ISSN 1563-3004
ISBN 92-95014-42-3

ICAR TECHNICAL SERIES NO.6

BEEF RECORDING GUIDELINES: A SYNTHESIS OF AN ICAR SURVEY

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JULY 2001

Cover page: 17th century engraving by Pieter Jacobsz van Laer of Haarlem, dit Bamboccio, (1599-1642), representing a livestock farm in the Latium region of Italy

Title of the Series: ICAR Technical Series

Title of the Volume: Beef recording guidelines: a synthesis of an ICAR survey

Editors: H. Simianer, H. Täubert & K. Küttner

Publisher: ICAR, Villa del Ragno, Via Nomentana 134, 00162 Rome, Italy

Responsible for ICAR Technical Series: Cesare Mosconi

ISSN: 1563-2504

ISBN: 92-95014-02-2

In the same series:

- K.R. Trivedi (Ed.), International Workshop on Animal Recording for Smallholders in Developing Countries, Anand (India) 20-23 October 1997. I.T.S. no. 1.
- T. Vares, M. Zjalic & C. Mosconi (Eds), Cattle Identification and Milk Recording in Central and Eastern European Countries, Warsaw (Poland), 23 August, 1998. I.T.S. no. 2.
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- B. Moioli, J. Mäki-Hokkonen, S. Galal & M. Zjalic (Eds), Animal Recording for Improved Breeding and Management Strategies for Buffaloes, Bled (Slovenia) 16-17 May 2000. I.T.S. no. 4.
- T. Vares, F. Habe, M. Klopcic & D. Kompan (Eds),The Role of Breeders' Organisations and State in Animal Identification and Recording in CEE Countries, Bled, Slovenia, 15 May 2000. I.T.S. no. 5

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The International Committee for Animal Recording (ICAR) wishes to express its appreciation to the *Ministero per le Politiche Agricole e Forestali* and to the *Associazione Italiana Allevatori* for their valuable support of its activities.

ICAR would like to express its appreciation to the National Organisations who participated to this survey

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July 2001

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Preface

The present study would not have been possible without the help and financial support of following organisations:

	Animal Genetics and Breeding Unit Agricultural Business Research Institute	Australia
	Zentrale Arbeitsgemeinschaft Österreichischer Rinderzüchter	Austria
	Ministère des Classes Moyennes et de l'Agriculture	Belgium
	Landbrugets Rådgivningscenter	Denmark
	Institut de l'Élévage	France
	Arbeitsgemeinschaft Deutscher Rinderzüchter e.V.	Germany
	Irish Cattle Breeding Federation Society Ltd.	Ireland
	Associazione Italiana Allevatori	Italy
	Fédération des Herdbooks Luxembourgeois	Luxemburg
	Agricultural Research Council	South Africa
	Arbeitsgemeinschaft Schweizerischer Rinderzüchter	Switzerland
	Koninklijk Nederlands Rundvee Syndicaat	The Netherlands
	Meat and Livestock Commission	United Kingdom
	Beef Improvement Federation	USA

I want to express my deep gratitude to all of the above mentioned sponsors for the generous contributions they made to set this project into practice. The study was initiated for the following reasons: in milk recording the impact of standard setting by ICAR is clear and follows 50 years of history and experience.

In beef recording the relevant national guidelines and rules of the recent decades have been developed independently from ICAR, as ICAR did not cover this field of activities when the appropriate guidelines were created, and so no regular international exchange of beef data occurs at present.

In 1990 ICAR expanded its activities to any kind of animal recording in ruminants and established at that time a working group for beef recording. However, when the ICAR Beef Group started to compile some initial guidelines, an inherent problem quickly became apparent: in order to avoid, where possible, recommendations which might be contradictory to existing national schemes, the ICAR guidelines could only be a rough framework with a substantial lack of detail.

For this reason the ICAR beef group guidelines could not be used as a comprehensive and detailed instruction manual, which would be necessary for practical field application. The consequent risk is that organisations and individuals interested in beef recording would not take ICAR beef guidelines into consideration when they develop their procedures, and undoubtedly further diversification of locally applied beef recording schemes would occur.

The only approach to overcome this risk was to look at all the current national guidelines and to draw a synthesis from them which would provide both, broad acceptance by national users as well as clear and detailed contents. Hence the study reported here was commissioned by the ICAR Beef Group.

The project was executed by Dr. Henner Simianer, Head of Applied Genetics Network, Germany. In my opinion the ambitious objective of the study was fully achieved and I want, therefore, to particularly thank Dr. Simianer with his collaborators Dr. Helge Täubert and Dr. Karola Küttner for their careful and comprehensive work.

The key for the present study was a 56 page questionnaire sent to 48 countries. Although it would have been time and labour intensive to work through it, responses were received from 29 major beef breeding countries. The response has certainly exceeded our expectations. I would like to take this time to personally thank all countries, organisations and persons involved who spared the time and made the effort to provide all the figures and replies requested.

Much helpful advice and support also came from the ICAR President Dr. Joseph Crettenand, Switzerland and from the ICAR Office with Dr. Jean Boyazoglu and Mrs. Elena Couto, Italy. A very special thanks to them.

Last but not least I would like to thank my colleagues from the ICAR Beef Group for their valuable und untiring advice and help.

Hans J. Schild
Chairman of the ICAR
Beef Performance Working Group

1. Introduction

This study was commissioned by the ICAR beef recording working group to define a basis for the development of new international guidelines for beef recording to be included in the ICAR set of recording guidelines. The whole project is based on a survey which collected information on national and internationally applicable guidelines of differing compulsory nature.

Based on the outcome of the survey recommendations will be made, which will form the basis of an updated ICAR beef recording guideline. The detailed formulation of this guideline remains the responsibility of the ICAR beef group, though. The main operational function of this new guideline is to set the stage for joint international genetic evaluations for beef performance traits, based on raw data and covering all relevant aspects of beef cattle production.

The primary goal of the ICAR survey of beef recording guidelines was to get an overview of the actual (year 2000) state of beef cattle data recording and processing in the major beef production countries of the world. An extensive questionnaire was sent out to 48 different countries, of which 29 responded and 19 returned at least one completed questionnaire. In total, 36 completed questionnaires were received and analysed (see table A1 in the appendix). The outcome of the survey has been to create a data base which is accessible through the internet (http://pc-howarth.une.edu.au/icar.html). Tables summarizing the most important issues of the survey are given in the appendix of this report.

Based on this survey, a synthesis had to be compiled, which should form a base for the development of new international guidelines. Obviously, there are a number of difficulties associated with this task:

- The global survey covers a variety of different production systems;
- Very different types of organisation of beef production (private, commercial, herdbook, marketing organisations, etc.) are included;
- Breeding and genetic improvement (for which uniform data recordings are most important) is not a central aspect of many of the production systems considered;
- The survey focused only on guidelines affecting beef recording practices. In many cases, guidelines will only cover parts of the relevant process, or beef breeding practice may even differ from the respective guidelines;
- In many cases, similar traits were recorded, but in virtually as many (technical) ways as there were countries returning completed questionnaires.

These and other arguments make it difficult, to derive general recommendations from the outcome of the survey, but make it necessary to weigh and interpret these results. Based on this somewhat subjective approach, recommended standards may in some cases not be supported by the ‘majority’ of countries participating in the survey.

In this report, a short summary of the survey results is given at the start of each section with recommendations for the different trait complexes. For more detailed information, the reader is refered to the tables in the appendix of this report and to the mentioned data base.

In general, an international guideline should fulfill two main purposes:

- It should define a minimum set of recorded data that are essential for an exchange of data across borders, both for trading and breeding purposes (e.g. international breeding value estimations). This set has to be limited to the most important trait complexes and indispensable (essential) data (like animal identification etc). The respective data should be recorded according to a common standard, which includes the exact definition of the traits, the way of recording them, the type and format of the data to store etc. All countries wishing to participate in this type of international exchange of animals should be encouraged to comply with this standard and to provide the respective data in the suggested form.
- It should list additional traits or recordings, which though not essential, are in many cases useful for the international exchange of beef animals. Often, these traits are considered to be necessary in national or breed specific breeding programs or for management purposes. This includes traits which are only relevant in certain production systems and / or for certain breeds. For this class of additional traits, recommendations are given on how they should be defined and recorded. If a country or a breeding program decides to record such a trait, it is strongly advised to do this in a form which is compatible with the suggested standard. Only in this case will it be possible to exchange data internationally on this set of additional traits.

In principle, data recording should provide the basis for an objective assessment of the characteristics of an animal, but it should be neutral when it comes to ranking animals according to their economic or genetic ‘quality’ or ‘value’ . In the context of international breeding value evaluations, different countries may have different ideas of ‘good’ and ‘bad’ with respect to quality of beef or beef animals. A good example may be the German and US type of beef meat quality standard, where the top ranked product in one would be difficult to sell in the other.

Many of the national guidelines being reported in the survey have been in use for a long time and / or are very difficult to change (as e.g. laws). Therefore, it is probably unrealistic to expect, that all of the suggested standards will be adopted by all the ICAR members immediately. Nevertheless, such a guideline with widely agreed common standards should be a motivation for countries to develop actual guidelines (or recording practices) in the defined direction, which will lead, in the long run, to a set of internationally implemented data standards.

In the survey, many countries have not reacted at all or have answered, that no guidelines are existing. A number of mostly Eastern European countries are in the process of developing new guidelines. For those countries, an international guideline will be most useful since they will have the opportunity to adopt all the suggested standards in their national guidelines, thus allowing their participation in the international exchange of breeding and production animals and the corresponding performance data immediately.

