait controlling productivity and profit  
                      • Unique to each production environment  
                      • Difficult to measure directly  
                      • Emphasise indicator traits                                                                                                                   |
When meat production is involved, measures of body size are the main indicators of production. Body size is ideally measured in all animals at similar ages, and, assuming that birth dates are known, can be further adjusted to a constant age. Generally measures of body size may be taken at weaning, at times when animals are chosen for marketing, and at times when management or nutrition change (for example at transitions from wet to dry seasons or when animals are brought in from summer grazing for winter). In most cases, an indicator of body size at a relatively young age is desirable because, at least in suckling mammals, such a measure provides information on both the growth potential of the offspring and the mothering ability of the dam.

A measurement of body size is usually also needed at marketing time, because this is when replacement animals are distinguished from market animals and because these measures of body size will be most closely related to animal value and farm income. In many cases, and especially in low-input smallholder production systems, there will be strong pressure to sell the largest (i.e., most valuable animals), even though these may also be the best replacements. Careful analysis may be required to determine which of these is really best for the farmer, followed by an educational programme to make results of the analysis known.

Other measures of body size may be useful, depending upon the production environment and the pattern of parturitions and marketing (see Section 5.1.2.). Measures of offspring growth should also not be neglected in dairy production where sales of offspring may be an important source of income. However, it should be recognised that in dairy production, the number of offspring produced per year is probably more important than their growth rate which will be primarily influenced by how much milk they are allowed to drink. By-products of meat production, such as hides for leather may also be a source of income, and must be
recognised as important. Suitability of surplus males for draft may also be an issue in both meat and dairy production.

In poultry production, both meat and eggs will usually both be important products, and scavenger birds may be an important source of both food and income from sale of surplus products. With a short life cycle and reasonably large numbers of animals produced in even smallholder production systems, identification, measurement and evaluation of individual birds is rarely practiced in medium- and low-input systems. However, use of animal recording to specifically compare native and imported birds or other different germplasm sources may be important. Such comparisons will involve measurement of number of eggs, duration of lay (i.e., broodiness characteristics), and growth of offspring.

In fibre production, weight of fleece is commonly measured. If animals are all sheared annually at about the same time, duration of fibre growth is automatically standardised. However, if possible, it may be necessary to adjust for reproductive status (open, lactating, number of offspring suckled) or for age.

5.1.2 Measurement of product quality

Definitions of product quality must be made in relation to current and potential markets and family needs. Attention to product quality is appropriate only if improving product quality leads to increased food security and product prices or if measures of product quality are indicators of other favorable production characteristics (e.g., lean animals usually have higher feed efficiency).

The most common measures of product quality in dairy production are fat and protein content of the milk. In fibre production, fibre diameter (“fineness”) is the most common measure of value, although there are other potentially
important quality attributes (including scouring yield and fibre length, uniformity, color, strength, etc.). These measures are relatively simple to obtain, but require use of simple laboratory equipment and often cannot be evaluated directly on the farm. Instead, a common situation for milk and fibre recording is to evaluate quality measurements when product is delivered to market. This is generally an acceptable approach, but does require that the identity of the animals producing the product be recorded and maintained until product quality traits have been measured.

Measurement of product quality in meat production systems is more challenging. First, one must define what constitutes “quality” in a particular market. Increasingly, lean meat products are being favored, but fat is still not discriminated against in many markets. An intermediate optimum amount of fat is commonly desired, and in harsh environments may be difficult to attain. Even when freedom from external waste fat is desired, relatively high quantities of intramuscular fat may be desired to optimise eating quality of the lean. This is a particular issue in pig and poultry production in developing countries where very lean types may not be preferred.

Sophisticated measures of meat quality involving direct measurements of carcasses or meat samples or the use of ultrasonic equipment on live animals will generally not be feasible under developing-country conditions. In most cases, measures of product quality in meat production will be restricted, at least initially, to simple condition (fatness) and muscling scores to accompany measures of body size. If persons assigning the scores are properly trained, such scores can provide reasonably accurate and repeatable indications of body composition. In pigs, simple physical measures of backfat depth can be obtained using a backfat probe. Research relating animal scores or backfat measurements to prices received in local markets can then be conducted and
used to better estimate animal value from recorded measurements.

Other measures of product value that may need to be considered, especially when comparing diverse genetic types or exotic breeds, include color of hair, wool or feathers, and pelt and hide characteristics.

