Goal-Led Livestock Recording Systems for Low To Medium Input Production Systems

G.E. Pollott

Wye College, University of London
Ashford, Kent, TN25 5AH, UK

1. Introduction

1.1 Background

The major objective of this paper is to outline the principles underlying good recording schemes and then to use this outline in a process aimed at developing guidelines for any new scheme, with particular emphasis on low to medium input systems.

Interestingly, considering the widespread use of recording in livestock work, there seems to be very little literature which can be used to address these questions. Key publications dealing with livestock recording are listed in the Bibliography. This paper, therefore, draws on a combination of the limited literature and other experiences of designing, running and evaluating livestock recording schemes in both developed and developing countries and involving livestock systems ranging from intensive to low-input.

Although this paper is primarily about the development of livestock recording schemes for low/medium-input livestock production systems it will be based on the set of principles which can be applied to any livestock system.

1.2 Recording in perspective

Livestock recording can be viewed as an imposition on the normal routine of the livestock farmer; it is an additional task which has a cost but at the same time may have an additional value. The ultimate question about any livestock recording scheme is therefore about the additional benefits to the livestock farmer in relation to the additional costs (i.e. is it worth doing). It follows that the rationale for any recording scheme is based on economic (in its widest sense to include monetary, social and cultural value) rather than technical decisions. This may seem an obvious and basic idea but few recording schemes are assessed in terms of their economics before they are designed and implemented. This is true whatever the type of

livestock recording scheme considered. It may be that the value of the recording process accrues to different players in the scheme, farmers, governments, merchants, added-value companies etc.

The two major determinants of a successful livestock recording scheme are two non-technical factors, these are the physical constraints of the livestock system being recorded and the financial returns likely from a given recording set-up. The physical constraints which determine if a recording scheme is likely to be successful include the accessibility of the animals when needed for recording, accessibility of the farm to recording agency staff, if the required infrastructure is in place etc. In intensive livestock recording schemes it is assumed that the pay-off for expensive according procedures makes the recording worthwhile. But even in this situation the recording of certain desirable characteristics may not be economical to the breeders concerned. One example of this can be found relating to the use of X-ray computed tomography and its ability to measure the live animal composition of species such as pigs and sheep and the limited use of this technique in commercial livestock breeding. The technique has been shown to be successful in improving genetic gains but its uptake has been extremely. Therefore any recording scheme is a compromise between what is desired and what is physically and financially possible. This is true whatever the species, system and likely level of inputs.

1.3 Classifying and implementing livestock recording schemes

There are a number of criteria that could be used to classify livestock recording schemes. These are listed in table 1. A number of these criteria will be developed later in the paper and used to discuss the characteristics of different schemes.

Table 1. Possible criteria for classifying livestock recording schemes.

Classifying criterion	Examples
Purpose for recording	Management decisions, genetic improvement
Production intensity	Intensive, extensive
Level of recording	One herd, all herds, males, particular progeny
Operating methods	Farmer recording, agency recording, research
Legal requirements	Statutory information, farmer's choice
Species or species subgroup	Cattle, beef, dairy, sheep, breed, herd
Level of integration with other activities	Extension, AI, veterinary input, policy development

It is a common belief amongst planners, managers and agencies that if livestock recording is required as part of a project (the word project is used throughout this paper in its broadest sense) then it will probably be possible to find an existing scheme and import it into the new situation. This belief has been supported by a number of companies/individuals who have developed livestock recording software and attempted to market it widely. However, there are a number of reasons why this has not turned out to be successful in practice. These include:

- Even within apparently similar livestock enterprises, different variables need to be recorded in different situations.
- The physical situation of the recorded enterprises.
- Infrastructure differences.
- Different cost structures.
- Reports are often required in different formats.
- Hardware/operating systems differ.
- Poor documentation of programs makes amendment difficult.
- Required analyses differ.

Even with the move towards a more common hardware and operating system world-wide (IBM-compatible PC and Microsoft Windows) these problems are still apparent and lead to very inefficient and costly development procedures. Even recording methods applicable to low-input systems, perhaps based on cards, record books and calculation sheets, have some of the same problems.

It is a major contention of this paper that recording schemes are not portable to any great extent, and that in any new situation a new scheme will need to be developed. Consequently the design of most schemes should start from first principles, which should allow for local variation in physical and human infrastructure, market conditions and, most importantly, objectives.

In order to overcome these problems this paper proposes that livestock recording should be approached in a logical manner, using a set of principles outlined in this paper and aimed at developing the necessary technical expertise to handle the recording scheme at local level ('local level' means at the most appropriate level for the individual scheme). This is a fundamental approach that is not always found in practice. It is also the reason why this paper is not prescriptive, in the sense of providing an easily applied set of recording schemes for every situation. Almost all aspects of any livestock recording scheme will be dependent on local factors and recording schemes must be designed to be appropriate for the situation in which it will be used. It is of little value to try to change the local circumstances to fit an imposed recording scheme.

As outlined above, recording schemes must be viewed in terms of their real benefit to the individual farmer, not the researcher, government official or commercial company. In fact most successful recording schemes are farmer-originated and arise from a perceived need at the farm level by those intimately concerned with the day-to-day running of the livestock enterprise. Many failed recording schemes are the result of an imposed system which had no net benefit to the farmer.

1.4 Products

The most commonly recorded species, world-wide, is probably the dairy cow and the most common product from it is milk. However, there is a much longer list of species farmed by the human race and the products from this list of species is numerous. Table 2 lists the major farmed livestock species and table 3 the major products from these animals (FAO, 1995).

Table 2. The major farmed species of livestock world-wide (FAO, 1995).

Mammalian species	Avian species
Buffalo	Chicken
Cattle (all *Bos* and *Bibos* species)	Domestic duck
Yak	Turkey
Goat	Muscovy duck
Sheep	Domestic goose
Pig	Guineafowl
Ass	Partridge
Horse	Pheasant
Dromedary	Quail
Bactrian camel	Pigeon
Alpaca	Cassowary
Llama	Emu
Guanaco	Nandu
Vicuna	Ostrich

Table 3. The major livestock products world-wide (FAO, 1995).