2. Principles of data recording

There are some basic principles that guidelines and recording practice should conform to in order to facilitate efficient recording, storage, use and exchange of animal performance data. These principles require for example that each animal should have a unique and permanent identification which is the key to all its data, that recording and storage of data should be as efficient as possible, and that animal-related recordings should follow a standard format etc.

Due to the 'grown' or evolving structures of animal data recording systems, these principles are rarely in place in practice, nor are they generally reflected in the current national guidelines.

Given that data will be used for the assessment of the production or breeding potential of an animal, it is essential that data are stored in a centralized form, which in many cases will be a national data base, but also may be a data base at the level of regions, large farms, commercial breeding companies or breed associations etc.. The necessity of a data base results from the fact, that performance data of different animals or the same animal at different ages have to be combined to retrieve the relevant information.

Ideally, data of one 'breeding population' are stored in one data base or in data bases following a common structure with well established links and defined interfaces for data exchange.

It is possible to define a general structure of the data that are to be recorded in such a way, that following this recommendation, a very flexible and efficient use of these data for a variety of purposes is possible. 'Structure' means both the hierarchy of different types of data and a general format, in which data should be recorded and stored. The format (not the contents) should be independent of the production system. Once this general format is defined and accepted, it is possible to develop guidelines for data recording in a very standardized form.

One very general recommendation is, that throughout the recording process, four key pieces of information should be attached to any recording that is made :

- the ID of the animal (or animals, if more than one animal is involved);

- the actual date of recording;
- the actual location (farm, station); and
- the person (or institution) doing the recording.

For practical reasons, it will be useful to define standardized identification codes both for locations (farm ID) and recording personnel if required. Location data will be essential for any statistical analysis or genetic evaluation that takes contemporary group effects into account. The information on recording persons may reflect the possibility to use A, B, or C methods of performance testing, according to the general ICAR standard.

In principle, the information can be categorised into four different types of animal related data:

2.1. Invariable animal data

This includes all data that are specific for an animal, are available at the birth of the animal and do not change during its lifetime. This set of data encompasses:

- The internationally unique ID of the animal (containing the code of the country of origin, see section 3.1)
- The breed or breed composition of the animal
- Date of birth of animal
- Sex of the animal
- The ID of the animal's genetic parents
- In case of embryo transfer ID of recepient mother
- In case of fostering ID of foster mother
- If the animal is an identical twin or a clone, the ID of the other genetically identical animal(s)

2.2. Life history data

This class includes information on the status of the animal (alive or dead, suckling or weaned etc.) and the farm or management conditions the animal is kept in. These data are time-critical in that, for a given animal and a given date, it should be possible to retrieve all relevant information pertaining to management condition, reproduction status etc. from this set of data.

There are two main areas of information that have to be collected and permanently updated in this class of data:

a) Where is the animal physically?

With respect to location, it seems most practical that information is collected whenever an animal changes its actual localization, i.e. if it moves from one farm to another, if it is sold abroad, if it is

slaughtered etc. Depending on the production system, this can also enclose a change of a management group or environmental conditions within herd (change to pasture, feed lot etc.).

A standard format for recording such an event may look as follows:

- Animal ID
- Date
- Recording person
- Actual location: farm ID (management-group within farm if applicable)
- Changing to: farm ID (management-group within farm if applicable)
- Code(s) for special events (e.g. weaned, died, slaughtered etc.)

It must be decided, whether these data, especially animal movements from one herd to another or between management groups within herd, are recorded in a separate data collection process or only in combination with trait recordings, i.e. that with each recorded trait - like weight - an information on the actual location of the animal is collected, which is then used to update the life history data.

In the EU system for cattle recording, animal movements are recorded in a redundant form, such that both the herd of origin and the herd the animal is moved to report the animal movement, and the record is only accepted when both reports match.

b) What is the animal's reproductive status
This describes the general availability of the animal for breeding purposes and related information, and thus comprises such events as mating, insemination, embryo transfer and birth for females, and castration for males. If females are kept with one or several bulls during the mating period, this information (basically on 'possible' mates and mating dates) should also be included.

The relevant data can also be collected in a standardized format:

- Animal ID
- Date
- Recording person
- Actual location: farm ID (management-group within farm if applicable)
- Code of the reproductive event
- ID of other animal(s) involved (e.g. mating partner, calf, foster calf etc.; if applicable)

Having these two types of data of an animal's life history , it should be possible to access all relevant information for the calculation and statistical analysis of performance data. The way the data will be used and the importance of accuracy and completeness of data for this type of use determines the degree of effort that is justified in collecting and maintaining these data. This decision should be made in every recording system taking cost efficiency criteria into account.

2.3. Recorded data

Recorded data are directly recorded on an animal or animal group, which includes both objective measures and subjective assessments. In principle, different types of records can be used:

- **Objective measurements**, like weights, heights etc. which are assessed with the use of some technical equipment. These measurements, if recorded properly have a high degree of accuracy and are easy to standardize if the definition is clear. It is strongly recommended to use the metric system and kilograms internationally, but this may not be practical in all countries. Therefore, respective formats have to be agreed upon for the international exchange of data.

  It is often not possible to make the required measurements on the exact date when it is supposed to be made. If, e.g. the yearling weight is to be recorded, but only monthly or bimonthly weighings are technically possible, the expected weight at day 365 has to be calculated using a correction routine and will be stored as a 'calculated trait'. Nonetheless, basic recorded data should always be retained.

- **Subjective assessments**, like estimated body weight or dressing percentage etc. In many cases, subjective assessments are used to obtain values on characteristics that could in principle be measured exactly, but exact measurements may not be possible because they are too difficult or too expensive to get. With well trained personnel, these assessments often are sufficiently accurate, nevertheless it is essential to verify data quality on a regular basis, e.g. by comparing subjective assessments with exact results for samples of animals (Quality Assurance Systems).

- **Counts**, like number of inseminations or matings per mating period, number of calves born etc. If these data are properly recorded, they are also highly reliable.

- **Dates.** Considering recent computer problems, dates should have the 8-digit numeric format YYYYMMDD.

  It is strongly recommended that for recording purposes, recording dates are preferred over the recording of the age of the animal. The reason is, that additional information is required to derive the age of an animal,

and this may lead to erraneous recordings, arising from different formats (age in years, months, or days) or just deficient information. Nevertheless, a substantial proportion of the surveyed guidelines propose to record the age with the respective trait value.

The recording date, on the other hand, contains the complete age information when combined with the birth date, which should be in the data base for any animal. The date of recording also provides information on the month or season the recording has been undertaken in. This information may be useful for the further interpretation or statistical analyses of the recorded data.

- **Nominal classification**. Observations are given in discrete, unordered classes, like breed or reason for disposal. Well defined, mutually exclusive and comprehensive categories are required to gain as much information as possible.

  Often, there is an additional open class for all cases, that cannot be attributed to one of the defined classes. For these cases, the possibility should be provided to describe the case shortly (e.g. writing down a disease that caused disposal of the animal). These remarks can be analysed to amend the list of classes by the most frequent nominations.

- **Subjective scores.** This type of records classifies animals on a finite ordinal scale in a number of classes. Often these classes are an ordered sequence of numeric scores, where the lowest and the highest numbers represent extreme phenotypes on a linear scale. Also, descriptions of the different classes can be given in text or as pictures / drawings.

It is suggested that linear scales should be fixed within age / weight windows but should not be breed specific. They should primarily be determined by the biological range of the population under evaluation, i.e. young animals, weaned calves or adult cows.

It is generally recommended, that scores for a specific assessment should not have more than ten increments. If necessary, intermediate values with one decimal (e.g. 2.5) can be used. For some traits certain breeds may exhibit extreme phenotypes. In this case, a breed specific extension of the scale may be considered (e.g. muscularity index of Belgian Blue).

The main problem with subjective scores is to achieve that values are comparable, even if they are assessed by different persons or by the same person at different points of time. This requires clear definitions and permanent and systematic training of the persons in charge of doing the scoring. If such data are used in statistical analyses, the effect of the scorer has to be included in the statistical model. However, it is not only the mean, but also the variance of the scoring results that should be uniform across different persons.

Another aspect is that, although being subjective, scoring should aim to give an objective assessment of the animal irrespective of e.g. the environmental conditions. That is, two animals which are put in the same phenotypic class should be comparable in absolute terms, even if they have been kept under very different management conditions.

Regardless of the type of recorded trait, it is possible to use a standard format:

- Animal ID (or group of animals if applicable)
- Date
- Recording person
- Actual location: farm ID (management-group within farm if applicable)
- Trait code
- Trait value
- Additional information pertaining to the animal
- Additional information pertaining to the recording procedure

It is essential, that for all recordable traits in a given recording scheme, the trait is well defined and that a uniform two or three letter *trait code* is specified (like e.g. one code for live weight in kg, another code for carcass weight in kg etc.). It is recommended, that trait codes and definitions for the main traits are internationally standardized, this is obviously the main objective of international beef recording guidelines.

Note that a 'recorded trait' should strictly be the actual measurement, count or subjective score. If a trait e.g. has to be standardized for a given age or for environmental factors, the resulting adjusted weight is a calculated or derived trait, which is a function of the recorded weight and e.g. age derived from the weighing date and the birth date. Thus, 'weight' is a recordable trait, but 'weight at 200 days' will in many cases be a calculated trait.