5.1.3. Measurement of inputs

Estimates of the inputs required to support production may be critically important components of the development objective, but are frequently very difficult to incorporate directly into an animal recording scheme. By far the most important measure of a production input that might be desired is a measure of feed intake. If feed intake information were available, then measures of production could be adjusted for the feed required to achieve that production, giving a better measure of animal productivity or efficiency.

Individual measurements of feed intake are rarely included in animal recording schemes in developed countries and are essentially impossible on a large scale under developing country conditions. Estimation of feed intake is particularly difficult for grazing or scavenging animals. However, in some developing country situations, cut and carry feeding to individual animals is employed and limited quantities of energy and/or protein supplements may be provided to some animals for short periods of time. Recording of feed and supplemental feed levels, when provided on an individual animal basis (such as during lactation) may be useful, however, in evaluating production data.

Since feed intake will often not be measured, an alternative is to identify other measures which may serve as indicators of feed intake. Among practical measures, information on adult or near-adult body size may be most useful as it indicates the amount of feed required for animal maintenance. Simple
prediction equations can be used to estimate feed requirements for animals of different sizes. Thus if two animals have the same level of production but differ in body size, the smaller animal is expected to have consumed less feed to achieve that production and to have higher productivity. When larger animals also have higher production, it is more difficult to assess productivity and research may be required to define relationships among body size, condition scores, production levels, and feed intake in the environment of interest.

Other inputs that may impact on productivity include requirements for health care, housing and reproductive management. While at least some of these inputs may be measurable in theory, their actual recording in practical production systems has proven difficult. However, reasonable indicators of these inputs may be derived from records of reproductive performance and life history traits (see Section 5.1.5.). Finally, differences among animals in time and labor requirements may be significant and may significantly impact on productivity. Although very difficult to measure, the value of “trouble-free” animals is great indeed.

5.1.4. Direct measures of productivity

Several direct indicators of animal productivity (output per unit input), derived from simple animal measures, have been proposed as both animal evaluation tools and selection criteria. These indicators are composite measures of productivity and are designed to summarise animal performance across some production cycles. Examples include:

• milk production per unit time, calculated by dividing the total lactation yield by the time between successive lactations to account for differences in interval between calvings.
• milk production per unit body size, calculated by dividing total lactation yield by a measure of body size to adjust for animal feed requirements.

• weight of offspring weaned or marketed per unit time and/or per unit of dam size to adjust productivity for differences in time between parturitions, litter size, offspring survival, and offspring growth.

• weight of product produced per day of age, calculated by dividing total lifetime production by animal age to account for time to first parturition. This variable is affected by number of parturitions and so only animals with the same number of parturitions can be directly compared.

These measurements may serve to identify the most productive animals provided the indicator chosen adequately portrays key input-output relationships. They are particularly useful as culling tools to identify lowly animal with low productivity. These composite measures of productivity must be used more carefully, however, as indicators of genetic merit. Because they are constructed by combining information on several different traits, their genetic properties are difficult to define and may differ among production systems and/or environments. It is not clear that selection based on a single composite measure of productivity will be as effective as selecting on some other function of the component traits. Thus definition of optimal selection criteria will require investigation of the genetic properties of the composite trait and its components in relation to the development objective in the production system of interest.

5.1.5. Measurement of life history traits

Life history traits are those that define critical events in the animal’s productive life. They are generally time-related, including such things as dates of birth, weaning, matings,
parturitions, sale, medical treatments, ending of lactation, and death. If animals are closely managed, as in dairy production, life history traits are easily observed but must also be properly recorded. One of the challenges in recording life history traits is that their measurement often cannot be scheduled and therefore must be recorded by the farmers. It is therefore important to carefully identify the most important life history traits, to impress upon the farmers the importance of recording these traits, and to provide necessary directions and supplies for recording. Careful monitoring of recording will also be needed to ensure proper data collection.

Recording of life history traits is more difficult when the number of animals is large or animals are managed extensively, as in the case of grazing ruminants. Still, grazing animals are often herded in many developing country situations and, if animal identifiers can be read from a distance (e.g., brands, large ear tags), information on birth dates and other life history traits may be able to be recorded.

Measurement of life history traits is particularly important in low- to medium-input production systems in developing countries. In these situations, animals often develop slowly and enter production at relatively advanced ages. For example, in these situations, cattle and buffalo often do not calve for the first time until 4 or 5 years of age. When animals do not begin their productive lives early, it is absolutely essential that production subsequently be maintained for many years. Thus if a cow calves for the first time at four years of age and then lactates for only two years, two thirds of her life has been spent in an unproductive state and the number of offspring produced is barely able to accommodate her replacement. Longevity is thus a very important trait in developing countries and one that often suffers from introduction of exotic types of high-production potential. Though it is difficult to select directly for longevity
because it is not expressed until late in life, measurement of longevity and choice of replacements from females with a long productive history may make an important contribution to the development objective.