Meat	Milk
Wool	Hair
Skins	Pelts
Eggs	Dung
Traction	Wealth
Security	Cultural value
Blood	

In theory recording schemes can be applied to any species for any product and the objectives achieved. However, in practice this is rarely carried out. Considering the list of products above then organised schemes involving formal recording are found for only meat, milk, hair, skins, wool and eggs. This is because the cost of putting a scheme into operation is not recouped in many species/product combinations.

2.0 Types of livestock recording schemes

There is a wide variety of different types of recording schemes found in livestock production and its associated industries. Although this paper concentrates on those directly associated with the individual farmer, or group of farmers, a wider range of schemes that can be found within a livestock industry are listed, for completeness, in Table 4. Recording schemes fall into four main categories according to their purpose. These are categorised here as schemes relating to genetic resources, enterprise management, farming systems research, government policy and a miscellaneous set of other schemes.

This paper will concentrate on the first two categories, genetic resources and enterprise management, which are the schemes commonly operated at the farm level for the benefit of individual farmers. In the following section the requirements of a recording scheme to achieve a primary purpose will be described using a medium-input meat sheep system as the example, in order to illustrate what is required. The primary characteristics of all other species/purpose schemes for low and medium input systems will then be summarised in order to give an idea about the key aspects in which they differ.

2.1 Animal genetic resources recording systems

This type of recording is designed to define the breeding structure of a particular population at national level, although more local schemes may be required. They usually take the form of a survey and may cover one or several breeds, as the goal of the work dictates.

2.1.1 Breed/national population structure

Example 1

Although the Ministry of Agriculture, Fisheries and Food carries out an annual census of all farms in Britain there is no information collected on a regular basis of the size and distribution of sheep breeds and crosses. Information is available from breed societies about the number of registered sheep in each breed (for which there is a breed society) but this is not a true picture of the number of purebred sheep of each breed in the country.

In order to obtain a picture of the breeding structure of the sheep industry a postal survey has been conducted on three occasions (1971, 1987 and 1996). In these surveys a 10% random sample of all sheep farmers in Britain were sent a one-page form asking for details of their ewe and ram numbers, by age, and the mating pattern of their different breeds. The forms returned

were used to estimate the size and mating structure of the different breeds, in combination with census and other information from various sources (MLC, 1988 and as yet unpublished data).

Table 4. Types of recording schemes found in a livestock industry.

Genetic resources	Breed/national population structure Breed characterisation Population screening Pedigree information Genetic merit for performance
Enterprise Management	Phenotypic group performance, inventories etc. Resource use (Grazing use/Feed use) Farm management budgeting, accounts, costs, prices, margins Farm health records
Farming systems research	System comparisons Economic evaluations Baseline performance for production systems Market/abattoir/milk outlets prices, costs Breed comparisons Problem identification Indigenous knowledge systems
Government Policy	National/regional/local - value/economics/costs/returns/prices National/regional/local - census, inventories National/regional/local health schemes
Others	Veterinary practice records Product distribution companies records Wool company records Carcase classification/ other abattoir data Milk laboratory (Cell counts/ milk quality) Breeding stock production company AI/ET company Environmental impact assessments Indicators of sustainability

This is a relatively cheap way of obtaining information but depends on a number of factors which may not apply in all situations. These include a reliable postal service, the willingness and ability of farmers to answer and return the form, reliable mechanisms for cross-checking the data and estimating the complete population size. A more costly method for collecting the same type of information is by visiting a random, or structured sample of farms, and interviewing farmers. Whichever method is used a key criterion for success is to keep the number of questions to a minimum, commensurate with achieving the goals of the survey, and to make sure that the data summary and analysis system can cope with the data collected, within a sensible time span.

2.1.2. Breed characterisation

Breed characterisation usually takes the form descriptive and numeric information used to uniquely identify the characteristics of a given group (breed) of animals. Because phenotype is a product of genotype and its environment, it is essential to combine performance data with information on the production system under which the animals are kept. Apart from the value of the information as a breed description, it is more likely to be used for management purposes and breed substitution choices.

Example 2

Hill breeds of sheep in Britain are regularly sold from the mountainous areas, where they originate, to less harsh upland farms after 3 or 4 lambings. In their new environment these ewes may be kept for a further 3 or 4 lambings. Their lambing performance differs in the two different environments as shown by flock recording occurring under both sets of conditions. Such breed characterisation involves the measurement of key performance variables from a group of flocks over a number of years (Croston and Pollott, 1995).

2.1.3 Pedigree recording

Pedigree recording involves the recording of matings and birth events of individually identified animals in order to ascribe parentage to offspring. It is commonly used by breed societies but is also the basis for genetic improvement by selection. A number of different mating procedures can be used to ensure that the actual male mated to a female is known. This can involve group mating with one male, individual mating of each female with a known male or the use of artificial insemination with semen from a known source. Supervised births with correct mothering or individually penned females at birth is the second part of this process.

Example 3

Any breed society flock book is a useful example of pedigree recording output. e.g. Suffolk flock book.

2.1.4 Genetic value of performance traits

Recording the performance of individually identifiable animals in contemporary groups is the most common means of achieving genetic improvement. If at least one parent of each animal is known, and the known parent has several offspring, then the genetic evaluation of animals is possible. If no parental information is available then the use of this information is limited to screening a population for superior phenotypes, perhaps as the basis for building up a nucleus population from a variety of sources. This type of recording is usually carried out as part of a selection scheme to improve one or more traits in the selected population. Superior animals or their relatives are often used more widely in the population to improve production levels of the population at large.

Example 4

Several sheep recording schemes of this type operate world-wide. European schemes have been reviewed by Croston *et al.* (1980).

2.2 Enterprise management recording schemes

Livestock enterprises, like the farms on which they are kept, are an economic enterprise, just like any business. There are a number of features of the livestock enterprise that need to be recorded in order to help the business function more efficiently. Financial records are an obvious necessity in this respect. In addition certain key physical features of the enterprise should be recorded since they are crucial to the levels of performance necessary to achieve profitability.

2.2.1 Phenotypic group performance, inventories etc.

Keeping track of the number of animals in the herd and the changes that occur during the year is a fundamental requirement for good livestock management. The number of breeding females, the number of offspring born and reared and the number of animals dying are typical key variables in this type of recording scheme. In addition the collection of a certain amount of data on key physical performance traits can be of enormous benefit. The amount of milk produced, the time taken for a meat animal to achieve marketable weight, the weight of that animal at sale, the number of eggs produced per day or year are typical of the key variables that can be recorded and used as management information to improve the enterprise.