Additional information pertaining to the animal has to be defined trait specific and encompasses all relevant factors which are informative for the animal's situation. Many of these factors should be recorded in the 'life history data' of the animal, but there may be other factors (like health problems, heat, special concentrate feeding etc.) that may be relevant for the recorded trait and should be provided together with the record.
Additional information pertaining to the recording procedure refers to e.g. the technical equipment that is used to gain the information (if the trait is sensitive to this), or the contemporary group the animal is recorded in etc. This information again is only relevant, if it can and will be taken into account for a subsequent statistical correction of the recorded trait.

2.4. Calculated traits

This type of trait is somewhat different from the other categories, because calculated traits are derived from the 'raw' information included in the other three categories. In general, there are three different classes of calculated traits:

a) Adjusted traits

Often, raw data have to be adjusted for a defined age, weight, or length of testing period, to comply with the defined standard. If, for example, the weight at 365 days is defined as a standard beef trait, but an animal which is born on March 1, 2000 is weighed on March 15, 2001, the recorded weight is obviously taken at 380 days. Therefore, it has to be adjusted to the standard age by using e.g. linear correction factors.

For this kind of traits it makes sense to use a similar data format like for the unadjusted recorded trait, but to use a different trait code. Information that already has been accounted for in the adjusting procedure can be omitted. This may be the case, if e.g. the type of electronic device that has been used to generate the raw data measurement has been accounted for when standardizing the trait.

b) Functions of several recorded traits.

A number of interesting performance traits are derived from a combination of recorded traits. Daily gain in the test period for example is the difference between weight at end and weight at start of the test period, divided by the difference of age at end and age at start of test period, expressed as g per day. This type of data can be derived both from raw recorded data and from adjusted traits.

With these kind of traits, one often has several overlapping additional pieces of information. E.g. combined weights are recorded by different persons, at different dates, and eventually at different locations. Combined traits therefore should be defined to be largely independent of this type of additional information. A daily gain in a test period should pertain to a standardized test length, but e.g. different weighing equipment etc. should not play a role anymore. Trait definitions in guidelines have to specify which additional information is needed for a later analysis as e.g. age at start (or end) of testing period, test station, or contempotrary group.
The resulting data format may be as follows:

- Animal ID (or group of animals if applicable)
- Date of recording (start / end of test period etc.)
- Age of animal
- Relevant location
- Calculated trait code
- Calculated trait value
- Additional information pertaining to the animal (e.g. contemporary group)

Note that in this case the age (as a calculated trait) is included, while for recording purposes, it is strongly recommended to record exclusively dates.

c) Breeding values and other population-related indices

This type of data result, if an animal's performance is related to the performance of other animals in the same population, mainly to generate a ranking reflecting the production value or the breeding value of the animal. This type of statistical analysis includes trait information (raw or adjusted), pedigree information, classification of fixed environmental effects and covariables etc. Typically such analyses are done for all animals of a population simultaneously.

Estimated breeding values are by definition independent of environmental factors, but values change over time. Therefore they should be stored with the animal's ID, the date of estimation, and the reliability of the breeding value.

2.5. Data requirements for the estimation of breeding values

One of the main objectives of an international guideline for the recording of beef production traits is that raw data should be collected in a form that can be used for an international estimation of breeding values. Together with the performance data it is necessary to collect information on all type of factors that may systematically affect performance.

In principle, these factors can be attributed to three classes:

a) Genetic factors, which comprise, first of all, the breeding value of the animal itself. In BLUP-based systems, effects of related animals (parents, sibs, offspring etc.) are properly accounted for by including the relationship matrix into the equation system (animal model). An alternative is to use hierarchical models, like a sire model or a sire-maternal grandsire model, which only account for a part of the relationship structure and may or may not include additional relationships (e.g. the relationship of sires and maternal grandsires).

In any case it is essential to record the animal ID and the ID of its parents for this purpose. From this information, a complete pedigree file can be set up which contains all information on the genetic structure of the population. If this is done properly, it is not necessary to record the ID of additional relatives (e.g. grandparents, offspring etc.).

For international evaluations it is absolutely essential, that animals from different countries have a uniform, internationally unique, and invariate ID. If, say, a sire appears with different IDs in different countries, he will get different breeding values, which is not only a conceptionally contradictory result for this individual, but also affects the connectedness between populations (and therefore all breeding values estimated in the system) in an unfavourable way .

There are some special situations which need to be taken into account:

- In case of identical twinning and cloning, it is necessary to record the fact that two or more individuals are genetically identical, because just on base of pedigree information (identical parent IDs), these animals would be falsely identified as fullsibs.
- If a trait is not recorded individually, but for a group of animals, the ID of all individuals in this group has to be recorded together with the respective parents. Only then it is possible to include this information properly in a genetic evaluation procedure.
- In genetic evaluation systems it is common practice to include 'genetic groups' for founder animals. I.e. animals with unknown parents are grouped according to age (year born), country of origin and/or breed composition (if more than one breed is included). Therefore, it is essential to provide these data especially for older animals in the pedigree.

b) Systematic environmental factors on all animals in the population.
This comprises environmental factors which affect large numbers of animals across herd in a similar way, and thus can be accounted for either by using a precorrection of the data, or by including them as a fixed effect in the model for genetic evaluation. A typical factor in this class would be the age at first calving.

c) Systematic environmental factors on a defined group of animals.
The main mechanism to account for environmental factors in breeding value estimation is to look at the deviation of an individual's performance from the mean of a group of animals being exposed to the same environment or management situation, rather than using the absolute performance record itself. This can be done by defining 'herd-year-season' or similar classes in the model. This means, that an animal is compared only to contemporaries in the same management unit. However, it is essential that enough individuals are present in such a unit, otherwise the information content is poor.

As a general recommendation, recordings should whenever possible be made on all animals in one management unit simultaneously. In certain situations it might be necessary to record only a sample, which is acceptable if the sample is large enough and drawn at random. For the purpose of genetic evaluation it is detrimental, if the sample is defined in a non-random selective way, e.g. by selecting the seemingly best animals on the trait being recorded and only measuring this sample.

By defining contemporary groups, all factors affecting a group of animals in a similar way will be statistically taken care of. These include climatic factors, management, feeding etc. If, say, data from the slaughter house are used, the reference group (e.g. animals of the same breed slaughtered on the same day) may include both environmental factors as well as day-specific features of the people assessing the carcasses or the technical equipment used for measuring certain parameters.

In any case, it is essential that this classification in contemporary groups be recorded together with the respective performance data either directly or in a way which allows re-construction of the contemporary group (if e.g. herd and recording date are stored, the herd-year-season can be derived).

2.6. Synthesis

The suggested structure of data recording with four basic types of data is one (but possibly not the only) general format to collect and store animal data efficiently and in a conceptionally uniform system. If this structure is accepted as the basic format, it is still necessary to define the exact contents of the four data sections. Based on the suggested format, this can be done in a very standardized procedure, though.

If, say, 365 day weight is a trait to be recorded in a breeding program, the following steps must be taken:

1. Define the group of animals for which recording of 365 day weight is desirable
2. Define the time frame around day 365 in which the raw live weight of the animal has to be recorded (to be subsequently adjusted to 365 days). If this time frame is 365 days ± 45 days, farms have to weigh animals once in three months to meet this requirement.
3. Define the data format in which the raw weight recording has to be transmitted:

- Animal ID
- Weighing date
- Recording person
- Actual location: farm ID (management-group within farm if applicable)
- Trait code: live weight in kg
- Trait value
- Additional information pertaining to the animal (sickness etc.)

If the B-method applies and the weighing is done by the farmer or his nominee, it suffices to record the code of the farm as information for the actual location and the recording person.

4. Define breed or population specific adjustment factors or functions to calculate the 365 day weight from the recorded weight within the time frame and the age, computed as weighing date minus birth date of the animal.

3. Specific recommendation for data recording

3.1. Animal identification and tagging

3.1.1 Summary of the survey results

In the questionnaire it was asked for all aspects related to animal identification and tagging. In 20 out of a total of 36 guidelines from 19 countries a recommendation for the tagging of breeding stock animals was found. Production animals are recommended to be tagged in 12 guidelines. The tagging of a sample of animals, animals with tested performance or even all animals were found in only one guideline. The way of tagging was recommended very often. Individual tagging of breeding stock animals was mentioned in 21 guidelines, individual tagging of production animals in 11 and an identification of the farm was recommended in four guidelines. The method of identification was recommended to be permanent (20) and unique(16). With respect to the method of tagging, ear tags (16) and tattoos (9) were mentioned most frequently. Two guidelines recommended electronic identification and branding, while only one guideline mentioned a sketch or photo for identification. Five guidelines recommended to do the tagging within 7 days from birth, while six guidelines suggested to do this within one month. Tagging should be done by the farmer/breeder/owner (14 guidelines) or the breeding organisation (5 guidelines). Animal identification and parentage control on the basis of blood groups is only mentioned in 4 guidelines, while DNA-based approaches are mentioned as compulsatory option in the Swedish guideline.

3.1.2. Recommendations

It is an essential prerequisite for breeding programs, that certain animals can be individually identified. This is especially true for breeding animals (i.e. animals that are candidates for selection or to become parents of the

next generation of breeding animals). If e.g. a testing scheme is based on the performance of relatives, e.g. progeny, it may be sufficient to identify a group of animals as being progeny of a certain sire, but not with an individual and unique identification code. For production animals, identification often is only necessary to prove ownership or for purposes of herd management.

