

**FAO
STATISTICAL
DEVELOPMENT
SERIES**

4

**COLLECTING DATA
ON LIVESTOCK**



**Food
and
Agriculture
Organization
of
the
United
Nations**

Collecting data on livestock

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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FOREWORD

The Statistical Development Series is a sequence of comprehensive technical manuals on the various aspects of the statistical programmes which make up a national information system for food and agriculture. The publication "Food and Agricultural Statistics in the Context of a National Information System", "Programme for the 1990 World Census of Agriculture", and its supplements for Africa and Europe", "Microcomputer Based Data Processing and Sampling Methods for Agricultural Surveys", have already been published.

In the Statistical Development Series, emphasis is placed on the need to conceptualize data sources within the framework of a national information system in which the concepts are standardized and duplication of effort minimized.

This publication on livestock statistics is intended to assist statisticians in their work in a particularly difficult and varied area. Users of this manual are kindly invited to communicate to FAO their comments and suggestions for the improvement of subsequent editions.

The Director
Statistics Division

1. INTRODUCTION

1.1 Livestock

The term 'livestock' used in this manual covers all animals kept or reared mainly for agricultural purposes including cattle, buffaloes, sheep, goats, pigs, horses, mules and hinnies, asses, camels, poultry, bees, silkworms, deer, rabbits, llamas, yaks, as well as foxes, mink, etc. reared in captivity for agricultural purposes.

Livestock farming is recognized as an economic activity distinct from growing of crops. In the third revision of the International Standard Industrial Classification (ISIC), the structure of the Tabulation Category A, Agriculture, Hunting and Forestry is as follows: 1/

AGRICULTURE, HUNTING AND FORESTRY

DIVISION 01 AGRICULTURE, HUNTING AND RELATED SERVICE ACTIVITIES

011 Growing of crops; market gardening; horticulture

0111 Growing of cereals and other crops n.e.c.

2/

0112 Growing of vegetables, horticultural specialties and nursery products

0113 Growing of fruit, nuts, beverage and spice crops

012 Farming of livestock

0121 Farming of cattle, sheep, goats, horses, asses, mules and hinnies; dairy farming

0122 Other livestock farming; production of animal products n.e.c.

1/ ISIC, classifies all economic activities into: Tabulation Categories, Divisions (two digits), Groups (three digits), Classes (four digits) in descending order of generality.

2/ n.e.c.: not elsewhere classified.

013	0130	Growing of crops combined with farming of livestock (mixed farming)
014	0140	Agricultural and animal husbandry service activities, except veterinary activities
015	0150	Hunting, trapping and game propagation including related service activities
DIVISION 02 FORESTRY, LOGGING AND RELATED SERVICE ACTIVITIES		
020	0200	Forestry, logging and related service activities

It can be seen that livestock farming combined with growing of crops is treated as a class, separate from farming of livestock alone. However, services for crop growing and livestock farming are put together in the same class: 0140. Livestock services do not include veterinary services on a fee or contract basis. Veterinary services are in class 8520 under the Division "Health and Social Work".

This manual covers mainly the data related to livestock husbandry included in Groups 012, 013 and 014. The group 015 (Hunting, Trapping and Game Propagation Including Related Service Activities) is excluded. The production of certain livestock products included in the "Manufacturing" category is dealt with briefly.

1.2 Importance of Statistics on Livestock and Livestock Products

There is a growing awareness of the importance of livestock and livestock products in the socio-economic progress of developing countries. It is being increasingly recognized, that livestock products in the form of meat, milk and eggs, supply much needed animal protein, thus contributing to the improvement of the nutritional status of under-nourished millions. In most developing countries, draught animals provide power for the cultivation of innumerable and small agricultural holdings scattered all over the country. Livestock also provides much needed farm yard manure for enrichment of the soil. Animal and animal-

drawn carts are still essential modes of transport connecting thousands of villages, enabling them to haul their produce to marketing centres and bring back their agricultural and domestic requisites. Further, the livestock sector offers prospects of supplementary cash income to augment the meagre income of landless agricultural labourers and small farmers, by providing avenues of employment and opportunities for crop diversification. The livestock industry has great potential to contribute to economic development and, if developed on proper lines and if the conditions of international meat hygiene are met, it can earn foreign exchange through the export of livestock and livestock products.

In view of the important role that the livestock sector plays in the economy of many countries, it hardly needs emphasizing that programmes of livestock development should be formulated on a sound statistical basis. As a result of persistent national and international efforts, in recent years a greater appreciation has developed of the importance of and need for livestock statistics. The need has become all the more urgent in view of livestock development planned by a large number of countries. Timely and accurate livestock statistics are required for the formulation and implementation of realistic programmes in the livestock sector, and for the periodic evaluation of their impact on the national economy. The statistics collected are needed to analyse the available livestock resources, their current allocation, future growth trends, output of livestock products, their levels of productivity, and their effect on prices.

1.3 National Information System

Livestock statistics form a sub-set of food and agriculture statistics, the improvement of which is one of the primary objectives of FAO. However, in spite of the increased awareness in developing countries of the importance of timely and accurate livestock statistics for planning social and economic development, most countries do not have an adequate statistical department or trained statistical personnel for collecting, processing and analysing information on livestock. Livestock censuses and surveys and other related statistical studies are usually undertaken in isolation from each other and from their end

use. Further, there is a lack of coordination among statistical, planning and decision making departments which makes it difficult to integrate the various important elements for developing a national information system for the livestock sector.

To overcome these problems, FAO has periodically promoted the preparation of national, long-term, integrated programmes of food and agricultural statistics, including livestock statistics, in developing countries. Training courses in developing countries have promoted the concept and application of long-term, integrated programmes of food and agricultural statistics. These efforts have finally led to the development and operation of an information system designed to support effective government intervention in the agricultural sector, including the livestock sector. This system forms the basis of the 1990 World Census of Agriculture. 1/

In order to be able to contribute to the development of improved programmes of livestock statistics in developing countries, it is necessary to adopt a dynamic approach in which there is a continuous interaction between users and producers of information on the livestock sector, so as to meet, effectively and efficiently, the ever-changing demand for the required information. The underlying concepts, definitions and methods need to be constantly reviewed and adapted and the necessary human, financial and institutional resources maintained and developed.

For improving communication and coordination between suppliers and users of livestock statistics, it is necessary to identify the decision makers in the livestock sector. These people, mostly in the public sector but possibly also in the private sector, are responsible for guiding and managing the development and performance of the livestock system.

1/ FAO, Food and Agricultural Statistics in the Context of a National Information System, Rome, 1986.

Under these conditions, the long-term integrated programmes of food and agricultural information system will continue to be demand-driven, to meet the needs of the users, and thus to be an essential tool for taking efficient decisions.

1.4 Structure of the Document

The present manual is a revision and enlargement of the FAO "Guide to Statistics of Livestock and Livestock Products", provisionally published in 1976.

The manual consists of seven chapters, two case studies and an appendix containing the definitions of selected technical terms. The first chapter provides a general framework for livestock statistics. This general framework is the national information system for food and agriculture. In the second chapter methodological issues of collecting data on livestock numbers and livestock characteristics are discussed. After presenting various sources of data, the problem of enumerating nomadic livestock is examined. Chapter 3 is devoted to livestock census, which all countries are recommended to undertake separately from other censuses. Chapters 4 and 5 deal with the collection of data regarding livestock products such as meat, milk, eggs, wool and skins. In Chapter 4 attention is focused on the definition of the concepts. Chapter 5 covers the methodological issues. In Chapter 6 cost of production studies are described. Chapter 7 provides a general account of the methods recommended for collecting data on animal feed.

The case studies included in the manual concern Australia and Canada. For each country, the methods used for collecting livestock statistics are described. The Appendix is intended to serve as a quick reference to the definitions of various concepts used in livestock statistics.