2.2.2 Resource use

Efficient and profitable livestock enterprises are based on the effective use of a large range of inputs which are turned into saleable livestock products. By monitoring the use of these inputs and using that information to improve their conversion to outputs farmers can increase their profitability and hence success. The major input in all livestock enterprises over which the farmer has control is livestock feed. This may take the form of grazed material, both sown and natural, forage, or purchased feed. Records of the quantities of feed purchased and fed to particular groups of animals are fundamental in this respect. In controlled grazing situations the use of

grassland by livestock, the number and type of livestock grazed, the length of time grazed and the use of fertiliser can be used to monitor grassland use. If forage is removed from such pastures then further records can help to monitor forage production.

In most livestock enterprises feed is the major proportion of variable costs. However the use of fixed assets such as labour and capital equipment can be important in some situations and so their use should be monitored in order to improve efficiency.

2.2.3 Financial records

In many livestock enterprises the amount of money moving in and out of the business is significant and the prices paid and received for inputs and products is crucial to profitability. Recording of certain key aspects of the financial side of the enterprise is therefore critical to good management.

Financial margins, income minus costs, are a basic measure of financial success in any business. Thus records of all costs associated with the enterprise are essential. These will include purchases of new animals, feed, medicines and the many small items needed to manage a livestock enterprise effectively. In the controlled grazing situation the cost of sowing and maintaining the pasture, fertiliser, fencing and any costs associated with forage production are required. The costs of all capital expenditure needs to be recorded and apportioned to the various livestock enterprises realistically. Comparable prices of inputs from alternate suppliers may be useful in order to manage bills more effectively in the future. The income received from the sale of products needs to be recorded.

The financial figures collected form the basis of the farm accounts which provide an overview of the profitability of the whole farm business. This is a necessity for the individual farmer in order to manage his business more effectively. In many cases these records are a legal requirement for tax and other governmental purposes.

2.2.4 Farm health records

The control of livestock diseases is crucial in all livestock enterprises. Records of the occurrence of disease and any treatments administered can be useful to take. In addition the use of prophylactic measures in the herd should be noted and used as a management aid. In some cases this may be a legal requirement and the incidence of certain diseases may need to be notified to particular government authorities.

3.0 Principles of goal-led livestock recording

The difficulties of transposing an existing recording scheme to a new situation have been discussed above. The designers of new schemes can learn much from schemes currently in operation but must create a more appropriate scheme for their own situation. There can be no general list of

what needs to be recorded or what mechanisms should be used in a new situation. In order to achieve an effective new recording scheme a checklist of principles may be of value. These are outlined below.

3.1 Livestock recording - a tool, not an end in itself

Although livestock recording schemes very soon become a major task in any project and take up a great deal of time and resources it is of prime importance to be constantly reminded that livestock recording is *not* the purpose of a project but just a means to an end. It is critical, therefore, that everybody concerned with a project involving recording are aware of this and are constantly reminded of it. Data is only being collected in order to service a more fundamental question about the livestock or system being recorded. If this view of livestock recording is encouraged in a project, then many of the problems found with recording schemes may be overcome.

3.2 Defining the objective/goal of the project

If livestock recording is viewed as a process rather than and end in itself it follows that the objective or goal of the project is concerned with questions other than how the livestock will be recorded. This is the most important aspect of any project, to keep the goal in sight. Once the goals have been clearly defined then any livestock recording process can be devised to meet those goals and considerations of cost-effectiveness and physical infrastructure then become important. Defining the goal is the most critical part of the process to get right at the outset.

It is crucial to involve all parties associated with the project at this early stage, including farmers, data collection agencies, extension agencies as well as those designing and operating the scheme. Ownership of the scheme is a key concept and involving all parties at this early stage will help in the planning process, orientate the scheme to what the client really needs, avoid costly changes later on and give all stakeholders the feel of controlling the project. This should include a clear understanding of the roles of the various parties in the project.

3.3 Steps to achieve the project's goal

Any project will require a number of tasks to be performed in order to meet its goals. Once the goals have been defined, the project can be broken down into these tasks. One or more of these tasks will involve livestock recording (in the context of this paper) and it will now be possible to focus in on those tasks and to devise an appropriate recording scheme.

3.4 The role of livestock recording in goal achievement

The major role of livestock recording is to provide information on which some form of management decision can be based. More specialised livestock recording may be required for research purposes where the main goal is to answer a question, test a hypothesis or characterise a particular

aspect of livestock production. Whichever is applicable, some form of data will be collected which will need to be analysed appropriately to provide answers to these more specific questions.

3.5 Collecting data to achieve goals

Collecting data for its own sake or the 'if-it-moves-record-it' syndrome is a common error in many recording schemes. If the project is focused on the questions that need to be answered, it then becomes easier to think in terms of the minimum amount of new information that needs to be collected in order to complete the steps in the tasks mentioned above. This is a vital attitude to develop when operating recording schemes. The temptation to 'just record these few extra variables because someone might be interested in them one day' is always great but rarely, if ever, turns out to result in useable information. Either no one ever gets round to using the 'extra' information or else if they do, then there is always another few variables that would have been useful to collect in order to achieve the objectives of the secondary project.

3.6 Planning the use of the data collected

It is a common facet of many research projects and livestock recording schemes, sometimes for valid reasons, to design the data analysis system after the data has been collected. This should be avoided if at all possible. Often the need for certain variables, or their superfluity, is only realised at the analysis stage. Designing the analysis system in advance will help focus the mind on what is really required at the recording stage. This step should also include designing the way in which the results are presented. Often reports are needed for farmers, sponsors or other clients and a good understanding of what they need, well in advance, will help to focus the scheme on the essential requirements of the data collection. Another important aspect of this stage of the planning process is to decide when reports are going to be required from the system. Working backwards from the results stage towards the data collection stage will help in the planning of the most costly part of the scheme, data collection.