Identification can, in principle, be based on two different concepts:

- An animal is given a unique identification code and this one is attached to the animal in a form, that facilitates the reading of the information when needed. The most widely used techniques are ear tags, tattoos, or electronic chips. 'Reading' can mean to literally read a number or an alphanumeric code, or to use technical equipment (bar code reader, electronic chip reading device).

- Animals can also be identified through intrinsic characteristics, like e.g. a marker based information system, which allows to identify an animal as an offspring of a given mating from its marker genotype (given the parents' marker genotype is known). DNA based techniques also allow multiple sire joining with later identification of parentage. Other possibilities are to record special invariable phenotypic characteristics of an animal, like coat colour patterns or the special characteristics of the iris of an animal. This facilitates the later recognition of the same animal. Such systems are in development and clearly have the potential to replace tagging techniques, at least where cheap and automatic identification systems, presumably mainly for production animals, are required.

Triggered by the BSE crisis in Europe, it is European law that all cattle in the EU without exception have to be tagged in a standard form. Based on the actual crisis concerning food and mouth disease in the UK and other countries, it must be expected that international requirements concerning animal identification will be much more strict than they have been until now. It is very likely, that major importers of beef or beef cattle will allow imports only if animals are properly and reliably identified, allowing to trace back their way through the system. Therefore, animal identification is a central issue for all countries that wish to export animals or carcasses or that wish to take part in the international exchange of breeding material (including e.g. also semen or embryos).

Therefore, at the present stage, it is strongly recommended that all breeding animals within a country have to be identified and tagged. For production animals, this is also recommended, especially if data from production animals are used for breeding value estimation purposes (e.g. in a progeny testing scheme).

If animals are tagged, the tagging within one population has to be:

- permanent
- done in short time after birth.

Although 'uniformity' of tagging is mentioned in a number of guidelines in the survey, this requirement does not seem to be necessary, since the physical technique of tagging may differ between animals. It may, for example, be useful, to use electronic devices like chips for a certain part of the population and eartags for other animals. What has to be unique, though, is the 'soft' ID within country, so that a number or alphanumeric code is only used once.

Under certain conditions additional requirements may be sensible. This may be that a tag cannot easily be removed (in situation where live animal theft is a problem) or that e.g. ear tags cannot be removed from or exchanged between animals without destroying the tags.

Internationally, an alphanumeric code should be used, being a combination of two leading characters or three numerical digits as country identification following the ISO standard and a subsequent national alphanumeric or numeric sequence, providing a unique identification within country. At present, codes with up to 15 alphanumeric characters (including country code) are in use.

This suggestion allows countries to stay with their own internal identification and numbering scheme, where national codes either contain relevant information (e.g. herd number, breed, or sex) or are just consecutive numbers without any meaning. Check digits may be included. The only requirement is, that numbers are unique within the country they are used. Together with the country code, this makes the identification world-wide unique.

It is strongly recommended, that all animals should keep their identification throughout their lifetime. Experience shows, however, that animals often get a new ID when they are traded especially across borders. In this case, a minimum requirement is that the original identification of an animal has to be documented and stored in an accessible form with a link to its new ID. This is probably the single most important recommendation that has to be followed, if an international evaluation scheme is to be established successfully. As a standard, animals in an international evaluation procedure should always be identified by the ID they have in their country of origin.

The way of tagging is free to the owner or may be defined by the legal body issuing membership regulations as long as it matches the points mentioned above and is not in conflict with animal welfare laws or regulations.

Recommended ways of tagging are:

- ear tag;
- tatoo;
- chip.

Tagging can be done by any person e.g. by the farmer or some officer of the breeding or recording association etc.. However, reliability of identification has to be verified through appropriate measures, e.g. parentage control of relevant breeding animals and / or identity control of a sample of all tagged animals in the population on a regular basis. Where internal electronic devices like chips are used, the animal must be marked in a way that indicates the presence of that electronic device.

3.2. Identification of farms, locations, institutions, and personnel

3.2.1. Summary of the survey results

Among the 36 guidelines received, 15 guidelines suggest to record the ID of the farm and 12 (11) guidelines recommend to record the address of the breeder (owner) of the animal.

3.2.2. Recommendations

For a systematic recording scheme it is essential, that persons and institutions involved in the recording process can be identified in a systematic, reliable and simple way. Therefore it is recommended that farms and institutions being involved in the beef production and recording process (e.g. slaughterhouses, traders, markets etc.) as well as persons participating in the recording process (e.g. recording officers) are given a unique ID (as in some EU National Registration Systems) within the respective recording or breeding program. Additional information on the persons or institutions (names, addresses etc.) must be accessible through the ID as a key. Attached to the ID of the country or the recording or breeding scheme, this ID becomes worldwide unique and can be used for classification in international evaluations.

Using IDs instead of names of persons or companies, addresses etc. has the obvious advantage of being simple, short, and unambiguous. It also allows the retrieval of the complete information on the identified unit from a respective data base.

3.3. Recorded traits related to reproduction and life history

3.3.1. Summary of the survey results

Recording of the breed or breed composition of breeding animals is recommended in 14 of the 36 completed questionnaires. Similar frequencies are found for the other essential data such as date of birth (20), sex of the calf (18), ID of parents (14), breed of parents (11). Birth type is suggested to be recorded for breeding animals in 14 guidelines. With respect to embryo transfer, the fact that an ET has taken place and the ID of the recipient is suggested to be recorded in 10 guidelines. Other important traits are mating type (14) and the respective date (12), the calving ease code (11) and fostered yes or no (10). Recording of the date of disposal is recommended in 11 guidelines, with 9 guidelines suggesting a disposal code.

For production animals, the respective traits are suggested to be recorded in a smaller number (7 or less) of guidelines, while uniform farm labelling was mentioned in 4 guidelines only.

3.3.2. Recommendations

As described in section 2.2 of this report, all essential data reflecting life history and reproductive status of an animal should be recorded in a special section of the data base. Other records are clearly performance related, but in practice will be assessed together with relevant life history data (e.g. calving date and calving ease in many cases will be reported on the same form).

Especially with reproduction data, we often see that a trait is relevant for more than one individual, e.g. birth recordings are relevant for the dam, the calf and are also relevant for the reproductive performance of the calf's sire.

In a recording scheme and data base context it must be decided, for which animal(s) the respective data are recorded. In principle a minimum degree of redundancy is desirable. In a well-designed data base, it should be sufficient to store data on a given birth only with the calf or with the dam, and to retrieve the data for other animals (including the sire of the calf) if needed. Conceptionally, recording birth-related information primarily with the calf seems to be the most sensible solution, because the link to the other animals involved is clearly given through the parents' ID information.

Some situations may cause design problems, particularly twinning, where identical information is available for two individuals, abortion, stillbirth or death after birth but before registration, where the calf in most cases the dead calf, will not get it's own ID and thus will not appear as an individual in the data base. In the latter case, it might be useful to assign a 'dummy-ID' to the calf to stay consistent with the data base design.

A number of the traits described below (calving ease, birth type and stillbirth) are essentially recorded when a cow has calved. It is obvious that this information (together with other informations like sex of calf, abnormalities etc.) should be recorded in one recording procedure, e.g. by filling out a 'calving report', which contains all the essential data. This will be used to enter the calf as a new individual in the data base, hence the 'invariable animal data' as listed in section 2.1 have to be included in the calving report.

In addition to these basic data, it is recommended to record the following data for all breeding animals:

Trait	Recorded as
Insemination or mating date or mating period	Date, type, sire(s)
Embryo transfer	Code, genetic parents
Calving ease	Code
Stillbirth	Yes or no
Birth type	Code
Cause of disposal	Cause or code
Production environment	Classes

3.3.2.1. Insemination or mating date or mating period

To assess the reproductive performance of males and females it is essential to collect data on mating success. Most of the derived parameters used in practice, like the non return rate (paternal or direct), service period etc. are based on the number and dates of unsuccessful and successful matings or inseminations.

For breeding females it is also essential to identify the true sire of a calf, if more than one sire is possible (multiple matings or mating opportunities). The most likely mating date then can be derived from the observed calving date by subtracting a standard gestation period. Based on this information, potential sires can be excluded. For this purpose, it is helpful if the date bulls enter and leave a herd or management group of females is recorded.

3.3.2.2. Embryo transfer

It is essential to provide information on the fact, if a calf is born by its genetic mother or by a foster mother. Therefore, all embryo transfers (ET) have to be recorded when they take place as a record of the recipient female. In addition to the fact that an ET has taken place, it is also necessary to record the genetic parents of the embryo. When the calf is born, it is essential that the information on the genetic parents is provided for setting up the pedigree and that the ID of the foster mother is available to model the calf's environment in the pre-weaning phase.

3.3.2.3. Calving ease

Calving ease describes the circumstances of the birth of an animal. This record is very important and can be used for several analyses. It can give hints on the potential of a calf and can also be used to analyze breeding ability of the parents, especially with respect to the qualification of a sire to be mated to heifers.

It is recommended to record calving ease with the following five subjective scores:

1) easy calving without assistance;
2) easy calving with assistance;
3) difficult (mechanical assistance);
4) difficult (veterinary assistance); and
5) caesarean or surgery.

3.3.2.4. Stillbirth

If a calf is born dead or dies within a given time period (24, 48, or 72 hours) after birth, this event is basically a data event relating to the parents' performance and therefore should be stored as a record relating to the mother, together with the ID of the calf's sire, the birth type and the sex of the calf. A clear definition is required stating the critical duration of pregnancy to distinguish between abortion and stillbirth.