2. METHODOLOGICAL CONSIDERATIONS CONCERNING LIVESTOCK NUMBERS AND LIVESTOCK CHARACTERISTICS

2.1 General

Due to the special nature of livestock data, collection of livestock statistics requires particular techniques. Data on livestock numbers and livestock characteristics cannot all be obtained from a single source. In the first volume of the FAO Statistical Development Series (Food and Agricultural Statistics in the Context of a National Information System) various sources have been cited. In this chapter, after reviewing various data sources regarding livestock numbers and characteristics, the techniques used for enumerating nomadic livestock are explained.

2.2 Source of Data

In practically all countries the primary sources of livestock numbers and data on livestock characteristics are the following:

- (i) Census of agriculture.
- (ii) Livestock census.
- (iii) Periodic and ad hoc sample surveys.
- (iv) Research institute and experimental station records.
- (v) Administrative records and returns.
- (vi) Household income-expenditure survey.

Most countries use more than one of these sources to obtain data on livestock and livestock products.

2.2.1 Agricultural Census

The majority of the countries use the agricultural census as a source of data on livestock numbers. The information provided is tabulated not only at the national level, but also by broad administrative divisions of the country. Furthermore, the data is aggregated, in many cases, to suit the needs of agro-ecological zones. The information on livestock may be related to characteristics of agricultural holdings. The census information provides benchmark data for current statistics. Agricultural census

data suffer from the drawback that the information on livestock numbers is under-estimated, since livestock in non-farming households is omitted. Incomplete coverage also arises due to the omission of livestock maintained on holdings of a size below the prescribed minimum. Since an agricultural census is carried out generally once every ten years, livestock numbers during the inter-censal period are not available for countries which depend entirely on the census. For some species, such as ovines and poultry, a ten-year gap is too long a period.

2.2.2 Livestock Census

In some countries, the livestock census is an annual operation. In a very few countries it is conducted quinquennially. The census is usually conducted by extension officers of the Department of Veterinary Services or by other appropriate agencies with data collection capabilities. Data are recorded in a questionnaire prescribed by the census authority on a village basis or by interviewing livestock owners on a holding basis. Information collected may pertain to livestock numbers classified by species, sex, age and purpose.

In a livestock census, generally, the number of livestock, irrespective of ownership, present on a holding on a specific date is recorded. This number also includes the livestock belonging to the holding but temporarily away or in transit at the time of enumeration and which are not on any other holding. In most countries the data collected are limited to livestock holdings of a minimum prescribed size.

The subject of the livestock census is dealt with in the next chapter of the manual.

2.2.3 Periodic and Ad-hoc Sample Surveys

Periodic surveys, which may be annual, semi-annual, quarterly or monthly, can furnish detailed data on the number of livestock classified by species, age groups and uses, the total number of milk animals with a breakdown of animals in milk and dry animals, and the number of poultry subdivided into broilers, layers and chickens. Ad-hoc sample surveys are usually restricted to limited areas of a

country. Some countries utilize these sample survey estimates to establish inter-censal estimates and to study seasonal fluctuations.

2.2.4 Records

The data collected from research institutes and experimental stations are of a highly specialized, scientific nature and are used in the development of quality breeds of animals through genetic and nutritional improvement. These research institutes and experimental stations may provide data on rare species.

2.2.5 Returns

These are the summarized versions of the information contained in various routine administrative returns prescribed by the government, either through executive orders or under legal provisions. They are therefore obligatory. These records in many countries identify movement of livestock within a country, contain information regarding location of nomadic tribes, grazing and pasture acreage, along with details on location, annual acreage of cultivated fodder crops, types and quantities of vaccine produced, number of livestock treated, number cured and number dead, laboratory tests carried out for the detection of diseases, strength of veterinary staff classified by type of duties such as research, extension, administrative and clerical; number of livestock holders contacted and nature of assistance rendered, number of research stations, veterinary clinics, quarantine posts along with the number of animals quarantined, taxes levied on livestock. Most countries have prescribed administrative forms related to livestock which have to be filled in according to detailed instructions and sent on the due dates to the authorities concerned.

2.2.6 Household Income-Expenditure Survey

In many countries family budget surveys are used to collect data on livestock and livestock products, for example on livestock numbers classified by species, age and sex, average weight per live animal, along with other data.

2.3 Enumeration of Nomadic Livestock

Under the nomadic mode of living, a person is identified not as belonging to a particular locality, province or other delimited territory but belonging to a tribe which is a group of nomadic people usually having the same ancestral origin. Due to ethnic and religious differences, the social structure of the tribe may differ amongst nomadic people of different countries, but the general characteristics of all nomads are subordination of the individual to his clan or community and non-stationary residence or movement of livestock herds. The need to migrate is imposed by harsh climatic and physical conditions which compel them to move in search of pastures and water for their livestock.

Nomadism is broadly defined as a movement of tribes or clans and/or herdkeepers with their herds.

Nomads are found in a number of countries, such as western and central African countries, Sudan, Somalia and Ethiopia, as well as in some other areas of the world such as Latin America, Near East and Asia. The habitat is mostly confined to arid and semi-arid areas where growth of pasture and availability of water are seasonal and usually variable to a great extent. In the case of many tribes, movement takes place generally according to a clearly specified itinerary and along well-defined tracks. Sometimes, however, the outward and returning routes may not be the same and it may be in a circular fashion, as in the case of some tribes in the Near East. It is possible that the routes are changed from year to year but their camping places during the hot season are usually fixed. Nomads are reluctant to establish contacts with other civilian and with governmental authorities on account of the fear of taxation, of compulsory military service and other causes. They are proud of their nomadic way of life and their own system of values.

It is clear from the above description that the complete enumeration of nomadic herds is a very difficult operation which is sometimes impractical if not impossible. Suitable sampling techniques may have to be evolved to tackle the problem of enumeration through sample surveys. The difficulties of field work of such surveys would be:

long distances the tribes cover; travel conditions in arid areas; as well as lack of transport and other facilities (e.g. water, food, camping, etc.).

There is no best method that is better in all situations but whatever method used, it is necessary first of all to have a good knowledge of the tribal family groups, their customs and habits, pattern and time of movements, grazing grounds, including maps of the routes used by each tribe. This kind of information provides useful guidance in choosing the appropriate time and place of survey operations. Information on livestock management practices as well as on the size of the population of each tribe and on the size of its herds are also important, and can be utilized for stratification purposes and other improvements in the sample design.

The methods of enumeration, according to the type of sampling units, are listed below:

2.3.1 Sample Surveys Using Tribal Groups as Sampling Units

Tribal groups or other suitable sub-divisions can be used as sampling units in the enumeration of nomadic livestock. A list of these groups should be prepared with information on their size, time and pattern of movements, place and duration of camping. This information may be obtained from administrative records or from a previous population census. Special care should be taken to up-date the list to be used as a sampling frame, from which some groups are selected at random for enumeration.

This method was applied in Iran. A sample survey of nomadic tribes was carried out as part of the agricultural census of 1960. The list of the tribal sub-groups, known as branches, was available through the army officers responsible for their administration. These groups were defined by size, according to the number of households and livestock, name of the tribal chiefs, period and approximate location of their summer camps. The sampling was in two stages, the sub-groups were selected as primary sampling units and within each selected sub-group, a sample of households was taken, on which the enumeration of livestock was carried out.

Two main problems were encountered in this investigation. First, big differences were found between the number of households provided by the official list and the ones actually found. Another problem was caused by the difficult access to households scattered over relatively large mountainous areas.

The work of enumerating nomadic livestock is facilitated and improved when the cooperation and assistance of tribal chiefs and leaders are sought. In many countries these chiefs are usually well known to the administrative authorities and can often be easily located and questioned about the size of families under their supervision, the number of animals held, pattern and periods of the movements and places of camping of the tribes. Generally, they have a fairly good idea about these questions and their cooperation is very helpful in ensuring contact with the tribesmen. The enumeration work may require in some cases the assignment of an enumerator to a sample of tribal groups, to travel with them and enumerate the livestock held at certain periods of the year.