3.7 Planning data collection

Once the objectives of the recording scheme are clear and how the data will be analysed and presented is understood, much of the groundwork will have been carried out. At this stage a clear idea of what actual aspects of the livestock enterprise need to be recorded should be possible and so the data collection procedures can be planned. Think about how the data will be collected and the implications of this process for all the players in the scheme. This should include a realistic estimate of the costs of the data collection process, which should be looked at in relation to the likely benefits. It is often worth reconsidering the goals of the project at this stage, in the light of the cost/benefit analysis carried out.

3.8 Resources for data collection

When planning the data collection processes it is essential to develop a realistic idea about the resources required. These include both the human and physical resources. In many situations the cost of both the human resource and the travel to farms is very high and is a critical factor in determining the cost-effectiveness of a project. Recording procedures need to be planned to optimise the costs in relation to the returns expected. This does not always mean developing low-cost procedures, if the benefits are great. Whilst it is common to find the costs of the recording agency accounted for, at this stage, the cost of the farmer's time is often overlooked.

3.9 Motivating the key players

Motivation of the key players and the maintenance of morale are often a forgotten but essential part of many livestock recording schemes. Many common problems that could arise later may be minimised by involving all participants as early as possible. Including all parties in the planning and development process is an essential element of this. Giving people a sense of the objectives of the recording process, and providing regular feedback on how the project is developing or what the results found so far show is an important aspect of keeping morale high and the continued success of the project.

3.10 Feedback and evaluation

Whilst it is often costly to change a scheme, once it is working, it is better to modify it to achieve the goals set than to persist with unrequired procedures. It is essential to plan and incorporate feedback mechanisms into the scheme.

3.11 Design the recording and analysis system

Critical features of any recording system are that it should be simple to use, relevant to goals of the project, it should contain the maximum amount of validation and cross-checking of data. The reports should be easy to understand, relevant to the user and provide the means to achieving the goals of the project.

3.12 Minimising errors

It is common to find errors occurring in recorded data due to poor recording procedures. Data errors can be minimised by reducing/eliminating copying of data, using computers at the point of data collection, using prelists of animals expected a certain events, checking data at source and many other simple but effective procedures.

3.13 Testing the system

The new recording system will need to be tested, perhaps as a pilot scheme, and any feedback incorporated into modifications ready for general use. Once again it is essential to involve as many of the players as possible in this process, both to engender ownership of the system and to develop an improved recording system.

3.14 Using the recording system

Once the system is prepared and in use it is essential to keep the system under review. Keep an open mind about modifying any stage of the system in the light of how it operates in practice. Build feedback mechanisms into the system and use them to maintain morale and interest of the stakeholders, as well as to develop the most cost-effective recording system.

4.0 Characteristics of genetic resource recording schemes

In the next two sections recording schemes will be classified according to primary purpose (genetic resources - Section 4; enterprise management - Section 5) and species/sub-species group. Cross-tabulation of these factors will be developed and an indication given in the tables of where similar characteristics of the recording schemes apply to a number of cells in the table. For each cell in the classification which has an entry the main issues relating to the recording schemes will be outlined.

Table 5. Sections containing comments by species and primary purpose for genetic resources recording in low and medium input systems.

Species/Product	*Population survey*	*Breed characterisation*	*Pedigree identification*	*Breeding value estimation*
Cattle/Buffaloes milk	Section 4.1	Section 4.2 and 4.4.1.2	Section 4.3	Section 4.4 and 4.4.1.2
Cattle/Buffaloes meat		Section 4.2 and 4.4.1.1		Section 4.4 and 4.4.1.1
Pigs		Section 4.2, 4.4.1.1 and 4.4.1.5		Section 4.4, 4.4.1.1 and 4.4.1.5
Poultry-meat		Section 4.2 and 4.4.1.1		Section 4.4 and 4.4.1.1
Poultry-eggs				
Sheep/Goats milk		Section 4.2 and 4.4.1.2		Section 4.4 and 4.4.1.2
Sheep/Goats meat		Section 4.2. and 4.4.1.1		Section 4.4 and 4.4.1.1
Sheep/Goats wool/hair		Section 4.2 and 4.4.1.4		Section 4.4 and 4.4.1.4

4.1 Population surveys

Rationale Farmers need to know where different breeds can be obtained.
Planners need to know what resources are present, where and in what quantities.
Geneticists need to be able to plan breed improvement in the most cost-effective way.
Conservationists need to know which breeds are in danger and where they are.

Although population surveys operate at the farm level they are of little direct benefit to the farmers being surveyed. This makes them more difficult to carry out because the co-operation of farmers is essential in order to collect the required information, and to ensure that the information collected is accurate.

4.1.1 Definition of a breed/cross

One of the key areas in breed population surveys is the definition of breed and cross types and the standardisation of nomenclature throughout the survey. Training of survey staff to use the same definition at all times is a very important aspect of such surveys. The question then arises as to how the definitions are arrived at in the first place. In some situations breed societies will define what is an acceptable description of their breed but it is more common to find a lack of documented breed/type definitions. In this instance it is important to build up a set of working definitions based on the farmers' own perceptions married with those of local veterinarians and extension workers. Care must be taken to note the many local variations of breed names just as the breed definitions must encompass any variation in breed characteristics.

Often it is crucial in these surveys to use the farmer's knowledge of the parents and grandparents of their stock in order to correctly assign breed\cross names to any given stock.

4.1.2 Definition of livestock types to be surveyed

Surveys commonly ask questions about the productive state, age or purpose of stock kept on individual farms and count stock in individual classes or groupings of classes. These need to clearly defined and verifiable at farm level, during the course of the survey. Only in certain specialised situations are stock kept for a single purpose, so various combinations of purposes should be allowed. Again local knowledge about the use and description of livestock is essential when defining groups which will be recorded

4.1.3 Sampling issues

Clearly the objective of population surveys is to find out the number and distribution of certain classes of animals in a given geographical location. Counting every animal will give the complete answer to whatever questions are posed for which the survey is carried out. However, this is always the most expensive option and so some form of sampling is commonly practised. The question arises about the size of sample used to estimate the complete picture and what should be the structure of the sample.

There are many texts written about sampling in surveys. The important points as far as livestock population surveys are concerned relate to the sampling from within meaningful groupings of farms and balancing this against the cost of gathering the information.