The main life history traits can be divided into:

5.1.5.1. Reproductive traits.

These are the traits that must be measured to characterise the animals' reproductive efficiency. At a minimum, records of parturitions are required in most animal recording schemes. If births cannot be recorded daily, they must at least be recorded every few days, and usually at least weekly, to identify groups of animals of similar age or stage of lactation. Other measures of reproduction such as dates of return to oestrus and dates of breeding may be recorded if animals are being closely observed and handled. Under extensive production, it is important to at least know when males and females are together (see Section 5.2.).

5.1.5.2. Health-related traits.

The occurrence of disease and the need for health care can importantly affect animal productivity and profitability. Thus it is desirable to identify animals that require higher-than-normal levels of health care. While health-related problems are often fairly easy to observe, the incorporation of effective, efficient health recording procedures into animal recording schemes has been difficult in both developed and developing schemes. Some successes have been achieved in milk recording when animals are handled daily, but successes have been notably lacking in meat and fibre recording. If health-related traits are a key part of the development objective, the appropriate strategy is to focus on only a very few key health problems and to try to get recording of their incidence or treatment. Attempts to record a wide array of health-related events should be deferred until farmers
become thoroughly familiar with recording procedures and may never be very successful.

5.1.6. Measurement of adaptation

Adaptation, while difficult to define, is a critical characteristic in many production systems. Adaptation is not a single trait; rather it involves different sets of characteristics in each production environment. Thus evaluation of adaptation must first involve identification of the most important animal stressors, including diseases, climatic variable, endo- and ectoparasites, dietary deficiencies, and seasonal feed shortages. Appropriate, measurable indicators of susceptibility to these stressors must then be identified.

Among the simple performance measures already discussed, measures of growth rate and body size, of reproductive performance, of survival of offspring, and of various health-related events can often be used as indicators of adaptation, especially if scheduled to correspond with high-stress periods. Poorly adapted animals do not produce, reproduce or survive well.

More specific measures of adaptation also can be defined and may be practical under farm conditions if strongly related to the development objective. Recording of specific health-related life history traits may be warranted for a few key diseases. Scores or counts can be used to quantify resistance to ticks. Simple laboratory determinations of egg counts in feces can quantify internal parasite loads. Measures of changes in body size during high-stress periods (e.g., winter or the dry season) can be used to indicate adaptation to the nutrient environment.
5.2. When to Measure: The Scheduling of Animal Recording

The issue of when to measure animals relates primarily to the closeness of the relationship between the owner and the animals. The closer the relationship, the greater the potential to directly measure traits of interest. The scheduling of measurements must also be related to the production cycle as depicted in Figure 5.1 for milk and meat recording.

5.2.1. Milk recording

Procedures for milk recording are relatively advanced in both developed and developing nations because the collection of milk requires intimate association between the farmer and the individual animal. The product (milk) is available on a regular basis for evaluation and is easily associated with the animal producing the product. Because milk collection for human use usually begins at or near the beginning of lactation, time of parturition is usually known with reasonable accuracy, and significant events occurring during lactation (oestrus, health problems, rebreeding) may be directly observed. Access to animals for other measures is also generally available, at least during lactation. Decisions on when to record performance of lactating animals is therefore primarily a function of determining what pattern of recording is optimal from a data collection/utilisation standpoint and possible in terms of farmer willingness to participate.
Figure 5.1: The Scheduling of Animal Recording for Milk and Meat Traits

**MILK TRAITS**

Parturition → remove offspring → lactation → end of lactation → next parturition

**MEAT TRAITS**

parturition → offspring growth → dam rebreeding → next parturition

or

linear postweaning growth → seasonal cycles of growth → sale or slaughter carcass evaluation
5.2.2. Egg recording

Egg production represents another situation where the animal product is generally harvested daily. However, depending upon the production system and the number of females involved, daily production may not be easily associated with individual females. Thus, as discussed in section 5.3., the use of “tools” of some sort may be required for individual animal assessment unless the flock is very small and the arrangement of the laying house is such that the farmer can accurately assess individual production.

5.2.3. Meat recording

Production of meat and hides usually involves a single harvest time which may be the same for all animals or may be determined on an individual basis. Even though sale or slaughter is the time when meat is harvested, this is generally not be the best time to assess meat production traits, especially in developing-country production systems. One must instead attempt to identify times in the production cycle when cohorts of animals are accessible for evaluation and when the members of that cohort can be fairly compared.