2.3.2 Water Points as Sampling Units

A method that has been recommended in nomadic livestock surveys is one that uses water points such as drinking wells, waterholes, or segments of river banks as sampling units.

This method was tried in a pilot survey of livestock in Southern Ethiopia, carried out in 1957. The survey covered the Borena Region in Sidamo Province, occupied by semi-nomadic pastoralists who depend entirely on livestock for their livelihood. A meeting with the tribal leaders was arranged and they were very helpful in providing the general information required by the survey team, which included the enumeration of permanent wells, and areas where water shortages were more acute. They even accompanied the team to some wells in order to meet individual herdsmen whose stocks were to be examined.

The survey team concentrated its work on estimating the livestock population dependent on permanent wells during the dry season. The first step was to enumerate these wells. Detailed observations made at two wells over a period of three days demonstrated that it would be

possible to estimate the livestock population dependent on permanent wells by making counts at a sufficient number of holes.

A stratified sampling scheme according to the size and type of wells was used. The first stratum consisted of large wells with deep-shafted holes, the second stratum was made up of large wells with many shallow holes and finally the third stratum of smaller wells. From the first stratum a sample of five wells was chosen and a sub-sample of four water holes was taken from each well. The stock watering at each of these holes was counted. In the second stratum there were six wells and all of them were included in the sample; from each well eight holes were selected at random. In the third stratum a sample of five out of 34 wells was taken, without a sub-sample of holes.

Young animals of less than 15 months which normally water at springs near the temporary villages were not covered, and the survey team estimated the number of these animals by examining the stocks at villages, as 30% of the cattle population. In addition to the omission of young animals, the coverage was incomplete because the banks of the two permanent rivers were not accessible to motor vehicles over the greater part of their length. Apart from this, due to the exceptional rains in 1957, the main wells were not in full use at the time of the survey.

At most of these wells visited by the survey team, arrangements were made with the local leaders to examine one or more of the herds at the temporary village enclosures. In this way the animals could be examined individually and age determined by the teeth and general conformation. It was of course realized that at all ages large variations occur in teeth development.

This method was also tried in the nomadic area of the Tahoua district of Niger. The plan was to reach the households and their herds through a list of water points compiled at various administrative centres, and supplemented with new information gathered in the demographic survey that preceded the livestock enumeration. The demographic data were collected for all families staying around the water points, and the list prepared was passed to the enumerators of the livestock survey. One-tenth of them

chosen at random was included in the sample, but it was found that by the time the livestock enumerators arrived at the watering points a large part of the population had moved away, and this technique had to be given up.

The main problem in the application of this method is the lack of accurate lists and adequate maps of water points, as they are not in general well-known to the administrative authorities. In addition, there is a high seasonal variability of the water points, either in number or in capacity of watering the livestock. These were the reasons why it was not feasible to prepare an exhaustive list of water points in western Iran, where some transhumance movements are practised. Consequently, the survey was based on a sample of camps or small villages.

There is also the problem of incomplete coverage, as it excludes the young animals which are usually watered at springs near the camps because of the long distances between the camps and the water points. Furthermore, there are herds that obtain their water from rivers. Supplementary inquiries are therefore necessary to estimate the part of livestock which is not brought to wells. The figures obtained by using surveys of water points may well be below the actual number for the reasons mentioned above, and the fact that the number of livestock during the dry season is usually lower than in other seasons.

The enumeration of livestock by this method consists of either enumerating or estimating the total number of animals utilizing a given water point. If the method of enumeration of animals is used, the number of herds using a water point and the interval of watering for each livestock species should be taken into consideration. The total number of livestock may be estimated by considering, for instance, the number of herds watered per day, the average size of the herds and the interval between successive waterings by each species. This technique consumes less time than the complete count of all animals, but it is less accurate.

It is considered that the practice of branding animals may be of help in improving livestock enumeration. But it should be realized that not all animals are branded and sometimes the same brands are used by different owners, and

in some instances the animals are branded several times as they change hands due to sale, gift, etc.

2.3.3 Stock Routes as Sampling Units

Another method that can be considered is the utilization of stock routes as sampling units. This method consists of selecting a sample of stock routes and then of counting all nomadic animals that pass through during the whole period of their movements. The enumerators should be placed at strategic points, at appropriate times during the year, in order to count the herds without omission. This method is applicable in countries where the movements of the nomads with their herds have definite routes which can be accurately determined before the movements take place. This method is difficult to apply in large mountainous areas.

One problem that arises with this method is that it is not sure that the same routes will be utilized in successive years. In fact, it is likely that the nomads will change their routes after being informed of the survey operations. Another difficulty with this method is the possibility of confusing, by the enumerators, the herds of the sedentary population of neighbouring villages with the nomadic livestock. A great disadvantage of this method is that it is not appropriate to collect data on age and sex distribution and other information, as the tribesmen may not agree to stop the herds for such purposes.

2.3.4 Aerial Surveys

Aerial survey is one of the methods that has also been advocated for the estimation of nomadic livestock. The information available is not decisive, and a great deal of experimentation would be required to make this method feasible in the conditions that exist in certain countries.

Two techniques have been employed in aerial surveys. The first consists of a direct count of the animals observed from the aircraft while it flies along certain flight routes which have been selected as a sample. These counts are made by experienced observers at given intervals of time. Besides being expensive, this technique has the disadvantage of missing the animals under the shade of

trees. A further disadvantage is the difficulty of identifying smaller species and in differentiating livestock from wild game. It is not possible either to differentiate the nomadic animals from those belonging to the sedentary population of neighbouring villages. This technique of counting is very fast, but only totals of each species can be estimated.

In the second technique the nomadic dwellings and camps used by the nomads seen along the selected flight paths are mapped or counted and then a sample of dwellings or camps is surveyed on the ground for the estimation of total livestock. The survey operations should be undertaken while the nomads are stationary.

Aerial surveys for the enumeration of nomadic livestock can be very expensive per unit of observations, especially in very large regions, as livestock may be concentrated in a few places. These surveys could be useful for precounting investigations to spot a herd or a flock in remote and inaccessible places. From the experience of the countries which adopted aerial photography for enumeration of nomadic livestock, it is found that by any standards the cost is considered to be reasonable for estimates.

The method of aerial survey is found to be advantageous as experienced in Sudan and some neighbouring countries (Kenya, Uganda and Ethiopia). The conditions in Sudan are:

- The country is vast with over 100 million hectares of grazing land largely inaccessible by road;
- Over 90 per cent of livestock is held by nomads without barns to cover the animals, the majority of the stock being found in flat open country or low woodland savannah;
- There is a well-known pattern of seasonal stock movements;
- Excellent flying conditions exist throughout the year with only a few dusty days;

- It is very difficult in practice to enumerate the stock through interviewing households or by direct counting on the ground;

When using aerial photography methods the sources of errors have to be taken into account and quality control measures used. These are discussed below:

(i) Sampling Errors in the Aerial Survey

The variance between transects is the only source of sampling errors. Although the number of sample transects in any given stratum should be optimized, taking account of the size of the stratum, inherent variability and costs much depend on the ability of the surveyor to minimize the variability between transects, through stratification. He should plan the direction of the transects so as to reflect maximum variability within the sample transects. For instance, flying parallel to systematic movement of stock would maximize sample variance while flying across would tend to minimize it. Another important precaution would be to avoid flying at times when stock tends to group together, as for example in the evening while going towards watering points. The surveyor should also be in a position to modify his stratification if in the course of flying, some odd features are noticed that would obviously contribute substantially to sampling variance unless taken care of separately. Use of satellite imagery stratification can cut down costs and make it more efficient.