4.1.4 Timing of the survey

Animal populations are not static and so it becomes important to fix a time when these type of surveys are carried out. Ideally all records should be collected on the same day but this is usually impractical due to the constraints of manpower. Tying the survey to an event may be useful in some instances e.g. mating time in a seasonal breeding species. However, it is more likely to accept some variation in numbers from location to location as part of the sampling error of the survey.

4.1.5 Animals to be recorded

Surveys are basically about counting animals in certain categories so all animals selected for sampling should be recorded but according to the predefined categories, as discussed above. These categories usually comprise breeding females, breeding males, young offspring (sometimes by age group) and replacement breeding stock not yet mature enough to breed.

4.1.6 How the scheme is operated

Surveys of this type are usually one-off activities, even though they may be repeated at various time intervals. They are best co-ordinated centrally with any number of tiers of staff between the organisers and the farming population. Needless to say the fewer the tiers the better but a balance should be struck with local knowledge which is often invaluable in such surveys.

Data is checked locally but collated centrally, most likely with the aid of a specifically written computer programme. The size of the task is commonly underestimated and the manpower and computing requirements are often great. This type of survey is often of least direct value to the farmer and consequently results in poor feed-back mechanisms.

4.1.7 Integration with other activities

Surveys are often planned to be carried out by local veterinarians or technicians in conjunction with routine visits to farms, villages or dip tanks. This at first sight appears to be an advantage, particularly since the cost of travel is a large component of the cost of these surveys. However, there are a number of reasons why this may not be such a useful approach. These include the time required to complete the questionnaire may be incompatible with the other tasks, there may be a problem meeting the right people to help with the questionnaire, not all animals come to dip tanks and so some may be missed from the survey.

4.1.8 Variables recorded

Counts are the most common variables recorded in surveys.

4.2 Breed characterisation

Rationale. Farmers need to know the relative performance of their possible breed choices.
Farmers need to know how breeds perform under different conditions.
Planners need to know breed performance in different systems.
Conservationists need to distinguish one breed from another.

Breed characterisation is a descriptive process aimed at understanding what features of a breed make it different from other breeds of the same species. In this sense it is of little value to the individual farmer. However, where some choice between breeds is a possibility, at the farm level, then the information gathered as part of the breed characterisation process could be useful. As pointed out above, breeds need to characterised in all environments where they are found, since all animals are the result of their genotype as modified by their environment. In this case breed characterisation should always be carried out with some form of environmental or system characterisation, at the same time. This makes the characterisation process more complicated than it first appears and some form of rationalisation of the environments in which the breed is found is necessary.

Clearly, each farm on which the breed is found represents a different environment but it would be too expensive to record animals on them all. The grouping of farms on a climatic, agroecological zone or other relevant basis provides a starting point for a more realistic approach to characterisation. In many areas farmers operate similar systems of production and so geographical location may be a useful means for selecting farms. However, differences in the level of intensity of production, disease challenge and other management factors may require different sets of characterisation data for each situation.

Characterisation should cover both the visual appearance of the breed and key measures of performance, under the described environmental conditions. This makes breed characterisation a longer process than a single farm visit to inspect and describe the outward appearance of the animals in a breed. It will involve some form of measurement over time to record performance data and may require information on features of the breed which are not immediately obvious on inspection. These may include disease resistance, climatic stress tolerance, ability to cope with particular feeding regimes etc.

4.2.1 Animals to be recorded

All ages and both sexes of the breed being characterised need to be considered in the characterisation process.

4.2.2 How the scheme is operated

Since there is no direct payoff to the farmers of breed characterisation then funding must come from outside the farming system to support it. This inevitably leads to an agency of some type devising and running the scheme, using fieldstaff to collect the information.

4.2.3 Integration with other activities

The collection of breed characterisation data may be carried out in conjunction with some of the enterprise management and genetic evaluation schemes described in other sections of this paper.

4.2.4 Variables recorded

Any and every feature of the breed which distinguishes it from other breeds of a similar type need to be recorded. These include external measurements of body dimensions, descriptions of colour, shape, coat characteristics, horns, humps etc. In addition performance data will need to be collected for the main traits of importance for the breed. This will vary by the types of products for which the breed is kept and is similar to the list described in Section 4.4.1.

4.2.5 System and environment characterisation

The importance of recording the characteristics of the environment and production system under which the breed characteristics are recorded cannot be stressed enough. No genotype exists outside a physical environment and the expression of any genotype, in the form of a living animal, can only occur within a particular set of climatic, geographical, nutritional, managemental and health conditions. These factors are the major aspects which should be used to characterise the physical environment in which the animals perform. It is impractical to carry out valid trials in all possible environments with all possible breeds to determine which factors affect performance significantly, and hence determine under what different combination of factors any given breed should be characterised. The more usual approach is to record animal performance within the environments in which they are found and then to consider the range of important physical factors which affect the animal's performance. In many situations there is a gradual change in a particular factor e.g. altitude, rainfall, and so some arbitrary division between environments will need to be defined in order to arrive a workable definition of a 'different' environment. In other situations differences are clear cut. The presence or absence of a disease vector is clearly identifiable and so make defining environments easier.

4.3 Pedigree identification

Rationale. Farmers can have some faith in genetically transmitted characteristics from specific parents.
Farmers know that the package of genes described as a breed remain together.
Farmers can avoid inbreeding problems.
Geneticists have the means to estimate breeding values of relatives .

Pedigree is an essential part of several aspects of genetic resource work and is designed to provide a way of knowing the parentage of a particular animal, and hence to trace its line of descent or lineage. This may be used to mate animals from certain families with known or perceived characteristics, to avoid increasing inbreeding too rapidly or as a basis for the genetic evaluation of individual animals. Often this type of recording is operated by a breed society who use it to maintain breed type, if used in conjunction with some elementary form of breed characterisation. In modern breed societies pedigree identification is secondary to performance characteristics of the animals in the breed.

Animal identification systems are crucial to pedigree and performance recording schemes. A system of unique, easily read and foolproof identification is required e.g. ear tags, branding, tattoos, electronic tagging, are just a few of the possible systems in place.

4.3.1 Animals to be recorded

In its basic form pedigree recording is concerned with the identification of the sire and dam of a particular individual. Thus matings need to be identifiable and birth events traceable back to a particular mother. In addition some form of individual animal identification is necessary (see Section 6).