Note, that it is essential to store this information with the dam, since in most implemented recording systems the dead calf does not get an own ID and therefore will not be represented in the data base as an individual.

The alternative is that stillborn animals get an individual ID and record in the data set. This would be more consistent with the general recording philosophy suggested here and therefore is recommended.

3.3.2.5. Birth type

For recording of birth type, a uniform code should be used. Information on twin birth affects both the assessment of the dam's and the calves' performances. Therefore, this information has to be available both for the dam and the calves. For the latter it is essential to store the ID of the respective identical twin, since this information is needed to set up the relationship matrix correctly. If growth capacity of the calf and maternal ability of the mother in the pre-weaning period is of interest, it is also essential to provide information on whether the (identical or non-identical) twins both stay with the mother or if they are separated in the pre-weaning phase (e.g. by putting one of the twins to a foster mother).

Non-identical twins genetically are and have to be treated as full sibs. The zygosity status (mono- vs. dizygous twins) can only be verified based on blood groups or marker techniques.

3.3.2.6. Cause of disposal

The cause of disposal is the reason, why an animal is leaving the herd. It is the last record of this animal in this herd, and thus it has a 'dual' function in contributing to life history of the animal and, in case of premature death of the animal, it provides information for the assessment of productivity and longevity of the animal and its relatives.

The cause of disposal should be recorded as a code. A standard format derived from guidelines in various countries could be:

1) died at or within 72 hours after birth (if an ID has been assigned to the animal; overlap with stillbirth!);
2) was alive at 72 hours after birth but died before weaning;
3) died after weaning;
4) sold for breeding;
5) sold for commercial use;
6) slaughter or sold for slaughter within a given period (e.g. one week).

If an animal is sold, it is essential to record the ID of the farm or commercial unit (trader, slaughterhouse etc.) the animal is sold to.

This list can be extended. Additional classes can be defined to reflect the situation of the production system, so e.g. theft or predating may be valid classes in some production systems. To achieve greater specificity, different sets of disposal codes for pre-breeding animals and replacement animals may be considered.

For the first three classes, information on the reason for disposal should be collected. For breeding purposes, it is essential to collect information on reasons for a premature disposal due to diseases or lack of performance, like e.g. unsuccessful mating or inseminations. However, these animals may be 'hidden' in any of the classes 4, 5, or 6. Hence, a separate class could be considered for the cows that are removed from the breeding herd for fertility or other reasons, like e.g. poor mothering ability.

Using a clear disposal code forces all farmers in a breeding organisation to use a unique code and facilitates the processing and analysis of the data subsequently.

3.3.2.7. Production environment

For most recordings, it is essential to have additional information on the corresponding production environment of the animal, i.e. if it was kept under intensive or extensive conditions, in suckler herds, feed lots etc.. The possible types of production environment are very different between different countries. A uniform definition of possible types of production environments that is applicable in all countries is strongly recommended.

3.4. Live animal weights

3.4.1. Summary of the survey results

With respect to weight recording, most guidelines recommend to record birth weight (11) and weaning weight (13), for the latter, the suggested standard age is highly variable, though. Apart from this, a very high heterogeneity was found concerning the recommendations, which live animal weights should be recorded. The two most frequently recommended weights after weaning are the weight at the start of the test period (12 for

males) and weight at 365 days / yearling weight (9). Apart from that, weights at any age between 100 to 730 days are recommended in at least one guideline.

3.4.2. Recommendations

Live weights are essential for the calculation of growth and related parameters like growth rates or food conversion rates. There are a number of key dates, mainly biologically determined like birth or weaning, which also mark the start or end of a certain period of the production system. The weights at these dates are essential to assess growth rate and efficiency of the respective steps in the production system.

Breeding programs often have defined test periods where the performance of breeding candidates is assessed under comparable environmental and management conditions. Weighing of the animals at the beginning and the end of this test period is essential, additional regular (like e.g. monthly) weighings are a prerequisite if it is intended to modify growth curves genetically.

All these recordings should be done in essentially the same way according to the general format for recorded data suggested in section 2.3 of this report. The only 'trait-specific' additional requirement is that 'time windows' are defined, in which e.g. the weaning weight or the yearling weight are to be recorded (to allow a subsequent adjustment on the exact age the trait is defined for).

The following weights should be recorded for all breeding animals:

Trait	**Recorded as**
Birth weight	Weight
Weaning weight	Weight
Weight at start and end of the test period (if applicable)	Weight
Yearling weight	Weight

3.4.2.1. Birth weight

Birth weight is the weight of an animal at birth or short time after birth. If birth weight is not measured directly after birth, the time between birth and weighing must be recorded, which is given if birth date and weighing date are recorded as separate dates. Birth weights measured more than 72 hours after birth have to be corrected for the days between birth and weighing. Birth weight may be extremely difficult to record in large extensive herds, though. If birth weight is not recorded within 72 hours of birth the weighing should be considered as a separate weighing event from birthweight.

3.4.2.2. Weaning weight

Weaning weight is the weight of an animal taken at, or just before the separation from its dam. Weaning weight is essential for the assessment of the gain of a calf between birth and weaning and therefore provides information both on the maternal ability of the cow and on the growth potential of the calf.

It might also be an option to suggest a weight recording at a fixed age prior to weaning to evaluate maternal ability with highest informativeness. In some production systems, weight at weaning may be too late for that, and an earlier measure should be used. The optimal age should be chosen such that the heritability for maternal ability is maximized under the respective production circumstances.

Weaning weight is measured worldwide at different ages of the calf. To facilitate comparisons between animals, measuring weaning weight at a fixed age would be useful. However, this is only sensible, if weaning roughly takes place at a fixed age. If e.g. one calf is weaned after 180 days and another calf is weaned after 240 days, correction of both weaning weights to a standard age of 200 days may be misleading when used for comparisons or breeding value evaluation, since management and feeding conditions for these two animals would be quite different.

For weaning weight recording it is therefore essential to record both the date of weighing and the date of weaning. Additional information on the situation, e.g. if early weaning was necessary due to certain circumstances or if more than one calf was suckling on the cow, have also to be recorded.

3.4.2.3. Weight at start and end of a testing period

Breeding programs often test their animals in a special period. This can be useful for several reasons, e.g. testing the growth rate of a possible bull or testing a group of progeny of a bull on testing stations. In testing animals over a period the weight of the animals should be recorded at least at start and end of the period together with the respective weighing dates. From this the age of the animal and the length of the testing period can be derived. It may be useful to record the weight of the animals in regular intervals during the testing period to fit regression functions to calculate adjusted start and end weights.

3.4.2.4. Post weaning weights

For the comparison of animals in the post-weaning growing phase, yearling weight is an international standard. Different countries have defined different ages (between 280 and 550 days) at which the yearling weight should be recorded. It is recommended that yearling weight be defined as the weight at 365 days of age. In more extensive production system, a ‘long yearling weight’ recorded at 452 or 550 days may be preferable.

As for other traits, it must be recognized that the recording schedule is largely depending on the production system. With seasonal production systems, a 14 to 15 month weight may be more appropriate, since at this age females have to be mustered and drafted into mating groups anyway, so that for practical purposes it is preferable to take weights at this point of time. Another criterion for the identification of the optimum weighing date is the informativeness, measured through the heritability of the trait, which should be maximized.

In non-seasonal production systems, the time window for recording a weight to be adjusted to the yearling weight should be ± 6 weeks. This can be achieved by quarterly weighings.

3.4.2.5. Additional live weight records

Additional weight records are optional. Records are for example regular weights (e.g. every 100 days), mature dam weight, live weight at slaughter and sales weight. Additional weight recordings should comply with the same standard, in that the ID of the animal and the date of weighing are recorded with the weight.

3.5. Live animal assessments

3.5.1. Summary of the survey results

Live animal assessments can be seperated in objective measurements and subjective scorings. For measured traits the muscular development is the most frequently recommended trait with 10 entries, before mature size (5). Apart from that a large variety of possible measurements is recommended in at least some guidelines, but every trait only in up to 3 of them, so that no uniform recommendation could be derived from the survey. For example fat depth is recommended to be recorded in 6 guidelines but each of them gives a different position to measure this trait (rib 4, rib 10, rib 12, rib 13 ...).

A similar situation can be found in the subjective scorings. Only one score is recommended in more than 10 guidelines, this is the body condition score, which is mentioned in 11 guidelines, followed by locomotion score (9) and scoring for udder (6). A large variety of additional scores are mentioned in the guidelines, but there is not one that is recommended in more than two of them.

3.5.2. Recommendations

Besides weight records and traits derived thereof, like daily gain, the other major class of traits with a direct commercial impact are traits of the body conformation. There are, in principle, two ways to assess respective data:

- evaluations on live animals, either by subjective scores, or by using electronic devices like ultrasonic equipment;
- carcass evaluations, which usually are also based on a subjective classification although, in principle, an exact quantification (e.g. of the meat yield) would be feasible, though at high costs.

Besides quantitative traits, quality of the carcass and the meat is also relevant for breeding purposes. However it is difficult to define quality *per se*, since different production systems or different cultures may have a different idea of quality. Therefore, quality traits should reflect objective criteria of quality (like the fat / meat ratio), allowing a different valuation of the respective phenotype according to the market preferences.

The following traits can be found in various breeding and recording schemes and are suggested to be considered as desirable traits to be recorded in beef production systems, depending however on the relevance of the respective trait or trait complex for the population and production system.