(ii) Biases Inherent in Flying

Stratification and sampling on the map, when actually implemented in the air are subject to a number of possible biases arising from difficulties in identifying the exact boundaries of the strata, in keeping constant height of the aircraft, in keeping a straight flight line over the sample transect, and in keeping a constant angle of sight by controlling the tilt. Some of these biases cannot be completely avoided but means are available to minimize them.

(iii) **Biases Due to Animals Missed from Count**

Despite best efforts on the part of the surveyor, a certain number of animals will be missed from the count as a result of either being under cover or in the shade of trees or overlapping one another. A number of steps can be taken to minimize the number of missed animals. For instance, flying should be avoided when shadows are long and also when animals tend to go under shade. Nevertheless, the animals under cover would still be missed and their number has to be estimated through careful ground work and used to correct the estimates.

(iv) **Biases due to movement of stocks**

Random movements of stock are of little consequence as they would not influence the count in randomly selected transects. On the other hand, systematic movements of stock can cause substantial biases unless recognized in advance and taken into account in stratification, in setting the direction of the transects and in the sequence of flying various strata. By taking appropriate measures, the bias due to stock movements can be minimized. In the case of inter-provincial movements, the survey timing has to be coordinated with the movement pattern so that the survey reflects the desired administrative distribution, or the survey has to be repeated at different times to reflect seasonal variations. In the case of movement across international borders special arrangements have to be made to enumerate the border areas at a time when the national livestock is within the country.

(v) **Personal Biases**

Human ability to observe, recognize and count stock on the ground from a fast moving plane varies with individuals. Controlled tests in which known numbers of animals released in test areas were successfully counted by flying technicians have indicated that, while flying at 300 to 400 feet under good visibility, conditions a very high measure of efficiency in counting animals on the ground can be

achieved. There may be some confusion between sheep and goats which can be resolved by ground counting on a sub-sample of the transect areas. An important factor affecting the efficiency of aerial counts is the width of the transects in relation to the density of animals and type of vegetation and grass cover on the ground. It is important that an optimum width for different conditions should be established by each surveyor. Above all it must be recognized that the efficiency of the entire operation depends greatly on the experience of the aerial surveyor.

2.3.5 Use of Satellite Imagery

Satellite imagery could be useful for direct counting of the livestock. Photographs on a scale of 1:250 000 have been found to be very useful as an aid in stratification in Sudan.

3. LIVESTOCK CENSUS

3.1 Design

The livestock census is the most important source of data on livestock in many countries. In this section questions that need to be addressed in designing a livestock census are explained. The basic approach adopted here is similar to that of the agricultural census as explained in the Programme for the 1990 World Census of Agriculture. 1/

3.1.1 Objectives

The two main objectives of carrying out a livestock census are:

- (i) to obtain data on basic characteristics of livestock, such as age, sex, breed, use and livestock system;
- (ii) to provide a frame for specific surveys on livestock.

The main users of livestock census data are government officials involved in planning and evaluating the livestock sector; farmers raising livestock; agencies involved in providing technical and/or financial assistance to farmers; international organizations like FAO which are concerned with the state of livestock in the different countries of the world and the world's food supply situation; and business and research organizations.

3.1.2 Scope

The scope of a livestock census will vary with the stage of statistical development of a country and the importance of the livestock sector in the overall economy. It is important to emphasize underline that the scope of any census needs to be decided within the context of all

1/ FAO, Statistical Development Series N^o 2, Programme for the 1990 World Census of Agriculture, 1986, Rome.

other data collection activities, and of a long-term statistical programme.

A livestock census will generally include the following items:

- Location of holding
- Legal status of holder
- Age of holder
- Sex of holder
- Livestock system
- Livestock numbers by
 - type
 - age
 - sex
 - race
 - purpose
- Number of milk animals subdivided into
 - in milk
 - dry

Some other items which may also be included are:

- Stables
 - area
 - construction, type of walls
- Number of livestock
 - born
 - died from natural causes
 - slaughtered
- Access to veterinary services

3.1.3 Coverage

The livestock census should, in principle, cover the entire national territory, including both rural and urban areas, and comprise all species of livestock. The experience of conducting country-wide censuses, however, indicates that certain inaccessible areas of the country, because of harsh climatic or communication difficulties, are left out of the enumeration. While in some countries censuses and annual enumerations cover practically the entire livestock population, in others the coverage of enumeration is either confined to animals kept on farms or

in rural areas only, or to those holdings which have a minimum number of animals. Obviously, the relative importance of the animals which are excluded from the count varies from country to country. In this respect, it is recommended that all countries should aim to have the whole livestock population covered by current livestock statistics. If, because of administrative difficulties, the coverage of the enumeration is limited in any way, estimates should be provided for the non-reported portion, through special surveys.,

3.1.4 Frequency

Livestock censuses may be conducted twice a year or annually. Some countries take their livestock censuses every five years. Livestock populations are subject to marked seasonal fluctuations, except possibly in the case of horses, asses, mules and camels; cattle, pigs and poultry show a strong seasonality. Consequently it is important always to conduct censuses at the same time of year if the time series data are to be meaningful.

3.1.5 Time Reference

The time reference for livestock census is a given day. The date(s) of the livestock enumeration should be indicated in the statistical publications.

3.1.6 Enumeration Period

The livestock census should ideally be carried out and completed throughout the country on the same day, i.e. on the reference date. Although in actual practice this is not possible, attempts should be made to reduce the enumeration period to a minimum. Preferably, enumeration should be completed within a fortnight. Prolonged enumeration may result either in the omission of certain animals or double counting of the same animals due to frequent animal movement from one part of the country to another.

3.1.7 Statistical Unit

The statistical unit of a livestock census is the livestock holding. The definition of livestock holding is given under section "census items".

3.1.8 Complete or Sample Enumeration

A livestock census may be conducted with complete enumeration, or with sample enumeration, or both. Complete enumeration provides a good frame for specific sample surveys on livestock and provides data for any geographic or agro-ecological region, however small it may be. It makes it possible to identify holdings keeping rare animals. It also provides a list of holdings operated by women.

Sample enumeration also has certain advantages, for example where access to parts of the country is extremely difficult, or in countries where it is difficult to find a sufficient number of qualified enumerators, or where data processing facilities are limited.

3.1.9 Census Frame

A list or any other means which contains all the units on which the relevant data are collected is generally termed 'frame'. A frame is needed for both sampling and also for complete enumeration.

An ideal census frame would be the register of holdings which exists in some countries. These registers contain regularly updated information, taking account of the continuity of holdings over time, as well as of their appearance and disappearance. A farm register has a fixed reference number for each holding, and basic information on the characteristics of the holding is entered periodically in the register.

In countries where a register of holdings is not maintained, other frames are needed. One such frame can be obtained from a population census if it is carried out prior to the livestock census and the questionnaire permits the identification of holders. However, if the time-lag between the population census and the livestock census is too long, the list of holders obtained from a population census may be out of date.

Other possible frames for a census of livestock include a list of enumeration areas, a list of localities

(villages), aerial photographs and maps. An enumeration area is an area with clearly identified limits. The boundaries of enumeration areas should be established in such a way that there is no overlap between the enumeration areas. Care must be taken to update the list of localities, although there is normally little change in their size and composition in a relatively short period.

There are several possible reasons for inaccuracies in the frame. The principal among these are: a) omission of some holdings; b) double-counting of some holdings; c) presence of some holdings not eligible for the livestock census.

If, on checking, it is found that inaccuracies are few and not serious, and that they can be corrected without much expense, efforts should be made to remove them. Alternatively, if the inaccuracies are known to be very small compared with other types of error, and correction would involve considerable cost, they can be ignored.

Some inaccuracies in the frame may be treated statistically. If the census is based on complete enumeration, the inaccuracies of category (b) and (c) are detected automatically at the time of detailed checking of the livestock census data, and the final correction can be made when tabulating the census data. However, if the census is based on a sample, special procedures need to be adopted to correct the estimates.