4.3.2 How the scheme is operated

In most cases it is up to the individual farmer to arrange the management of his/her herd in order to be unequivocal about the parentage of any offspring. In certain rare circumstances this may be backed-up by other methods, such as DNA 'fingerprinting', or blood tests based on other criteria. When AI is used then an AI technician may provide evidence of a particular mating, particularly since the technician should have details of the male who's semen is being used. Either the farmer may maintain his/her own pedigree register, or it is quite common to find breed societies operating a herdbook system.

4.3.3 Integration with other activities

Pedigree recording is often associated with performance recording for genetic evaluation purposes, and the use of AI. Recording of the birth events are often part of the farming routine and so the mothering of the offspring is often controlled.

4.3.4 Variables recorded

Identities of the sire, dam and offspring are the usual variables recorded.

Rationale. Farmers can choose parents of the next generation on an objective basis.
Farmers can improve the physical performance of their herds.
Breeding companies can sell animals with predictable performance.

4.4 Breeding value estimation

4.4.1 Trait-specific recording issues in genetic value schemes

The traits recorded as part of schemes designed to estimate genetic value can be categorised generally across species. In these types of schemes the recorded traits may be the traits trying to be improved or they may be linked to other traits which cannot be measured directly. In the same way traits may be measured on relatives of the animals under selection. Only the particular features of the various species will mean that some traits are treated differently in the different species. This section describes the different traits and aspects of them which are common to all species.

4.4.1.1 Meat

In animals kept for meat production the traits of major concern are linked to growth, carcase composition, conformation and meat quality. Growth is commonly measured as liveweight at a given age, or series of ages, or the difference between two or more weights and expressed as weight gain per day. These measurements are relatively easy to take provided that an appropriate weighing scale is available. Weighing large animals in remote areas tends to be difficult. This has been overcome by use of a tape measure with a graduated weight scale on it. However, the relationship between heart girth (the commonly used dimension to estimate weight with this tape measure) and weight may vary from one breed to another.

Interest in the composition of the live animal, and hence its potential carcase, and a desire to select fast-growing animal which lay down lean rather than fat has resulted in measurements on the live animal which may be linked to carcase characteristics. These include various estimates of fat and lean on the live animal taken with relatively sophisticated equipment (ultrasound, x-ray computed tomography, velocity of sound etc.) or as visual/externally assessed scores. The measurement of conformation is a variation on this since it is believed that animal shape can be related to composition.

Carcase characteristics may be recorded on a sample of related sacrifice animals. These could include carcase weight, joint weight, lean/fat/bone content of sides or joints, fat/muscle depths, meat colour, visually assessed scores for fat and conformation and measures of meat quality assessed on cooked samples by trained or consumer taste panels. Aspects of meat quality such as colour, drip loss and toughness may be recorded under laboratory conditions.

4.4.1.2 Milk

The most commonly measured characteristic of animals kept for milk production is lactation yield, or some component of it which is highly correlated to total yield. This is commonly achieved by taking periodic daily measurements of milk and multiplying them up to estimate total lactation yield. More recent developments have been aimed at using test-day yields rather than estimated total lactation yield as the trait of interest. Suckling of milk by the young adds a complicating factor to the use of milk yield. Measurement of milk consumed directly by the young is impossible to record accurately under farm conditions, hence in most species where this is common milk records during suckling are disregarded in milk yield calculations. However, in many dual-purpose situations, where the young suckle for large proportions of the lactation, there exists a very unsatisfactory situation with respect to accurate milk yield recording. The influence of the farmer, through his/her management decisions on length of time the young is allowed to suckle can cause very inaccurate and even misleading estimates of milk yield to be made. One further complication in milk yield recording is the variation in milk-letdown to milking between different breeds and crosses.

Interest in the nutritive value of milk has resulted in milk composition becoming an important aspect of dairy animals. Fat and protein yield and/or proportion may be recorded from a sample from individual lactating animals under laboratory conditions. Characteristics of the animal under milking conditions such as milking speed and milk letdown are other factors considered important in some recording schemes. Traits correlated with manufacturing quality of the milk are also traits of interest in some recording schemes.

In many dairy industries the use of AI is widespread and so the genetic merit of males is of vital importance. Since milk recording can only occur in females a males will commonly be evaluated in terms of his daughters' performance. This is a more reliable estimate of his breeding value for a number of reasons; daughters are often more numerous than other female relatives, daughters actually express half the genes carried by the male (on average) and daughters are more likely to be evaluated under a wide range of farm conditions, providing a better estimate of breeding value.

Because of the importance of milk in many societies, the range of products made from milk and the almost instant financial returns from the sale of milk, a considerable number of sophisticated milk recording schemes are found. However, these are usually associated with easy access to markets for milk, sizeable herds and high yielding animals which can benefit from the sale or use of high value males.

4.4.1.3 Eggs

In poultry species kept for egg production, several measures can be recorded to provide useful information on which to base management or genetic decisions. The number of eggs laid in a given time period or the

frequency of lay are common measures of performance. Where eggs are sold by a particular payment system then size, measured or graded, or weight may be important characteristics to record. Measurements of egg quality may include shell colour, blood spots, yolk and albumen characteristics depending on the market or selection criteria being used.

One of the critical aspects of egg poultry recording is the matching of the egg with the bird that laid it. A number of systems have been devised to accomplish this, including the use of individual cages to house the birds or the use of trap nests. Under low-input systems this is not so easily achieved since control of laying may be non-existent.

4.4.1.4 Wool/hair/ pelts/skins

One of the most important aspects to record on animals kept for wool is the quantity of wool harvested. This usually measured as a weight but the size of skins and pelts may be of importance. Since skins and pelts are only available from the dead animal then close relatives may be recorded to provide information on animals kept for breeding. Several quality features of wool/hair may be of importance to record. These include fibre diameter, fibre type, crimp characteristics and staple length. Various systems have been developed to described fibre diameter, or its associated qualities, to circumvent the more time consuming and costly measurements required to give precise measures of quality.

In many respects wool improvement by genetic selection is one of the most readily achievable goals in livestock breeding. Often traits are highly heritable, readily measured on all individuals in the population and genetic gins per year can be high. However, these factors may be offset by poor market prices for the product on a fluctuating world market, with competition from man-made alternatives. In many industries breeding schemes for wool are limited to males only or even non-existent.