The primary trait used to evaluate rate of meat production is body size at a fixed age or the increase in body size between two or more fixed ages. For intensively managed or closely held animals, measurement of birth dates may be generally feasible and the choice of times for evaluation of body size or rate of growth may be defined largely by theoretical considerations and the farmers’ willingness to cooperate.

The situation is more challenging in extensive production systems. Successful measurement of growth-related traits under these conditions often required integration of recording with other activities that involve mustering of animals. Factors to be considered in identifying times for
measurement of growth-related traits will include the seasonal pattern of parturitions and the nature of the marketing/harvesting process.

5.2.3.1. Effects of pattern of parturitions on animal recording.

In terms of the pattern of parturitions, the following possibilities may exist:

5.2.3.1.1. A single annual birthing season.
In this situation, all young stock will be of roughly similar age and likely can be placed into one or a few cohorts based on date of birth. Assessment of growth may then be based on a small number of measurements (perhaps 1 to 3). These measurements ideally would be synchronised with other activities that require or facilitate handling of animals, but may require gathering of animals specifically for purposes of recording. The existence of a single annual birthing season also generally suggests potential for rather accurate control of mating.

5.2.3.1.2. Several annual birthing seasons.
In this situation, the number of cohorts of young stock will be increased, as will the number of measurement times during the year. The size of each cohort will be correspondingly less, and may become quite small. Problems in animal recording in this case primarily relate to the need to motivate farmers to record the necessary information on all animals in each cohort. Again, however, the existence of fixed birthing seasons suggests potential for control of mating.

5.2.3.1.3. Continuous births.
This common situation, usually arising from failure or inability to control matings, is difficult to handle from a meat recording standpoint. The difficulties are practical, not theoretical. In theory, animals can be grouped into cohorts based on birth dates, compared within cohorts, and
differences among cohorts accounted for in data analysis. However, from a practical viewpoint, recording of births throughout the year represents a substantial challenge unless animals are closely managed. Likewise, recording must occur on a more-or-less continuous basis to provide rough comparability among birth cohorts in age at measurement. The situation is only a bit less difficult if parturitions tend to be grouped within a season based on climatic or environmental (as opposed to management) variables. Thus sheep and goats in temperate regions may express a fair degree of synchrony in parturitions because of seasonality of breeding. However, without controlled matings, parturitions is still likely to be spread over long periods and meat recording will remain difficult.

5.2.3.2. Marketing patterns and animal recording.

Marketing patterns will also affect ease and timing of meat recording activities. Consider the impacts of the following alternative situations:

5.2.3.2.1. Seasonal marketing.

In this situation, marketing is a seasonal activity, often tied to either declines in feed supply or to culturally mediated demand for specific animal products. Synchronisation of animal recording activities with marketing decisions is often advantageous. Recording of young stock in association with marketing provides opportunity for selection of replacement animals, for decisions on which animals to market, and for prompt economic feedback on current and previous selection decisions. Within these seasonally constrained marketing systems, the actual decision on which animals to market may be based upon:

- age, with primarily surplus animals from the most recent birth date cohorts marketed. This is generally advantageous in terms of animal recording, with young stock evaluated and then divided into replacement and
market animals. However, for many medium- to low-input production systems this situation is not the norm.

- weight-based marketing is more common than age-based marketing in most developing nations. The key issues here are that animals born at the same time are often not marketed at the same age. Several years may be required for animals to reach market condition, with birth date cohorts progressively thinned as they reach market weight or condition or as resource constraints require that animal numbers be reduced. This situation is challenging from an animal recording perspective because the total information array develops over several years, with progressive removal of animals from the cohort. Use of early indicators of body size and growth before any of the animals are marketed is advantageous but may not provide all of the desired information. Later measures which characterise the animals ability to maintain weight gain or minimise weight loss under conditions of stress may be important to achievement of the breeding objective.

5.2.3.2.2. Continuous harvesting/marketing.
In this situation, animals are marketed or slaughtered for local use on an “as-needed” basis to provide cash or food. While accurate animal recording may be possible in such situations, logistical problems abound. If animal recording can be synchronised with periods of animal handling, and if birth dates are known, meaningful information can be obtained, but demonstration of benefits to participating farmers is difficult.