Trait	**Recorded as**
Assessment of muscular development	Score
Assessment of body condition	Score
Assessment of skeletal development or	Score
Wither height at a given age	Measurement

3.5.2.1. Assessment of muscular development

Muscular development is one of the most important assessments to evaluate the carcass of live animals. As all subjective scores the record needs to be standardized, such that assessments of different persons or the same at different dates are comparable both with respect to the mean and the variance of the score. Muscular deveopment should be scored on a linear scale. There are different scales in use worldwide, ranging from 9 scores to as many as 50 scores. It is recommended, that the scale should be uniform and should not have more than 10 different scores, going from low numbers to high numbers in combination with low muscularity to high muscularity (e.g.: 1 - poorly muscled, 10 - extremely muscled). Within one breeding scheme (i.e. usually one breed), a unique muscularity score has to be used. Given the breed differences in muscular development (e.g. Belgian Blue vs. dual purpose breeds), scales have to be breed specific. The ICAR beef group has issued a guideline on this trait complex.

3.5.2.2. Assessment of body condition

The body condition score (BCS) is the second most used assessment system worldwide. Body condition score is related to maintenance, growth, milking ability and many more relevant characteristics. A regular recording of the body condition of every animal can help to avoid errors in the production system, and supports the management in keeping the animals healthy to have high performance results. Actually, the BCS is an indicator for the nutrition status of the animal. It is often used for cows in suckler herds.

Different BCS-systems are used. They all have in common, the feature that the condition status of an animal is described in a scoring system. The scoring systems for BCS presently in use have up to 15 scales. It is recommended, that breed specific scales with no more than 10 different scales should be used, assigning poor body condition to the lower part and good body condition to the numerically upper part of the scale. If BCS are to be used for breeding purposes, it is essential that within one breeding program the BCS reflects as objectively as possible the condition of the animal as it is, without taking into account environmental conditions. Thus, two animals with the same BCS should look very similar, even if they are kept under very different environmental conditions and indeed one of them performs relatively well under unfavourable conditions, while the other performs poorly in a good environment.

Since the BCS is largely dependant on the nutritional circumstances, it is recommended that body condition is scored for a whole contamporary group to be useful for further evaluation.

3.5.2.3. Assessment of skeletal development

Skeletal development of an animal has finished before the muscular development. By estimating the skeletal development it is to a certain extent possible to predict the muscular development. For the skeletal development, bone thickness, shoulder width and other traits are evaluated. A linear score with no more than 10 scores for the development is recommended. Within a production system, a unique linear scoring has to be used.

Skeletal development can also be assessed based on a measuremnent of wither or hip height. To allow comparisons, it is essential to take this measurement also at a standardised age. In five questionnaires in the survey, wither height at 13 months is defined as a trait. Given that yearling weight is suggested as desirable trait to record, it should be considered to assess weight and height for the same standardised age, so that animals in general have only to be assessed once.

3.5.2.4. Additional traits assessed on live animals

There is a long list of additional traits that can be assessed on live animals that are mentioned in one or several of the guidelines being reflected in the survey. These traits can be classified in:

- scores, e.g. for beef type, locomotion, leg quality, general appearance, udder etc. All these scores should follow the general requirements for subjective scores as pointed out in section 2.3 of this report;
- direct measurements, like mature size or pelvic size etc;
- ultrasonic measurements, which allow the scoring of carcass quality traits on the live animal. Although this type of recording was only mentioned in one guideline, it must be expected that this technique will become much more important in the near future and therefore requires international standardization. This should include scanning

devices that can be used, body sites, where measurements are taken, definition of measurements (areas, depths), additional traits like marbling scores etc.

3.6. Carcass assessments

Only few guidelines recommend some carcass assessments traits. In seven of the 36 completed questionnaires, the carcass weight and a carcass classification and score are recommended to be recorded. All other possible traits are only rarely mentioned in no more than one guideline each.

3.6.1. Summary of the survey results

3.6.2. Recommendations

The ultimate objective of beef production of course is to produce high quality carcasses that sell for a good price. Therefore, carcass weight, composition and quality are essential traits to be recorded at the slaughterhouse. An essential prerequisite for gaining records in the slaughterhouse is that the ID of the live animal stays with the carcass or that a system is used, that facilitates the recovery of carcass data with the ID of the corresponding live animal.

The following traits are recommended as desirable traits for breeding purposes:

Trait	Recorded as
Carcass weight	Weight
Estimated meat yield	Per cent
Carcass classification / scoring system	Score

3.6.2.1. Carcass weight

The weight of the carcass is an important parameter with a major impact on the financial return for the farmer or breeder. However, in different countries or parts of the world, carcasses are defined differently, i.e. there is no general agreement concerning which parts of the animal belong to the carcass and which do not. Carcass weight definition requires also a statement as to when the weight is measured, if it is on one or two halves, hot or cold carcass etc.. Direct comparisons of recorded values are only possible in systems where carcasses are equally defined.

3.6.2.2. Estimated meat yield

The percentage of lean meat in the carcass usually is subjectively assessed and also has a major impact on the market price that can be achieved. In countries where scoring systems like the EUROP classification are used, the estimated meat yield is one of the major parameters determining the score of the carcass. Additional records like fat and muscle depth may be used for a more objective quantification. Also, the kill out percentage can contribute to a more precise quantification of the meat yield.

3.6.2.3. Carcass classification / scoring system

The classification of the carcass represents a description of its quality in a meaningful code for the consumer (in this case the butcher, processing industry etc.). Therefore the score is not only quantitative, e.g. reflecting the meat content of the carcass, but should also allow the addition of complementary information e.g. of the fat deposition etc. The EUROP system is an example for such a scoring system. Together with the carcass score, information on the type of animal (e.g. bull, steer, cow, heifer etc.) has to be available, which, however, should be extractable from the life history data recorded.

It must be emphasized, that carcass classification scores are not assigned primarily for breeding purposes, but are a part of the priceing system in the market and therefore have to reflect the market needs in the specific production system and for the respective needs of buyers in that market. Therefore, it is probably not possible to standardize carcass classification systems across countries or production system.

3.6.2.4. Other carcass assessments

In a few guidelines, other measurements on the carcass, like the weight or percentage of specific cuts, scores for fat quantity and distribution etc. are mentioned. Meat quality can be assessed on basis of a subjective score (including e.g. a marbling score), through taste panels, or by using technical devices to measure the meat colour, tenderness, intra-muscular fat, physiological parameters like the pH at different points of time etc.

3.7. Other recorded traits

3.7.1. Summary of the survey results

Recording of fertility traits is covered by a considerable number of guidelines, and the recommendations focus on a few key traits that are mentioned in the majority of the respective guidelines. 16 out of 36 guidelines suggest to record the calving date, other important traits are calving ease (14), calf dead / alive (11), birth type (10) and mating / AI date (9). For the male fertility, scrotum circumference is mentioned in three guidelines.

Eleven guidelines recommend to record the feed intake, in most cases for male animals on station test, but only three countries (Belgium, Ireland and Namibia) define this trait to be mandatory.

Health events and sickness are suggested to be recorded in four different guidelines. A score for temperament is mentioned in six guidelines, mainly in countries with extensiv suckler production systems, like Australia, South Africa and USA.

3.7.2. Fertility traits

Fertility has a considerable economic impact in beef production systems, because reproduction is the starting point for any production process. In the suggested system of data recording and storage, female reproduction

should mainly be reflected in the 'life history data' section, in that all reproductive events, like mating or insemination, ET, calving etc. should be recorded there.

Male fertility traits like scrotum circumference and sperm quality can be measured and recorded separately. The scrotum circumference is an indicator of the bull's ability to produce sperm and the sperm quality is an indicator for the ability to mate successfully. These traits do not allow accurate predictions for fertility and have to be recorded by veterinarians or experienced and trained technical personnel.

3.7.3. Feed intake

High feed intake and feed conversion ratio, for which the feed intake is required, is a goal in some breeding programs. It allows to produce more meat with limited feeding of expensive high concentrated energy food. Accurate measurements of feed intake is only possible in testing stations. If this trait shall be recorded, it is essential to conduct an analysis concerning the quality of the food. Parameters are the consumption of the quantity of dry matter per day or within a testing period.

3.7.4. Health traits

Healthiness of the animals is an essential prerequisite for production, and its genetic basis, e.g. the animals' constitution, robustness, general or specific disease tolerance or resistance etc. therefore is a trait complex of considerable economic impact. However, it is difficult to specify traits in a standardized form such that data quality is assured and an exchange of data is possible. In some countries (e.g. the Nordic countries) veterinary diagnoses and treatments are systematically recorded and thus available for breeding purposes. Other traits, such as tick counts, can be recorded but are restricted to certain environmental conditions and production systems. Another approach to consider animal health in a breeding scheme is to include functional longevity in the set of breeding objectives (see section 4.6)

3.7.5. Temperament

This is a trait which is of considerable relevance when it comes to the handling of animals in the production process. Overly aggressive animals may be excluded from the herds for safety reasons. Thus, temperament also has a considerable economic value. The relevance of the temperament however depends on the production system and will differ between populations. Temperament can only be subjectively scored, where it is essential to define certain 'typical' patterns of behaviour or aggressiveness for different scores on the scale.

3.7.6. Molecular information

Progress in molecular genetics provides information on genes affecting a number of mendelian traits, most of which are genetic defects or diseases, but others are relevant production or breed criteria, like genes for coat colour or polledness etc. Also, anonymous molecular markers can be used to collect information on linked QTL with effects on production traits. Markers can also be used to carry out parentage and identity control of animals.