4.4.1.5 Reproductive performance

In all recorded farm animals various measures of reproductive performance are important. The most common measure is the number of offspring born/birth event, often referred to as litter size. In species with very low litter size then the frequency of births may be a more important measure of reproductive performance. The incidence of barrenness and other reproductive disorders can be important in some situations. Components of the breeding interval such as birth to weaning interval or birth to rebreeding interval may be of more interest in these situations. If this is so then the recording of event dates becomes important. A further useful measure may be the length of reproductive life and the occurrence of any reproductive disorders.

In males semen characteristics such as motility, viability rate and volume could be important traits.

Reproductive characters are generally found to have a low heritability, so genetic improvement is often ignored. However in several species some families are more prolific than other, major genes for ovulation rate have been identified and the phenotypic variance is high enough to offset low levels of additive genetic variance in selection schemes.

4.4.1.6 Health traits

All livestock are susceptible to diseases. Some record of which diseases and conditions an animal is susceptible to is important. The traits measures may be of an all-or-none nature (e.g. susceptible or not) or may be more continuous (level of resistance). The advances being made in molecular genetics are likely to have the greatest effect in the short term on animals with identifiable disease resistance genes.

4.4.1.7 Functional/ Type traits

A number of traits relating to the shape of form of the animal are recorded in some species. These may relate to movement, shape or posture or be associated with longevity, productive lifespan or other non-quantifiable but important characteristics.

4.4.2 Contemporary groups, population size and structure

The recording of livestock in order to estimate the genetic value of individuals always requires that the measured animals are kept in contemporary groups. These groups should be large enough to give an accuracy to the genetic value estimate which is commensurate with the use to which it will be put. Issues of group size and genetic linkage are more related to the genetics of the traits measured than any particular aspect of recording. It is not possible to estimate genetic values in situations where contemporary group sizes are small (say <3), where knowledge of at least one parent is lacking or where parental groups are small. Under such circumstances it may be possible to identify animals with good phenotypic performance and use them as the basis for a nucleus breeding scheme.

There are a number of techniques that can be used to improve a population with a poor structure in order to make recording and genetic evaluation worthwhile. These include the use of AI, village bulls (or other species as appropriate), ram circles, nucleus breeding schemes and sire-referencing schemes.

4.4.3 How the scheme is operated

The nature of selection schemes for genetic improvement means that the recording effort has to be co-ordinated and sustained over a long period of time in order to show any appreciable results, if at all. There are many examples where this has been done on an individual herd basis but the economies of scale are particularly advantageous in these types of schemes. Consequently it is common to find an agency, of some description, operating the recording process on behalf of participating farmers. This

agency will not only provide recording services but also carry out genetic evaluations, or link with another organisation with the necessary means to do them.

4.5 Level of inputs and genetic resources recording schemes

No mention has been made in this section about the effect of the level of inputs on the way in which genetic resource recording schemes are run. This is because these schemes are neutral to the level of inputs applied or the level of intensity of the livestock enterprise. Many factors have already been mentioned as having an effect on the way schemes are run, particularly the physical and economic circumstances within which the various schemes operate. For example, the reasons why very few genetic selection schemes are found in small-holder livestock enterprises are often related to factors such as herd size, accessibility, costs of the scheme, etc. rather than the level of inputs, which in many cases run at a relatively high level.

5.0 Characteristics of enterprise management recording schemes

Table 6. Sections containing comments by species and primary purpose for enterprise management recording in low and medium input systems.

Species/Product	*Physical performance*	*Resource use*	*Financial records*
Cattle/Buffaloes - milk	Section5.1 and 5.1.1	Section 5.2	Section 5.3
Cattle/Buffaloes - meat	Section 5.1, 5.1.2 and 5.1.3		
Pigs	Section 5.1 and 5.1.3		
Poultry - meat	Section 5.1 and 5.1.3		
Poultry - eggs	Section 5.1 and 5.1.4		
Sheep/Goats - milk	Section 5.1 and 5.1.1		
Sheep/Goats - meat	Section 5.1 and 5.1.2		
Sheep/Goats - wool/hair	Section 5.1 and 5.1.5		

The main purpose of enterprise recording schemes is to provide the farmer with information which can be of used to make the farm business run more efficiently. Since farming enterprises are heavily dependent on many biological processes, their utilisation and manipulation, then much enterprise recording depends on the recording of appropriate biological

aspects of the enterprise. In many ways this is similar to recording for genetic value estimation, described in Section 4.4. However, in the case of enterprise recording the level of recording is often less detailed and a greater variety of factors are recorded about the enterprise. This is a result of the fact that in any given livestock system the benefit:cost ratio for enterprise recording schemes is likely to be lower than for schemes designed to estimate genetic value. In addition, once a basic set of enterprise recording schemes is in place then the marginal value of extra variables recorded is very low.

In most cases the primary recording operations are carried out by the farmer with specialist techniques only being used where laboratory, veterinary or abattoir information is either cost effective and/or a statutory requirement. Advisors may collect the information from the farmer and add value to it by further processing, but this adds a considerable cost element to the recording system. This cost may be borne by any of several players; the farmer, the advisory organisation, veterinary practices, different levels of government, and commercial companies being the most likely.

The use of sophisticated recording techniques, such as computers, is less of a necessity than for genetic resource recording schemes, can help to make the recording more useful. A well organised paper record system can be just as useful and probably more cost effective.

5.1 Physical performance recording

Rationale. Farmers need to know how well the biological features of their livestock are working.
Farmers and advisors can compare their current groups with previous groups.
Farmers and advisors can compare herds on different farms.
Farmers and advisors can set realistic targets for new groups of animals to achieve.
Planners can estimate expected output at regional or national level

Physical performance recording schemes are usually designed to provide details about the main biological aspects of an enterprise which influence profitability. This will vary according to the type of livestock product which is important in any given enterprise. Although the value of any individual animal may be high in some types of enterprises, e.g. large ruminants, this is not so for all species. However, the recording of individual animal's performance in this type of recording scheme is partly dependent on its own value but also on the value of the output and the likelihood of a high benefit:cost ratio from recording. Thus the recording of an individually identified dairy cow's milking performance is more likely to be carried out than the recording of an individual identified sheep's wool production.