Errors in the frame may cause serious biases. Any bias in the total number of units in the frame automatically introduces bias in the total of all the characteristics estimated. Of course, the magnitude of this bias depends on the distribution of errors in the frame. It may be large if either omissions or duplications are numerous. However, in either of these two cases it will be small if the units in question contribute little to the totals of the characteristics concerned.

An accurate frame is of paramount importance in the census. Every effort should, therefore, be made to prepare an accurate frame.

3.1.10 Data Collection

In a livestock census, data are usually collected through personal interview and/or by mail. In the interview technique, an enumerator visits the holding and enters in the questionnaire the responses of the holder to the questions. Interviewing may be supplemented by observations or measurements carried out by the enumerator. Interviewing is the basic technique in most developing countries, where postal services are inadequate and the literacy rate is low in rural areas.

The mailing technique is much less costly than interviews. The questionnaire, together with explanatory notes, is mailed to the holder usually with a stamped and addressed envelope. This technique is used mainly in developed countries. It may be necessary to send one or more reminders to holders to increase the response rate.

Sometimes interviewing and mailing are both used, to complement each other. A sample of holders who have not responded, even after the reminder letters, might be sent to interviewers. Sometimes data are collected from juridical holders or government operated holdings through mail, and enumerators are sent to other holders. Each country must decide on which technique is most suitable, taking into account its conditions and available resources.

3.1.11 Non-Sampling Errors

Apart from the sampling errors which arise only when sampling is used, it is common experience that data collected in a livestock census may suffer from many other types of errors common to both complete and sample enumeration. A frame which does not include all holdings, ambiguously worded questions, failure of the enumerators to find the respondents or to record the correct answers, non-cooperating holders, failures of editing and coding personnel to carry out the work accurately, etc. are some of the causes of non-sampling errors.

It is important to take steps to control all possible sources of non-sampling errors at various phases of census operations. Detailed manuals on work to be done by both field and office personnel, adequate training programmes

and efficient control of activities help to reduce errors due to enumerators, editors, coders and other data processing personnel. The design of the census should allow for a quality check survey as well as other appropriate measures to cope with non-cooperating holders and holders that cannot be contacted. Reference can be made to FAO publication 1/ or to other sources, for detailed information on non-sampling errors.

3.1.12 Data Processing and Analysis

Normally today computers are used for the processing of the data. It is important to plan ahead for the acquisition of hardware, training of personnel, participation of data processing experts in the design of the questionnaire and acquisition of software, or writing the computer programs.

In countries where livestock census has been a periodic activity, the results of these censuses over a few decades indicate the trends of changes in livestock numbers. Both these changes and the complex relationships between variables are best analysed by means of appropriate models, which may be of different levels of completeness and complexity, depending upon the availability of information. With both macro- and micro- analysis, the objectives of the census and the requirements of main users of livestock census data should be kept in mind.

3.2 Census Items

A census "item" in this manual, refers to specific information on a certain category of livestock. The census items for data on livestock are listed in the document "FAO Statistical Development Series N° 1 - Food and Agricultural Statistics in the Context of a National Information System". In this document, the objectives and the work load on the respondents and on the field personnel are considered for each item. This document attributes a

1/ Zarkovic, S.S. (1966). Quality of statistical data:
FAO, Rome.

six digit code to each item. The first two digits show the category, the following three digits indicate the division, the section and the subsection, respectively, each referring to a particular area of interest, in decreasing order of generality. The sixth digit identifies the item within a subsection. The category title "Livestock" has been assigned two codes 07 and 08. This category provides data on the type of livestock system of the holding and on the characteristics of the present population of livestock kept. Depending on the needs, some items from other categories may also be included in the livestock census.

Livestock: Livestock refers to all animals kept or reared mainly for agricultural purposes, including cattle, buffaloes, sheep, goats, pigs, horses, mules and hinnies, asses, camels, poultry, bees, deer, rabbits, llamas, as well as foxes, mink, etc. reared in captivity on the holding for agricultural purposes. Countries may wish to collect data separately on various types of livestock grouped under item 071304, to suit their needs.

Livestock system: This refers to the general characteristics of livestock keeping practices. Four different livestock systems are identified:

- (i) households with no permanent place of residence, which do not practise regular cultivation;
- (ii) households with a permanent place of residence, which they keep for several years. These households cultivate crops as a supplementary food source, but they move the herds on transhumance to assure sufficient forage and water;
- (iii) cultivation carried out by households with a permanent residence;
- (iv) livestock kept on ranches.

Livestock population: The "present population of livestock" refers to the number of animals present on the holding on the specific reference date, regardless of ownership. It includes animals temporarily away or in transit at the time of enumeration.

3.3 Tabulation Programme

3.3.1 Link Between Questionnaire and Tabulation Programme

Tabulation and the content of the questionnaire are interlinked. The main consideration in preparing a tabulation programme is the information needed. Ideally, the tabulation should be planned concurrently with the questionnaire. This would ensure that items of information needed in the tabulations are included in the inquiry.

The arrangement and presentation of the data in tables for analysis and publication must then be determined. The table format should be such that the meaning and significance can be readily grasped by the user.

In determining the classification to be used, it is useful to examine tabulations from the previous census, and results of current surveys, to see whether these classifications are still relevant to the users of census data.

There is an increasing demand for tabulations at the level of the smallest administrative unit, and one should be aware of the limitations of statistics produced using sampling methods. If data are collected by a complete enumeration of all holdings, it is possible to tabulate data for the smallest geographic areas. Even rare characteristics of holdings can be presented.

However, in many countries a complete enumeration of holdings may not be feasible. Instead a sample enumeration is employed. In this case the results are subject to sampling error. The tabulations have to be more limited for the lower levels of administrative units. The tabulations which can be produced for the lowest administrative level, depend on the sampling scheme, sampling variance of characteristics and desired level of reliability.

3.3.2 Tabulation

As mentioned above, the systems analysis must go hand in hand with the planning, design and preparation of the questionnaire and the requirement as regards statistical

tables. This will enable the systems analysts and computer programmers to determine what programs to prepare and what software packages to use.

Printed output of test runs of programs should be generated so that the validity, reliability and reasonableness of tabulated data can be verified.

3.3.3 Evaluation of Tables

All the tables should be systematically reviewed before they are published. The purpose of such a review is to eliminate major errors in census tables and to minimize the effects of minor errors. Some of the possible approaches are the use of external check data, consistency over time as shown by comparison of census results with those of previous surveys or available statistics, and internal consistency between the various items of the census. It is also possible to use post-enumeration surveys for this purpose. If large discrepancies are discovered, the verification of the original data is necessary.

To facilitate the evaluation of the tables, efficient control of the field operations during the census enumeration is essential. Such control will minimize the sources of error and hence the errors in the final census tables.

3.3.4 Recommended Cross Tabulations

These cross-tabulations have to be examined for their meaning and relevance, for each of the possible combinations of characteristics.

The following cross tabulations are recommended:

- (1) Total number of livestock by type and by sex of holder.
- (2) Total number of livestock by type and by age of holder.
- (3) Number of a given type of livestock by purpose and by sex of holder.

- (4) Number of a given type of livestock by purpose and by age of holder.
- (5) Number of a given type of livestock by sex and by purpose.
- (6) Number of a given type of livestock by age and by purpose.
- (7) Number of a given type of livestock by race and by livestock system.
- (8) Total number of livestock by type and by livestock system.
- (9) Total number of milking cows by race and by milk status (in milk, dry).
- (10) Total number of livestock by type and by legal status of holder.

3.4 Guidelines for Taking a Livestock Census

In this section, the basic principles to be observed in preparing and carrying out a livestock census are presented. The aim is to provide a check list of the major aspects, rather than an exhaustive description.