At the time of the survey, none of the guidelines mentioned any recommendations with respect to molecular data. It must be expected, that this type of data will soon form a third class of key basic data, playing a major role together with pedigree and performance data. Therefore it is strongly suggested that a standard is developed to allow the storage and exchange of molecular data in a standardized way. Since the genotype of an animal does not change during its lifetime, these data should be linked to the invariable animal data described in section 2.1.

4. Recommendations for calculated traits

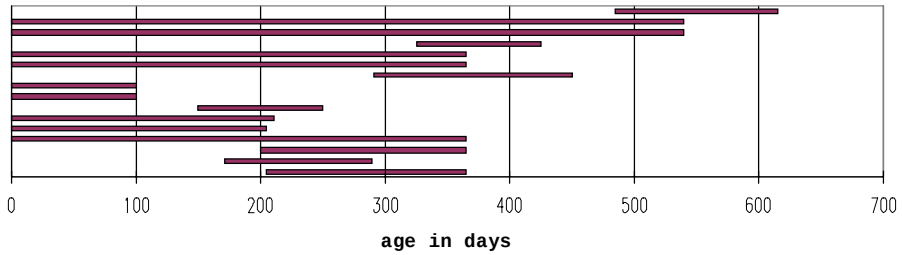
As pointed out in chapter 2 of this report, there is a clear differentiation between recorded and calculated traits. To operate a breeding scheme, data recording (including invariable animal data, life history data and recorded performance data) plays the central role. From these recorded data, informative traits can be calculated in a very flexible way, which means that it is much more important to find an agreement about which data are to be recorded (on which animals, in which way etc.) than to specify the calculated traits. Of course, it is useful to find a common definition of the most important traits to support the international comparison and exchange of animals.

In addition, calculated traits play a role in that they determine, which raw data of the animals have to be recorded. If, e.g., growth until weaning is an essential trait, it is necessary to get a record on the birth weight and the weaning weight together with the respective weighing dates.

4.1. Summary of the survey results

Although virtually all recording guidelines in the survey name growth rate or average daily gain as one central parameter to be calculated, they differ strongly in the time periods this parameter is to be calculated for.

The following graph shows the variety of time intervals that are mentioned in the different guidelines:



For fertility traits age of first calving (14) and average calving interval (14) are the most frequently recommended calculated traits. There is also a high heterogeneity in the calculated fertility traits. Calving ease (11), gestation length (7), maternal ability (6), non return rate (5) and stayability (5) are the traits with highest frequency in the survey.

Efficiency traits are not often recommended. Only feed efficiency (5) and live calving percentage are recommended more than once.

Live aninmal assessments and carcass assessment traits as calculated traits are hardly ever recommended in any of the guidelines. The only traits mentioned are linear scores, adjusted measurements or carcass conformation.

4.2. Calculated growth and weight traits

As was mentioned in section 3.4, weights are recorded as raw weights together with the weighing date. If weights should be exchanged in a standardized form, e.g. as yearling weight, weaning weight etc., they have to be adjusted to the correct age.

Growth traits are calculated from the age of animals and their live weight at this time, the result is usually expressed as daily gain in g per day.

For the international exchange of data, a standardization of time intervals is strongly recommended. Obvious time intervals determined through the production system would be:

- birth until weaning or fixed age;
- weaning until slaughter;
- weaning until first mating for females; and
- daily gain in a defined test period.

To be useful for comparative analyses, intervals should be as much standardized as possible, i.e. 'biological' recording dates (like 'weaning') should be replaced by fixed ages (e.g. 200 day weight).

Additional growth rates can be defined.

4.3. Calculated fertility traits

For female fertility, age at first calving and the average calving interval are the central parameters that are mentioned in most of the guidelines taking part in the survey. In many beef production systems, seasonal mating and calving is practiced which leads to an automatic culling of cows having fertility problems. However, this information is essential to select bulls to inherit high female fertility, i.e. information on female reproduction should be collected to allow a progeny testing of the cows' sires. Suitable parameters would be the non-return rate, the conception rate, days to calving or straws per conception, that are mentioned in some of the guidelines.

Especially in intensive systems using AI, the direct male fertility also plays an important role, with the paternal non-return rate (bull as sire of potential calf) as the parameter of interest, accompanied by other traits like scrotum circumfence or sperm quality traits as routinely measured for AI bulls.

4.4. Calculated efficiency traits

If feed consumption is measured on the test station, the feed efficiency, expressed as consumed food per unit of weight gain in the respective periods, can be calculated. In this ratio, consumption can also address dry matter or net energy intake, given that the food analysis data are available, which accounts for variation in the food quality. It is also possible to standardize feed efficiency e.g. for a given body weight or to use a 'net feed intake' corrected for growth and maintenance requirements.

Other efficiency traits used in some countries pertain to a lifetime productivity (e.g. calves per cow, total production per productive year or lean yield per day of age).

4.5. Calculated body composition traits

Based on both live animal assessments and carcass data, a large variety of traits can be calculated that reflect the composition of the carcass, especially the proportion of high priced cuts etc.. As shown in the results of the survey, these traits are defined specifically in each country so that they are rarely used across countries. Therefore no recommendations can be given as to which calculated traits in this area should be used on an international level.

4.6. Longevity traits

Longevity is an essential breeding goal, reflecting the ability of an animal to cope successfully with the environmental conditions given in the production system. Length of productive life of breeding animals can be calculated from the life history data of an animal However, the scientific community agrees that 'functional longevity' should be the trait of interest, i.e. longevity corrected for performance. In this context, culling for low productivity is disregarded (because performance is used as a different selection criterion), only culling for health problems or other non-production causes is taken into account. Since longevity also is a trait which typically is censored for the most interesting selection candidates (which are still alive), this trait is difficult to assess and requires complex statistical analyses.

5. The ICAR beef recording survey internet database

The ICAR beef recording survey "Comparative Analysis and Synthesis of National Guidelines for Beef Recording" was replied by 19 countries and two international organisations. In total, 36 questionnaires were answered. The information of these questionnaires was stored in a Microsoft Access Database. The size of the questionnaire, 106 complex questions and tables on 55 pages, made the database very large and complicated. The size of the complete database was 18.1 Megabyte. The chapters of the survey were stored in several tables, because they were too large to store all the information in one table. This computer storage problem made the analysis of the survey technically very difficult and an easier tool was developed to make the information easier to handle. This allowed the participants the opportunity to control the information they have given and to check whether the answers in the survey are correct or not.

For these reasons, a database access via the internet was programmed. This internet tool was also designed to make requests to analyse the survey. This data base retrieval system was the key tool for the development of recommendations for a general ICAR guideline. It is possible to make requests about each country's questionnaire as well as about beef recording traits that are used worldwide.

The programming was done with CGI-scripts written in the programming language *PERL*. This script language is free for all computer platforms and a standard equipment of all UNIX/Linux computers. The script-language works on the most widely used web-servers like the Apache Web Server, which also is a free program and a part of standard UNIX/Linux distributions.

The database tables were transformed into simple textfiles. The CGI-scripts read these textfiles and recognize all data entries based on key words. The advantage of using simple textfiles instead of real database tables is, that textfiles are much smaller and require much less disk-space than the database files. In the present case, the text files used only 0.7 Megabytes,

which is 3.8 per cent of the total size of the access data base for the same data. All text files can be read in the script simultaneously which makes the requests much faster than accessing database files.

The only disadvantage of this system is, that updates cannot be done per internet access. The updates have to be inserted into the database, from where the textfiles are generated again and loaded on the internet server. In the present project this is not a real disadvantage, because the survey does not have to be updated very often. After the revision by the participating organisations all errors should be found and only one update was nessecary.

The internet datebase could be installed on a web server of the Animal Genetics and Breeding Unit (AGBU) at the University of New England in Armidale, Australia. Hans-Ulrich Graser and Bruce Tier are gratefully acknowledged for providing the web space and the technical support.

The internet web-page with the database request possibility can be found under the following internet address:
http://pc-howarth.une.edu.au/icar.html

The structure of the requests follows the structure of the survey. All nine chapters can be found there. By clicking on a link to a chapter the page with the request possibilities for this chapter is loaded. There are no request possibilities combining variables across different chapters. The request is done in the same order of events for all nine chapters. At first choose a chapter you want information from (e.g. chapter 2: data recording and testing schemes). After two clicks first select the country you want information about (e.g. South Africa) with the left select box. Then choose the topic of your interest (e.g. live weights) with the right select box. Then press “Result” and a window opens with all live weights measured in South Africa for breeding and production animals.

The tables generated are close to the tables in the survey, so it is easy for the corresponding organisation to check, if the information is correct or not. For a new request press “Chapter 2” again to make a new request within this chapter. To select a different chapter, click “table of contents”, where a new chapter can be selected.

Beside this request within the different chapters, there are three request possibilities called “specials”. These requests are programmed to analyse the most important part of the questionnaire - the measured and calculated traits. In these points one can analyse, which traits are used worldwide in which countries, how they are defined and how often they are used in beef recording programmes. The traits mentioned are only traits that are described as mandatory traits in the respective guidelines. A lot of guidelines describe traits which can be measured as additional, non-mandatory traits, which are not included here.

To use these tables, click on the link of one of the three special topics (e.g. recorded data) and a new page is loaded. Then select in the left box the complex of traits (e.g. live weights) and in the right box the way the data should be presented (e.g. overview of all traits). Then press “Result” and a new page is loaded with all traits of this complex, which shows an overview of the countries, the trait definition within the country and the unit of measurement. To make a new request within this complex, press “Recorded traits” to go back to the selection menu, or press “Table of contents” to select a new complex of traits.