5.2.4. Fibre recording
Fibre recording programs present a different array of time-related considerations. On the positive side, fibre harvesting is often a seasonal activity, so recording of production and product characteristics can often be accomplished for all
animals in the flock at a single time. Likewise, removal of fibre is an individual-animal process, with clear opportunity to attach information to the animal producing the fibre. Fibre is usually primarily harvested from adult animals, and so, in contrast to meat recording, may be less influenced by environmental factors during early development. Finally, fibre is a relatively nonperishable product that can be sampled for later analysis of product characteristics. However, fibre-producing animals are often managed under relatively extensive conditions, so many of the same challenges involving knowledge of birth groups and animal identity, and setting up of appropriate contemporary cohorts described for meat recording also apply to fibre recording. Similarly, several nongenetic factors influence fibre production and quality, including reproductive status, number of offspring suckled, animal age, etc. Thus many of the life history traits of breeding females that are useful in meat recording programs are also useful in fibre recording programs, but may be similarly difficult to obtain.

5.2.5. Draught recording

Many developing nations use animals for various forms of draught; providing an important added but also energy demanding animal product. The ability of an animal to provide draught power varies according to, among others, breed, species, sex, type of work required, implements used, environmental conditions including feed and health and from animal to animal. This “draughtability” may be measured through simple observation while the animal is performing a specific work as compared with others as using measuring equipment that have been developed for that purpose.
5.2.6. Life history recording

These life history traits, including reproductive histories, survival data on offspring and individuals, and health records can be extremely important, especially in extensive or subsistence production systems, but have been very difficult to incorporate into animal recording schemes, even in developed nations. They are generally not amenable to scheduled recording and their capture thus must often rely on farmers’ records. When animals are not closely held and/or are maintained in large groups, it may be difficult to record many of these life-history traits with high accuracy. However, if individual animal identity is maintained, recording of acceptable information on reproductive histories may be possible. **Early life survival and reproduction data can be very important** for farm management decisions for comparative evaluation of exotic and indigenous types in developing country medium input production systems.

5.3. How to Measure: The Tools for Animal Recording

The tools used in animal recording may vary from the very simple to the very sophisticated. The choice of tools should be based on the premise that **simple procedures and equipment always are to be preferred over complex procedures and equipment so long as both are sufficient to meet the goals of the animal recording activity.** In particular, use of simple tools to measure many animals on many farms is generally superior to measurement of smaller numbers of animals on fewer farms using more complex methodology. One of the goals of any animal recording scheme is widespread participation, and the use of simple tools and methods is usually helpful in reaching this goal. Even if more complex tools are advantageous in some situations, initial use of simple, straightforward equipment may be preferred until farmers have accepted the value of animal recording. Once the value of the information being
collected is recognised and acknowledged by the farmers, the introduction of new, and better, tools becomes an opportunity rather than an imposition.

In developing nations, the choice of tools for animal recording must take into account the infrastructure of the region. Access to electricity, reliable batteries, pure water, electronic communications, and rapid transportation of samples to laboratories and of results back to farmers are often lacking in rural areas of developing nations, and the tools used for animal recording must be consistent with these limitations.

In point of fact, **credible, useful animal recording programs can be designed which require no use of measurement tools whatsoever.** For many fitness and reproductive traits, records of dates, times, numbers of offspring, offspring survival, and indications of reproductive events or the occurrence of disease are the most important information. Simple scores, if properly applied, can adequately describe and discriminate among animals, and provide very useful information for improving productivity of the herd and flock as a whole. Additional simple linear and volumetric tools such as tapes for measuring animal size and standardised containers for measuring milk yields and egg size can provide the basis for credible animal recording programs. It is the consistency in application of the tools, not their sophistication, that will control the success of the scheme.

In evaluating tools for animal recording, the following categories may be useful:

**5.3.1. Tools that reduce cost and complexity**

Tools exist that permit simple, low-cost recording of animal performance under essentially all conditions and without reliance on electronic or elaborate mechanical equipment. These tools are inexpensive, durable, and do not require periodic calibration. Examples include tape measures for linear body measures (with associated weight conversion tables); simple balance beam scales for weighing small animals or animal products such as fleeces; and standard
volumetric containers for measuring milk yields. Use of these tools, when coupled with recording of appropriate life-history traits, can form the basis for effective programs to improve reproduction, growth, and fitness.