3.4.1 Developing the Census Programme

The livestock census is part of the overall programme of a country's data collection activities.

The establishment of a legal base, in the form of a law or a decree or other instrument, depending on the legislative procedures of the country, is necessary for conduct of the census. Census legislation is essentially meant to identify the responsibilities of government agencies and respondents, and to serve as a base for budgetary allocations. The responsibilities of government agencies should include securing the confidentiality of the data collected from individual respondents. Such a guarantee of confidentiality helps to obtain the cooperation of the respondents. The census legislation, in general, also indicates a broad description of the scope of the census and its timing.

The list of items referred to in Section 3.2., should be reviewed in order to clarify the scope of the census and also to develop other sources of data.

3.4.2 Budget

A budget for the census of livestock, covering all phases of the census from preparatory work to publication of results, should be prepared. The budget should show the permanent and temporary personnel required, their salaries and wages, travel costs and expenditures for acquisition and operation of machinery and equipment, office space, communications, transport and supplies. Provision should also be made for unforeseen expenses. The agency responsible for the execution of the census should be empowered to reallocate resources in case of unforeseen difficulties, especially during enumeration and data processing.

The budget for enumeration and data processing should show the volume of work to be performed, rates of performance and costs of the measurable parts of the work programme. The amount of work required for each important operation should be assessed e.g. enumeration, examination of questionnaires, data entry. Periodically, the budget should be reviewed and work accomplished compared with budget expenditures. Corrective action should be taken when necessary.

3.4.3 Organization

The livestock census requires a hierarchical organization for its successful execution. At the top, an inter-ministerial committee might be established to give overall supervision of the census. This committee could be the central coordinating body of the national programme of food and agricultural statistics; or one of its sub-committees which includes representatives from agencies both producing and/or using statistics. Since membership in a census committee involves much responsible and time-consuming work, it is preferable to restrict its membership to people who are actively concerned with the census. The following activities should be carried out by this committee:

- decide on the scope of the census;
- approve the activities to be undertaken at various stages of the census;
- review periodically the progress of the census operations and advise the government authorities on required measures; and
- approve the publication of the census results;
- conduct an ex post census programme evaluation.

The census committee may carry out its functions through working groups on specific technical matters.

Alongside the census committee, the agency directly responsible for the conduct of the census should be designated. With the assistance of other agencies, and under the general supervision of the census committee, this agency will execute the census.

The organization may include province and/or district level census committees to oversee the field work of supervisors and enumerators.

3.4.4 Staff Recruitment

The principal administrative and professional staff must be qualified, recruited from personnel familiar with livestock, census methods and procedures, and government work. Supervisory personnel can be recruited or borrowed from government agencies or local sources, such as statistical and agricultural extension services and educational organizations. Such personnel needs to have knowledge of local conditions, customs, travel problems, dialects, and other relevant facts.

Enumerators are best recruited from the localities in which they work and should be qualified. Simple tests designed to measure the applicant's ability to read and apply instructions, communicate easily with people, enter information on questionnaires accurately and perform simple arithmetical operations are suggested for selecting qualified candidates.

Successful enumerators show tact and resourcefulness in handling problems that arise when meeting and talking with holders and others; their actions and attitudes should inspire and keep the respect and confidence of the holder. They must be willing and able to work full-time, without engaging in other activities, until the job is complete. They must work carefully and diligently, even when their supervisor is not present.

Staff who will edit, code and tabulate the data with the help of machines and computers must be carefully selected. Appropriate tests should be used.

3.4.5 Informing the Public

The importance of informing the public about the census cannot be over-emphasized. Experience shows that inadequately informed citizens may jeopardize the entire census. The purpose of publicity is to bring the census to the attention of all holders or at least one family member thereof. The scope and coverage of the census might be clearly explained in the national and local press, to familiarize people with the questions which will be asked. The publicity programme should explain the projected uses of data collected and establish confidence between the people and the census authorities. The confidential nature of the data collected and the need for accurate replies should be emphasized.

In many countries, the daily and weekly press, cinema, radio, television and posters are used for publicity. In others, the cooperation of local religious leaders, chiefs of communities, heads of business associations, labour groups and public service organizations has been effective. School publicity programmes may be efficient because school children are apt to pass the information to other members in their families. The national census committee or local committees could also play an important role in the publicity campaign. In some countries, committees have been organized in villages to read and explain census publicity material to illiterate farmers. The use of audio-visual aids under those conditions may be of great help.

3.4.6 Questionnaire

The questionnaire is the medium for recording the data obtained in a standardized manner. The development of census questionnaires is one of the most important tasks in the preparation of a census. The quality of the enumeration depends largely on the questionnaire and the enumerators who fill it in.

In designing the questionnaire, the possible difficulties of the enumerators and the required tabulations of the data should be kept in mind. The questionnaire must use concepts and definitions commonly understood by holders, or easily and clearly explained by the enumerators. For this reason the questions should be simple and phrased clearly.

The questionnaire must be prepared sufficiently in advance of the enumeration date to permit adequate pretesting, finalization of the tabulation programme and an early start on data processing programming.

3.4.7 Cartographic Preparations

The most efficient way to define each area is to provide each enumerator with a map of his enumeration area showing the exact boundaries. This will help in the enumeration of all holdings of a country, without omission or duplication, in a short period of time.

Long before the enumeration date, census authorities should investigate the cartographic resources of the country, and, where maps are not available, arrange for sketches to be provided, showing very clearly the boundaries of areas.

3.4.8 Instructions and Training for Enumerators

The preparation of an enumerator's manual is essential, as both an instructional text and a reference guide during the enumeration. The enumerator's manual should contain explanations on the procedures for conducting the enumeration, examples of completed questionnaires, tips on interview techniques, illustrations of how to handle problems (such as uncooperative holders), etc.

Instructions for enumerators should be in simple language and easy to understand. They must provide complete guidance on all major and frequently encountered problems. Good instructions and an adequate training programme are very important because the quality of the census data depends mainly upon the performance of the enumerators. They must be acquainted with the following:

- why the census is taken and its importance
- general information
 - his/her job
 - his/her responsibility
 - dealing with holders and others
 - confidentiality of data
- how the census is organized
- definitions of concepts
- filling in the questionnaire
 - from whom to obtain data
 - techniques for conducting a good interview
 - how to ask questions
 - making entries on questionnaires
 - ending an interview
 - checking questionnaires
 - calling back to obtain missing data
 - overcoming objections of holders to provide data
 - use of interpreters, if necessary
- administrative instructions
 - hours of work
 - absenteeism
 - what enumerators are required to do on administrative matters
 - submission of records on time and attendance.

3.4.9 Instructions and Training for Supervisors

Supervision of enumerators' work is essential for securing reliable and authentic data during the census. Supervisors control the work of enumerators and assist them in solving problems they encounter. Special emphasis should be placed on the instructions and training of supervisors. In view of the importance of their role, they should go through a training programme covering the following topics:

- why the census is being taken
- how the census work is organized
- responsibilities of the supervisors
- how to check maps of areas or enumeration districts
- how lists of households or holders are to be prepared, used and checked
- how to use training guides
- how to conduct training sessions for enumerators
- how to observe the enumerator at work
- how to determine whether or not each enumerator is performing his work according to the prescribed time schedule
- how to record and appraise periodic review of enumerator's work
- how to handle special problems encountered by enumerators
- actions to be taken when work is not completed timely and satisfactorily
- how to handle cases of refusal or unwillingness to provide required data
- aggregation of completed questionnaires
- preparation of reports on progress of work.

The presence of a supervisor and his inspection of the work of the enumerators help prevent carelessness and permit the detection of errors, allowing their correction while the field work is in progress. Supervisors need to encourage enumerators to perform acceptable work, to complete work assignments on time and help promote holders' cooperation. Supervisors should keep records to follow the progress of enumeration and take appropriate action whenever the work is not being performed in accordance with a predetermined time schedule. When the enumerator has completed one phase of his/her work in a locality, the supervisor must review his/her work to ensure that he/she has accounted for all households, interviewed all the holders and properly completed questionnaires for all holdings; in cases of any shortcomings, enumerators must complete the work satisfactorily.