Three different lists can be selected: overview of all traits, as mentioned before, frequency of all traits and traits listed by countries. Within each request page the traits are also categorized in complexes, as used in the questionnaire. In these three request pages all traits, the respective countries, the definition, their respective frequency etc. are displayed. This way of accessing the stored information provides a powerful tool to make use of the complex information that was contained in the 36 different questionnaires.

6. Summary

The ICAR beef group has commissioned a global survey of national guidelines for beef recording. The information provided by 19 countries and two international organisations was put in a data base which is accessible under the URL:
http://pc-howarth.une.edu.au/icar.html.

Based on the information provided by the participating countries and organisations, a synthesis was compiled which suggests a general structure of data recording in beef production and breeding systems. All recommendations are mainly given for the purpose of enabeling the international exchange of data, which is an essential prerequisite for international genetic evaluations. However, beef production systems are very variable on a global scale and recording practices and definitions of traits are depending on the type of production system.

Four principle types of data are identified, i.e. invariable animal data, life history data, recorded data and calculated traits. It is strongly recommended, that all data recordings should be based on a uniform data format, which is suggested for the different types of data, respectively.

For the different types of data, the most important records are discussed in detail. Specific recommendations are given for the trait complexes animal identification and tagging, identification of farms, institutions and personnel, traits refering to reproduction and life history, live animal weights, live animal assessments, and carcass assessments. Regarding calculated traits, recommendations are given for growth and weight traits, fertility and efficiency traits and for traits reflecting body composition.

The development of new international guidelines for beef recording to be included in the ICAR set of guidelines is supposed to be built upon the suggestions made in the presented synthesis.

Appendix

A1. Information on countries participating in the survey

A1.1. Countries addressed and their response

Country	*Negative reply*	*Completed questionnaires*
Argentina	No guidelines affecting beef recording practices	
Australia		1
Austria		3
Belgium		5
Botswana	No performance recording no breed societies yet	
Brazil[1]		
Bulgaria		
Canada		
Chile	Beef populations too small breeding organisation very small	
Columbia		
Croatia		
Cyprus	No beef breeds	
Czech Republic		1
Denmark		1
Estonia	No special guidelines yet	
European Community		1
Finland		1
France		6
Germany		1
Greece		
Hungary		
India		
Ireland		1
Israel		
Italy		4
Japan		
Korea		
Latvia		
Lithuania		
Luxembourg	Data recording and calculation: program Bovins Croissance / France applies herdbook activities according regulations from the main breeding region	
Mexico		
Namibia		2
New Zealand	No general regulations or guidelines Breedplan / Australia applies	
Norway	Scheme too small and too new	
Poland	Number beef cattle is too small and activities too young	

To be continued...

....To be continued

Country	*Negative reply*	*Completed questionnaires*
Portugal		
Romania		
Russia		
Slovak Republic	activities too young, no guidelines yet	
South Africa		2
Spain		2
Sweden		1
Switzerland		1
The Netherlands		1
Tunesia		
United Kindom		1
USA		1
Zimbabwe		

[1] Countries printed in *italics* never responded to the inquiry.

A1.2. Trait complexes mentioned by guidelines in the different participating countries

	Fertility traits	Growth traits	Carcass assessments	Meat quality
Austria	x	x	x	
Australia	x	x	x	x
Belgium		x		
Czech Republic	x	x		
Germany	x	x	x	
Denmark	x	x	x	x
European Community	x		x	
Finland	x	x	x	
France	x	x	x	x
Ireland		x	x	
Italy	x	x		
Namibia	x	x		
The Netherlands				
Spain	x		x	
South Africa	x	x	x	x
Sweden	x	x	x	
Switzerland				
United Kingdom	x			
USA	x	x	x	x

A2. Tables on the frequency of recorded traits mentioned in the guidelines

A2.1. Traits 'start to end'

Trait	*Number of questionnaires*
Calving ease code	13
Date of birth of the animal	20
Date of disposal (e.g. Date of slaughter)	16
Date of weighing at start and end of the test period (e.g. Progeny station test)	10
Disposal code / cause of disposal	9
ET yes or no	9
Birth type code (e.g. Single, twin)	14
Mating date or insemination service date of mother	12
Mating type (e.g. Ai, natural mating)	14
Sex of the calf	20
Dates of start and end of each production period (e.g. Feed lot)	4
Father	1
Fostered yes or no	10
Paticulars of the calf	1
Twin with heifer or with bull	1

A2.2. Live weight traits

Trait	*Number of questionnaires*
Birth weight	12
Weaning weight	13
Weight at start and end of the test period	12
Weight with 365 days / 12,0 months / yearling weight	9
Each 90 days / 3 months	3
Weight at start and end of each production period	4
2 records at least each year	1
Each 180 days / 6 months	1
Each 30 days / 1 month	1
Each 60 days / 2 months	1
Live weight at slaughter	1
Sales weight	1
Weight at scanning	3
Weight with 112 days / 3,7 months	1
Weight with 200 days / 6,6 months	1
Weight with 400 days / 13,3 months	1
Weight with 420 days / 14,0 months	1
Weight with 540 days / 18,0 months	1

A2.3. Recorded traits from live animal assessments

Trait	***Number of questionnaires***
Linear scoring for muscular development	10
Body condition score	11
Linear scoring for skeletal development	5
Wither height at 13 months	5
Scoring for leg	4
VOS system	3
Hind hock length of the calf	3
Locomotion score	3
Mature size (height)	3
Scoring for feet	3
Pelvic area	2
Scoring for beef type	2
Coat colour	1
Eye muscle area at last rib	1
Fat depth at rib 10	1
Fat depth at rib 12 / 13	1
Fat depth at rib 13	1
Fat depth at rib 4	1
Intra-muscular fat percent (marbling)	1
Scoring for breed quality	1
Scoring for fattening status	1
Scoring for functional abilities	1
Scoring for general appearence	1
Scoring for temperament	1
Scoring for udder	1
Suckling ability	1
Vitality	1

Trait	***Number of questionnaires***
Feed intake	4
Fertility traits and maternal ability	
Calving ease code	14
Cow weight at birth of calf / weight after calving	3
Cow weight at weaning of calf	3
Scrotum circumference	4
Sperm quality traits	2
Production environment	
Contemporaries	6
Grouping of animals	10
Health events, sickness	5
Production system (e.g. Extensive suckler herd, feed lot)	7
Season	3
Management group	5
Carcass assessments	
Estimated meat yield	1
Carcass classification / scoring system	7
Carcass weight	7
Estimated yield %	1
Meat colour	2
Fat colour	1

A3. Tables on the frequency of calculated traits mentioned in the guidelines

A3.1. Growth traits

Trait	*Number of questionnaires*
Growth rate	17
Average daily gain	9
Weight gain	3
210 days weight	1
Birth weight within 4 days after birth	1
Carcase gain	1
Cow weight gain / loss - claving - weaning	1
Growth rate	1
Live weight at end of test	1
Weight at 200d	1
Weight at 400 days	1
Weight at end of test	1
Weight at start of test	1
Weight at typical age	1
Weight for age 200 days	1
Weight for age 365 days	1
Weight gain during adaption period	1
Yearling weight	1

A3.2. Fertility traits and maternal ability

Trait	*Number of questionnaires*
Age at first calving	14
Average calving interval	14
Calving ease	11
Gestation length	7
Maternal ability	6
Non return rate	5
Stayability	5
Conception rate	4
Days to calving	4
Milk production ability	3
Number of calves	3
%calves born alive	1
Adjusted scrotal circumference	1
Age at last calving	1
Calving first interval	1
Days open	1
Days since last calving	1
Last calving interval	1
Non return rate ai-bulls	1
Non-return-rate	1
Reproduction index	1

A3.3. Efficiency traits and herd or sample performance

Trait	*Number of questionnaires*
Feed efficiency	5
Cow efficiency	1
Kleiber ratio	1
Standardized feed intake	1
Total production per productive year	1
Live calving percent	4
Number of cows exposed	1
Percent palpated pregnant	1
Weaning percent	1

A3.4. Live animal assessment traits

Trait	*Number of questionnaires*
Muscular development	2
Note	1
Adjusted body length	1
Adjusted shoulder height	1
Avaerage score per category	1
Beef type note	1
Breed quality	1
Final points over 100	1
Frame score	1
Functional abilities	1
Functional ability	1
Linear muscle score	1
Linear scoring breed character	1
Linear scoring legs+feet	1
Linear scoring muscularity	1
Muscular note	1
Partial note for beef type over 100	1
Partial note for legs, over 100	1
Partial note for muscular development over 100	1
Partial note for height over 100	1
Size note	1
Stand note	1
Ultrasound	1
Weights	1

A3.5. Carcass assessment traits

Trait	***Number of questionnaires***
Carcass conformation	2
Carcass weight	2
%yield	1
Euro conformation	1
Euro fat	1
Bone% (prime rib cut)	1
Carcass conformation europ	1
Carcass fat grade	1
Carcass fatness	1
Carcass meat color	1
Carcass weight / carcass length ratio	1
Carcass yield	1
Compacity of carcass	1
Eye muscle area / 100 kg cracass weight	1
Fat	1
Fat % (in prime rib cut)	1
Internal fat	1
Kidney and channel fat	1
Kill out %	1
Lean meat percentage	1
Lean yield per day of age	1
Muscle% (prime rib cut)	1
Net daily gain	1
Net gain	1
Value index	1
Yield	1
Marbling	1
Meat color	1