5.3.2. Tools that reduce complexity but increase costs

Tools in this category generally allow assessment of indicator traits that may be used to evaluate other economically important traits that cannot be measured directly. From the viewpoint of the farmer, these tools are simple to apply but generally have substantial overhead or subsequent laboratory processing costs that must be covered within the context of the overall animal recording scheme. Examples would be use of simple ELISA-based methods to assess antibody or hormone titres or any diagnostic procedures that involve only collection of blood or a tissue sample. Central testing of fibre quality and automated testing of milk composition would also fit into this category. Essentially all uses of DNA markers or diagnostic testing are included in this category of tools and may become important in the future. Screening for genetic markers that have been demonstrated to influence resistance to diseases or adaptation to various stressors permits selection to be practiced without or before actual exposure to the disease or stressor. However, a disadvantage to use of this type tools is that they often do not allow immediate feedback. Instead, information for decision-making must usually be returned to the farmer after processing of the samples.

5.3.3. Tools that increase complexity but reduce costs

These are the tools that involve greater on-farm application of technology in order to capture information that would otherwise be difficult or impossible to obtain. Use of ultrasonic equipment to assess body composition or carcass merit or of electronic identification and electronic scales are examples of such tools. Widespread use of such tools requires
a careful assessment of the conditions that are likely to be encountered in the field, of the technical skills of programme technicians, and of reliability of access and cost of both the initial equipment and replacement parts.

5.3.4. Tools that increase both complexity and cost

This category encompasses the use of very sophisticated tools such as whole-body scanners, laparoscopic procedures, and collection of individual feed-intake data (either manually or electronically). While potentially useful to address specific questions in on-farm studies, these technologies are currently not well-suited to ongoing schemes of animal recording for improvement. They are generally too expensive and difficult to apply to the large numbers of animals distributed across many farms that are needed in such schemes.

5.4. Comparing Animals Born in Different Years and/or on Different Farms: The Contemporary Group

Animal recording for breed improvement requires separation of genetic effects to be used in breed improvement from nongenetic effects that will not be transmitted from parent to offspring. Concerns over accomplishment of this separation led to development of the concept of the “contemporary group”: a set of animals that have been, for the most part, treated alike such that performance may be fairly compared among animals within the group without concern for major nongenetic differences among the animals. Thus animals born in the same season and raised under the same conditions are considered contemporaries, as are animals that give birth in the same season and lactate under similar conditions. In contrast, animals born or lactating in different seasons or under different feeding conditions can differ greatly in performance, but those differences are usually not indicative of differences in genetic merit.

When animal recording is primarily for animal management, management choices can either be made within recognised contemporary groups or, if level of production is the only concern,
can be made without concern for whether the factors influencing production are genetic or nongenetic. For example, if maximum milk production is the goal, retention of older females is preferred, even if younger females are anticipated to be genetically superior. On the other hand, if genetic improvement is the goal, retention of the younger females may be preferred, even though current production may be reduced.

A part of modern genetic evaluation methodology is the assignment of recorded animals to contemporary groups and the consideration of nongenetic contemporary group effects in prediction of genetic merit. Inherent in these analyses are the assumptions that the resulting contemporary groups are of reasonable size (to allow reasonably accurate estimation of the contemporary group effect and the ranking of animals within the group on performance) and that related animals appear across the different contemporary groups (to permit separation of genetic and nongenetic effects among contemporary groups).

In milk recording, the contemporary group is often taken to include all females giving birth in the same herd, year, and season. Similar contemporary group definitions exist for meat, egg, and fibre recording. However, when contemporary groups are very small, it becomes difficult to estimate contemporary group effects and to separate genetic and nongenetic effects. The problem of small contemporary group size is acute in many of the smallholder production systems of the developing nations where farmers may have from one to at most four or five breeding animals and where births from these animals may be spread throughout the year. In such a situation, the definition of the contemporary group must somehow be modified or expanded if genetic evaluation is to be possible. One strategy that has been recommended is to consider an entire village or a neighborhood within a village to represent a contemporary group. Such an approach can be acceptable provided the treatment of animals among households within the village is fairly uniform. This will often be the case when livestock graze alleyways or common lands with minimal supplemental feeding but becomes less satisfactory when households differ importantly in levels of feeding or management.
When animal recording is practiced for breed improvement, it is commonly desirable to be able to compare animals from different farms (or villages). The statistical methodology for such comparisons is well established, but the organisational requirements impose another level of complexity on the animal recording scheme. As the scope of the genetic comparisons increases, it becomes necessary to make genetic comparisons among animals in different contemporary groups. To accomplish this goal, there must be "genetic connections" among the groups; i.e., a structure of genetic relationships must be present to link the contemporary groups. One common way to establish these connections is through the use of the same sires in many herds, often through artificial insemination. The presence of offspring of the same sires in many contemporary groups serves to genetically link the groups and permits both direct comparisons of the linked sires as well as indirect comparisons of other animals that may appear in only one herd or flock. While use of common sires among herds and flocks is the clearest way to visualise creation of genetic linkages among contemporary groups, any mating system that leads to the presence of related animals has the same effect (provided the relationships are reasonably extensive) and is necessary for across-farm genetic evaluations.