3.4.10 Pretests

Pretesting is the enumeration of a limited number of holdings through interviews, for collecting evidence on the adequacy of various census procedures. The pretesting of

the census methodologies, the questionnaire and the enumerator's instructions and training programme are vital. A census should not be undertaken without adequate pretesting.

3.4.11 Field Work Quality Checks

Efforts should be made to remove and/or reduce the magnitude of errors arising from various sources at all stages of field work, by proper planning and control of activities. To determine the presence and possible magnitude of errors and biases, sample surveys should be conducted during or just after the main census enumeration, as quality checks.

Errors in a livestock census may arise from numerous sources, such as incomplete frame of holdings; ambiguous or misleading questions; incorrect answers by the respondents; inadequate supervision; lack of adequate training; and loss of questionnaires. In addition, errors are due to failure to correctly identify the holder in the household; and failure to report livestock which are temporarily away on public or common pastures or in transit outside holdings. Furthermore, errors and biases are sometimes traceable to unconscientious enumerators who enter false data or omit not easily accessible holdings or holders.

As quality checking often requires duplicating the work done during the regular enumeration, a sampling procedure may be the only practical approach. This sample check may be done not only during the census but also immediately after the conduct of the census. The application of sampling methods for determining the quality of census data involves first, a check on the quality of the listing, in order to reveal the effects of omissions and duplications on the census results. It also provides information on circumstances in which enumerators fail to follow the instructions for the listing operation. The next step is the checking of response errors to estimate their magnitude and obtain information for improving data collection technique.

The sample design to be adopted for the post-enumeration checks will correspond to the design adopted in the census enumeration, the main consideration being to

ensure that the larger area units are adequately mapped or known in detail, to detect possible omission or duplication of the smaller units comprising them. This procedure will help in verifying the coverage. Depending on the accuracy of the subsequent sampling frame, collection of the necessary data will have to be undertaken either from a sample of lists of households or other suitable ultimate units utilized in the census or from a new list of these units. From the sampling units selected, particulars of livestock numbers by type, etc. held on the date of the survey should be collected and compared with census data. The two figures would show discrepancies obtained for each characteristic under investigation.

In addition, it is necessary to collect as much information as possible from the sample survey units on census operations undertaken, e.g. visits made by census enumerators, in order to provide valid explanations of possible causes of discrepancies. Special note should also be taken of the difficulties that would arise in such verifications, especially those resulting from the failure to achieve a one to one correspondence between the units covered in the census and those sampled in the survey, usually through inadequate identification particulars.

3.4.12 Data Processing

The preparation for data processing must begin early in the planning stage for the census. In particular, sufficient time must be assigned to selecting and training the data processing staff. The present basic guidelines are oriented to electronic data processing, as all the countries use computers for processing the results of their national censuses.

Computer processing equipment may be available in the regional offices, or in a central office. The details of computer data processing will depend upon the equipment and the software packages available for the purpose. A number of common operations are briefly described below:

(i) Checking for Complete Receipt of Questionnaires

Receipt of questionnaires must be checked against the complete list of holdings, and action should be taken to obtain missing questionnaires.

(ii) **Maintaining Control of Questionnaires**

Records need to be kept on the flow of groups of questionnaires through the various processing steps, and they should be checked periodically to detect delays, misplacement of questionnaires, etc.

(iii) **Checking for Completeness of Entries in Questionnaires**

A visual check should be made to ensure that each questionnaire has all entries.

(iv) **Verification of Processing Operations**

Efforts to detect errors in statistical surveys are intended to control them, so that acceptable results are achieved. Complete or sample verification of data entry and other routine operations is important. Sample verification schemes must take into account the amount of time needed by data entry operators or clerical personnel, to acquire enough experience to perform their work at a relatively stable quality level and the acceptable level of error, taking into account that complete verification is costly and does not detect all types of errors. The control of errors and the detection of work units with excessive errors can be done by the verification of relatively small samples of each work unit. If the work does not meet the standards, then complete verification of the work units is necessary and all errors must be corrected until the quality of work becomes acceptable. Workers who do not meet quality standards within a reasonable time must be given additional training.

When the census is based on sample enumeration, verification of routine operations is even more important than in complete enumeration, and complete verification of data entry may be preferred.

4. SCOPE OF DATA ON LIVESTOCK PRODUCTS

4.1 General

The scope of statistics on livestock products may be broadly divided into (a) characteristics of basic livestock products, (b) development statistics, (c) export and import statistics, (d) statistics on health, morbidity and mortality, and (e) marketing statistics.

Statistics on basic livestock products characteristics include information for each species on such items as meat, milk, butter, cheese, eggs, honey, silk, wool, fur, hides and skins, total number of animals slaughtered with breakdown by public slaughter-houses, meat packing plants and by unlicensed butchers and households.

Development statistics are required for formulating sound livestock development programmes. Such data usually comprise information on lactation length, calving interval, age at first calving, mortality and off-take rate (percentage of slaughtered animals to the total), feeding and other farm management practices, fodder and feed requirements and their availability, energy and protein needs for growth, suitable feed formulations, grazing and pasture areas with an assessment of their herd-holding capacity and area of fodder crops, given separately under irrigated and non-irrigated conditions, cost of production and maintenance of livestock and cost of production and processing of livestock practices - separately for organized business establishments and for small farmers rearing livestock as part of their farming activities. Included also are extraction rates, i.e. ratio of each of (a) the dressed carcass weight (b) edible offals (c) inedible offals and (d) slaughter fat to live weight of livestock, and technical coefficients to convert one type of livestock product to another. These extraction rates and technical coefficients need to be established separately for each species of livestock by weight, sex, breed and age groups. Data on artificial insemination, projection concerning livestock and quantities of their main products, breed characteristics and genetic improvement, number of livestock product enterprises by types, e.g. dairy, processing and manufacturing industries etc., are also needed.

Export and import statistics consist of the quantity and value of livestock products exported and imported.

Marketing statistics include number and types of markets where livestock and livestock products are sold; structure of markets and distribution of markets in the country; wholesale, retail prices of livestock products at national, provincial, district, village level.

In developed countries, the range of data collected is very wide and the frequency of collection ranges from annual through monthly and even weekly or daily collection, depending on the nature and utility of the data gathered.

In most developing countries, the scope of such statistics is rather restricted for various reasons. Data on the production and utilization of livestock products in the traditional agricultural sector are either not easily available or extremely limited, because of resource limitations, illiteracy and/or lack of interest in record keeping and distrust of government intentions on the part of livestock holders, difficulties of communication, inability to benefit from extension advice and, above all, a lack of initiative. Nevertheless, in many developing countries, basic statistics on livestock products such as milk, butter, hides and skins, number of animals slaughtered and meat production, number of eggs produced, are available for the commercial sector.

The statistics on livestock production for international purposes should be classified by broad administrative and geographical regions within a country, and related to holdings classified by appropriate size classes. Livestock products should include broadly: meat, milk, butter, cheese, eggs, honey, wool, fur, silk, hides and skins. Other types of data would be: number of animals slaughtered by species, breed, weight and sex.

4.2 Concepts - Livestock Products from Slaughtered Animals

4.2.1 Meat Production

(i) Total Meat Production from Slaughtered Animals

This refers to meat from all slaughtered animals within the national boundaries, irrespective of

their origin. This takes account neither of net trade in live animals nor of net changes in meat on the hoof in the country. This concept is used in some countries such as U.S.A., Mexico, Argentina, Chile, Greece, Italy, Turkey, Netherlands, etc.