The most basic set of records will be summaries of contemporary group performance for certain key variables, depending on the species and type of product being produced. This may take the form of counts of numbers of animals produced, eggs produced etc. or may be based on measured variables such as the average milk per cow, wool per sheep, liveweight per bird sold etc. The exact type of record kept will vary by species, product, location-specific factors and likely benefit:cost ratio of recording. Basic to all enterprises are records of the number of animals present and the number of productive animals at key events e.g. birth, weaning, sale etc.

In this section individual animal recording refers to data collected on individually identified animals which is recorded against that animals identity for management purposes. Clearly many animals are individually measured but the data produced may only be used to produce group\herd statistics.

5.1.1 Females kept for milk production

In most situations milk is a high value product and is produced in relatively large quantities, compared to other products from the same species. It is, therefore, essential to be able to identify the animals which are under-performing and replace them with new animals which are likely to be better producers. Hence, in bovine herds some form of individual cow recording is common. In other species this may be less common. Estimates of lactation yield are basic in this situation with information on milk quality being important only in very special circumstances (e.g. where differential payments based on milk quality are high). Lactation length is a key feature of lactation yield in most circumstances and species.

Reproductive performance is a crucial aspect of dairy systems since the proportion of time that females are in-milk will be a key determinant of profitability. Thus the interval between births and its components (weaning to first service; first to successful service etc.) are important variables in many situations.

5.1.2 Females kept to breed meat animals

Individual animal performance recording is less detailed in this situation, compared to milk animals, with the most crucial measure needed on individual animals being litter size, barrenness and rearing ability. Contemporary group counts and basic performance measures are the most likely variables to be recorded. Counts are best expressed on a meaningful basis (e.g. number of lambs reared per ewe mated, piglets born per/sow/year). Performance measures may take a similar form (e.g. weight of calf weaned per cow).

5.1.3 Meat animals

Individual animal performance recording is unlikely for meat producing animals. However, data on growth (liveweight difference over a given time period), shape and carcase characteristics are often of value. Hence variables such as weight for age, average carcase weight, time taken to reach marketable condition are typical variables recorded.

5.1.4 Egg production

Counts of eggs produced and aspects of egg quality, including weight\size, are commonly recorded aspects of egg producing enterprises. Summaries of such data by on a per bird or per house basis are basic requirements of such poultry enterprises.

5.1.5 Wool production

The weight of wool produced and the quantity produce in different quality categories provide the basic measures required for wool producing enterprises. These are commonly expressed on a per animal shorn basis to enable useful comparisons.

5.2 Resource use recording

Rationale. Farmers need to manage natural resources in a sustainable and efficient manner.
Farmers need to know how well their stock are performing using key inputs.
Farmers and advisors can use measures of resource use to improve performance.
Planners need to know levels of resource use and input/output relationships.

In low to medium input systems the level of inputs is, by definition, is less than in intensive systems. However, the efficient use of inputs is still crucial and will affect profitability. In addition such systems will use a number of natural resources, which will need to be managed in a sustainable manner. Recording of these resources is, therefore, important.

5.2.1 Aspects to be recorded

The major resources used by livestock farmers are land and feed (including water) with labour and capital being of importance. Land is related to feed in the sense that most land is used as a source of feed, in the form of grazed material or forage.

Purchased feed (or feed transferred to the livestock from another enterprise on the farm) is often the most straightforward to record. This will take the form of the quantities of feed purchased and then fed to particular groups of animals. Simple summaries of the amount of food fed per animal are basic to this type of recording. Further details relating to the chemical composition of the feeds may be of value if suitable laboratories are available and rationing systems are a practical and cost effective proposition.

5.2.2 Grazing

The monitoring of grassland production and grazing use has a key part to play in many livestock production situations. Simple recording of grassland area, numbers of different stock types grazing the grass and the length of time grazed can be used to estimate a variety of measures of grassland output. These can then be used by farmers and advisors to improve grazing management and improve resource use.

5.3 Financial

Rationale. Farmers need to know if their enterprise is profitable.
Advisors can use financial data to help improve economic performance.
Planners need to know the economics of alternative livestock systems.
Tax authorities need to know farmers incomes.

Financial recording is a subject in its own right, often being dealt with by accountants and auditors. However the simple use of financial records can aid livestock production considerably. Records collected include the cost of all inputs and the value received for all outputs, which can then be used to compute gross and net margins, either on a per animal basis or, where land is a limiting factor, on a per hectare basis.

6.0 Concluding remarks

Livestock recording is a complex subject with many different facets, depending on the species and type of recording necessary. Key determinants of the efficacy of any system are the physical situation of the enterprise to be recorded and the likely cost:benefit ratio to the farmer. Questions about the detail of what a particular scheme should consist of depend more on local factors than a set of global blueprints. A series of steps have been outlined which should help planners and scheme designers arrive at viable livestock recording schemes.

7.0 References

Croston, D. & Pollott, G. E. 1995. Planned sheep production, Blackwells, Oxford, UK.

Croston, D. Danell, O., Elsen, J.M., Flamant, J. C., Hanrahan, J. P., Jakubec, V., Nitter, G. & Trodhal, S. 1980. A review of sheep recording and evaluation of breeding animals in European countries: a group report. Livestock Production Science, 7: 373-392.

FAO 1992. Collecting data on livestock. FAO Statistical Development Series, No. 4. FAO, Rome, Italy.

FAO 1995. World watch list for domestic animal diversity. 2nd edition. FAO, Rome, Italy.

Hughes, J.G. 1976. Short-term variation in animal liveweight and reduction of its effect on weighing. Animal Breeding Abstracts, 44: 111-118.

MLC 1988. Sheep in Britain. MLC, Bletchley, UK.

Owen, J. B. 1971. Performance recording in sheep. Commonwealth Agricultural Bureaux, Slough, U.K.

Ponzoni, R. W. 1992. Genetic improvement of hair sheep in the tropics. FAO Animal Health and Production Paper No. 101, FAO, Rome, Italy.

Uljee, B. & Rennie, N. 1990. Livestock recording for sheep and beef. MAF Tech, New Zealand.