5.5. The Prediction of Genetic Merit

Prediction of genetic merit, or breeding value, within the high-input production systems of the developing world has become a very sophisticated methodology. However, in planning animal recording schemes for breed improvement, it is important to realise that even within the developed nations, the recorded livestock population remains a relatively small proportion of the total. Thus while widespread application of animal recording is desirable for a number of reasons, in many cases the very detailed recording and genetic prediction procedures used for genetic improvement will involve only a segment of the total population. One goal of animal recording may thus be the organisation of that nucleus segment of farms. It should also be understood that useful prediction of genetic merit can be achieved using
a whole spectrum of prediction methods. The very sophisticated procedures of the developed nations are certainly attractive and are becoming increasingly accessible with improvements in computing capacity and reliability. However, relatively simple procedures may also be effective and more readily implemented across a wider range of production environments.

At its simplest, estimation of genetic merit involves the measurement and ranking within a single contemporary group of a set of candidates for selection. So long as the animals are contemporary and the same measurements are taken on all of them, ranking of the animals on performance corresponds to ranking them on expected genetic merit for that trait. Within the contemporary group, various types of simple adjustments to the data may be applied for things such as birth type, age of dam, or sex of animal for growth traits or for day of lactation in milk recording to potentially modify rankings and improve accuracy, but adjustments such as these do little to complicate the process of prediction of genetic merit.

More sophisticated methods for prediction of genetic merit come into play when:

- information is available on related animals;
- more than one performance trait is measured, or selection is to be based on some multiple-trait breeding objective, and all traits are not measured on all animals;
- animals have more than one observation for some traits, and the number of observations may differ among animals;
- animals appear in more than one contemporary group.

If observations are taken carefully and systematically, contemporary groups are properly formed, and appropriate genetic linkages exist among the contemporary groups, all of the above complications can be handled using available analytical methodology. Yet when one or more of these complications occur along with failures to rigorously maintain data collection protocols and animal identification, results can be
disastrous. Put simply, many forms of data structure and of missing data can be accommodated analytically within the context of a well-structured animal recording scheme, but advanced analytical methodologies cannot make up for flaws in the organisation of the scheme.

5.5.1. Use of information on relatives

Use of information on relatives is both an opportunity to increase accuracy of selection for traits that can be measured directly and an absolute necessity when selecting for sex-limited traits, for traits that are not expressed until late in life, or for traits that are only expressed in the presence of disease or other stressors. Thus selection of males for milk production, egg production, litter size, etc., must be based on records of related females. Likewise, selection of young stock for life-history characters (longevity, adult fertility, litter size, ease of calving) can only be achieved through use of records on adult relatives. In both these cases, the larger the number of available relatives’ records, the greater the accuracy of genetic evaluation.

Use of relatives’ records is effective only if accurate pedigrees are available to link individual animals with their ancestors and descendants. This implies control and recording of matings with good accuracy, which is often a serious problem in medium- to low-input production systems. At an absolute minimum, sire identification for lactating females used in milk recording and identification and access to dam records when selecting young stock for reproductive and life-history traits are required if selection is to be effective for these kind of traits. Without such information, one is limited to selection of young stock based only on indicator traits that can be observed directly early in life. However, it is generally much easier in practice to increase the genetic improvement realized by increasing the amount of selection, and dissemination to all farmers
of improved stock, than by increasing the accuracy of selection.

5.5.2. Measurement of multiple traits and selection for a multi-trait development objective

Single-trait selection is essentially never an appropriate strategy for improvement of net economic merit. This would certainly be the case in developing nations and in medium- to low-input production systems where a balance among productive, reproductive, and fitness traits must be maintained. Thus the development objective will always include multiple traits and the animal recording scheme must therefore accommodate measurement of more than one character on each animal. If all traits are measured on all animals, or if missing records occur strictly at random, traits can be analysed separately without biasing resulting predictions of breeding value. However, if the measured traits are intercorrelated or if selection is occurring (e.g., if the heaviest animals are sold whereas the rest are retained for another season and have weights recorded at other ages, or if some animals die of disease leaving only the survivors to complete a milk record), then use of multiple-trait breeding value predictions may be used to increase accuracy and may be necessary to avoid bias in genetic evaluations from selection.

Conduct of multiple-trait analyses require estimates of genetic associations among the traits. Estimation of these parameters is required for such analyses and may require a substantial initial database. Tables of average relationships among traits have been produced for a variety of trait combinations and species using reports from developed nations and generally high-input production systems, but these parameter estimates may not be directly applicable to low- to medium-input conditions in developing nations and often do not include the fitness and disease-related traits which may be important in these environments. However,
use of conservative initial estimates is generally satisfactory to initiate the system until sufficient information accumulates to permit derivation of estimates that are specific to the situation of interest.

5.5.3. Repeated records

Many performance measures may be repeated several times during the animal’s life. These would include information on lactation, fertility, litter size, fibre production, and egg production, among others. While each additional record is, in theory, a source of additional information and therefore greater accuracy in genetic evaluation, a number of significant pragmatic issues must be considered in deciding how to use repeated records. A number of established programs in the developed nations use only the first recorded expression of a character for genetic evaluation. Subsequent records may be used for animal management but are not used for genetic evaluation. Examples include use of first lactation records in dairy cows and yearling fleece data in fine-wool sheep. The reason for this approach is related to issues of contemporaneity: at the time of the initial record, animals are most likely to have experienced similar conditions during development and to be most nearly true contemporaries. After entering production, carryover effects of previous events in the animals’ productive lives become more important and complicate the formation of true contemporary groups. For example, a group of young cows may calve for the first time at similar ages, but as they become older, differences in fertility, duration of lactation, etc., will progressively spread out subsequent calving dates and introduce additional nongenetic variation. In ewes, adult fibre records are complicated by reproductive factors such as the number of lambs produced and suckled and the interval between lambings.

However, failure to use performance in adult females in genetic evaluation may create serious problems in the low-
to medium-input production systems of developing nations and cannot be recommended. This situation exists because the ability of animals to sustain appropriate levels of productivity over time in the face of an array of environmental stresses is an important component of economic merit in such systems. Young introduced stock, in particular, are often given enough preferential treatment during the early growth phase to initially perform at relatively high levels, but may not be subsequently maintained at levels that will permit sustained high production. Thus early production levels in low- to medium-input production systems may be less indicative of adult performance than is the case in high-input production systems. Yet the ability to sustain production is critically important in low- to medium-input systems where total reproductive rates are often modest and where high replacement rates due to low production of adult females are not acceptable. Thus use of repeated records on adult females in genetic evaluation should be encouraged, but will require careful modeling during analysis of data to assign animals to contemporary groups and to accurately portray the changes in performance that occur with age.

5.5.4. Evaluation of animals in different contemporary groups

As discussed previously, the ability to fairly compare the predicted genetic merit of animals in different contemporary groups depends on the presence of genetic connectedness among the contemporary groups, and the documentation of these genetic linkages requires knowledge of animal parentage. Thus the ability to identify relationships among animals is important for accurate genetic evaluation.

When comparisons are to be made between animals within different contemporary groups (e.g., birth years) but within the same herd, adequate genetic relationships to link the various groups will usually exist, provided they have been recorded and maintained. When comparisons are to be made
across different farms, however, a conscious effort to create and document relationships is usually required. The use of some of the same sires in the different herds is the most powerful method for creating these linkages. This can be done very effectively across large areas and large numbers of herds via artificial insemination (AI). When AI is not feasible, physical transfer or exchange of males for use with homebred sires is possible to create the linkages necessary to compare homebred sires to one another. In smallholder production systems, the same males can be used throughout a village, with periodic exchange of some of the males among villages. However, when natural service sires are used across farms or villages, care must be taken to avoid introduction or spread of disease. Genetic connections among farms can also be achieved through the use of related sires among herds, as when sons of the same group of sires are used across a set of herds. However, since the animals providing the genetic linkages are less closely related than they would be with use of common sires, larger numbers of connecting animals are required. Thus in setting up an animal recording scheme designed to permit comparisons of genetic merit across farms, the development of procedures to allow use of the same sires across the farms is an important consideration.

In larger herds and flocks, the decision to use single sire matings or artificial insemination to permit recording of parentage should not be entered into lightly, especially on extensive commercial farms and in stressful environments. The traditional use of multiple-sire breeding pastures in such situations generally yields higher levels of fertility than more restrictive breeding policies and, unless progeny of individual sires, either through natural matings or AI, are clearly more productive or more valuable as breeding stock, overall farm profits may suffer. In smallholder village production, however, use of AI by properly trained technicians may have little impact on female fertility. Still, as mentioned before, farmers that enter into the more detailed mating structures
and pedigree recording required for animal recording for genetic improvement must also have a mechanism to capture premium prices for breeding stock.