(ii) **Gross Indigenous Meat Production (GIP) (Production Concept)**

This includes meat from all slaughterings of all indigenous animals, plus the meat equivalent of exported live animals (slaughterings of indigenous animals = total slaughterings minus the slaughterings of imported animals). Countries such as the U.K., France, Federal Republic of Germany, Sweden, Spain and most of the American nations use this concept.

(iii) **Total Indigenous Meat Production (TIP)**

This includes meat from all slaughterings of indigenous animals, plus the meat equivalent of exported live animals, plus net changes in meat on the hoof (i.e. change in the total live weight of all the animals during the period of reference). This is the concept followed by countries such as the former U.S.S.R., Yugoslavia, Hungary and Austria. In Australia, total meat production is defined as originating "from slaughtered livestock originating in Australia" and passed for human consumption.

FAO compiles two sets of meat production figures, one "Meat from slaughtered animals" corresponding to concept (i) and the other "Meat from indigenous animals" corresponding to concept (iii) above.

4.2.2 Meat Available for Consumption During the Year (Consumption Concept)

This is equal to:

Meat from all animals slaughtered in the country, irrespective of the origin

- + Imported meat and the meat equivalent of imported derived product
- Exported meat and the meat equivalent of exported derived products
- + Change in stocks of meat and meat equivalent of derived products.

All elements in this calculation refer to the year in question.

4.2.3 Other Allied Concepts

Live weight of animals intended for slaughter is the weight immediately before slaughter. It is assumed that animals intended for slaughter are kept on the slaughterhouse premises for 12 hours, and are not fed or watered during this time.

Killed weight is the gross weight of the carcass including the hide or skin, head, feet and internal organs, but excluding the blood lost in the course of slaughter.

Dressed carcass weight is the weight of the carcass after removal of the parts indicated for each of the livestock species listed below:

Cattle, Buffaloes, Horses, Mules, Asses

- the hide or skin
- the head where it joins the spine
- the forefeet at the knee joint and the hind foot at the hock joint
- the large blood vessels of the abdomen and thorax
- the genito-urinary organs (other than the kidneys)
- the offals (edible and inedible)
- the tail
- the slaughter fats other than kidney fats

Sheep and Goats

- the skin
- the offals (edible and inedible)
- the genito-urinary organs (other than the kidneys)

- the feet
- the slaughter fats other than kidney fats

Pigs

- the offals (edible and inedible)
- the genito-urinary organs (other than the kidneys)
- the slaughter fats (other than kidney fats and back fat)

Carcass weight is the dressed carcass weight as defined above but including slaughter fats.

Countries which do not report according to the dressed carcass weight concept, should clearly indicate which concepts they use when reporting production figures. They should provide appropriate conversion factors to convert their production into carcass weight equivalent, indicating also which parts of organs of the animal are excluded for conversion to dressed carcass weight.

4.2.4 Edible Offals

Edible offals are those edible parts or organs of the animals, other than fats, which are usually separated off in the course of the preparation of the carcass at the slaughterhouse. The organs or parts that are considered to be edible offals vary from country to country, depending on the definition of "dressed carcass weight" adopted by the country in reporting meat production data, as well as national habits. Some countries calculate edible offals as a percentage of the carcass weight, the percentage varying from 3 to 10 percent, according to the class of animal.

Offals comprise the following organs of slaughtered animals which may be considered edible offals:

Head and cheek meat	Tail meat
Tongue	Spleen
Brains	Lungs
Heart	Diaphragm
Liver	Thick skirt
Sweetbreads (thymus, pancreas)	Genital organs
Throat bread	Udder
Feet (cleaned)	Stomach or tripe
	Blood

In this regard, it is recommended that the parts that are considered edible offals should be specified clearly for each kind of animal, and whenever possible, the quantitative relationship between the dressed carcass weight and/or the average live weight, and the average production per carcass, should be indicated.

Carcass weight is the weight of the carcass as defined above but including slaughter fats.

4.2.5 Fats

There are various concepts related to fats.

Total unrendered fat: All edible and inedible slaughter fats and butchering fats.

Total unrendered edible fats: Edible slaughter fats and edible butchering fats.

Slaughter fats: Edible and inedible unrendered fats which are discarded in the course of dressing the carcass and are recovered from discarded and fallen animals, such as guts, sweepings, hide trimmings, etc.

Edible slaughter fats (loose fats): Unrendered fats from discarded and fallen animals, such as guts, sweepings, hide trimmings, etc.

Butchering fats: Unrendered fats obtained from the excess fat trimmed or removed from wholesale and retail cuts during butchering. Kidney fats and pig-back fat are also included in this definition.

Processed fat: This concept covers rendered fats, such as lard, tallow, etc., obtained by melting or processing slaughter and butchering fats.

The coverage of slaughter fats differs from country to country, depending on the definition of "dressed carcass weight" adopted by each country in reporting meat production data.

It is recommended that countries collect production data for slaughter fats as defined above, preferably broken

down into edible and inedible fat. Countries reporting slaughter fats together with meat production in one figure, should indicate the approximate percentage of slaughter fats in the aggregated meat/fats figures.

As for processed fats, production data should be collected for lard and tallow (preferably on a product weight basis rather than on fat content), as well as data on utilization of these products for food, feed and industrial uses.

4.2.6 Meat from Small Animals

Data on the production of meat from small animals (poultry, rabbits, game, etc.) are usually reported according to one or the other of the following concepts:

a = thighs+wings+breast+ribs+back = Ready-to-cook
(oven ready)

b = a + heart+liver+gizzard+neck = Ready-to-cook
(incl. giblets)

c = b + feet+head = Eviscerated weight

d = c + viscera (inedible offals) = Dressed weight

e = d + blood+feathers+skins = Live weight

Production of meat of small animals should be reported preferably according to the "ready-to-cook" concept, specifying whether giblets are included or excluded. Whatever concept is used for the production figures, it is important that it should be clearly explained.

4.2.7 Hides and Skins

There is no worldwide accepted unit of measurement for the production, trade or utilization data, of hides and skins. These are given variously in countries' statistical series in terms of number (pieces) or of weight, while the product made from them, i.e. leather, is given in terms of surface area or in weight. The number of hides may be confusing, since the sizes of most common hides and skins differ considerably. However, if a weight basis is chosen,

there is considerable variation due to the ways in which hides and skins are cured. The most common state in which hides and skins are shipped, although by no means universally, seems to be wet-salted for cattle hides and calfskins and goatskins, but certain types of hides and skins are traded dry-salted or pickled. Generally, one kilogramme of dry hides is equivalent to about 2.5 kilogrammes of wet-salted hides. In view of the various combinations of units and of methods of curing, each country needs two sets of conversion ratios for raw hides and skins, in order to make national data internationally comparable.

- one relating all weight data given according to the various methods of treating hides and skins, to wet-salted for cattle hides and calfskins and to dry weight for sheepskins and goatskins respectively;
- one relating pieces to weight at various levels of processing e.g. the average weight of wet-salted or dry skin.

General conversion ratios for differently cured hides and skins are given below. Green hide or skin is the fresh skin as removed from the body of an animal.

General Conversion Ratios for Differently Cured Hides and Skins

green: wet-salted	1 : 0.85
green: dry-salted	1 : 0.55
green: dry	1 : 0.35
green: pickled	1 : 0.65
wet-salted: green	1 : 1.2
wet-salted: dry-salted	1 : 0.65
wet-salted: dry	1 : 0.4
wet-salted: pickled	1 : 0.8
dry-salted: green	1 : 1.85
dry-salted: wet-salted	1 : 1.5
dry-salted: dry	1 : 0.8
dry-salted: pickled	1 : 1.2

dry: green	1 : 2.85
dry: wet-salted	1 : 2.5
dry: dry-salted	1 : 1.3
dry: pickled	1 : 2.0
pickled: green	1 : 1.55
pickled: wet-salted	1 : 1.25
pickled: dry-salted	1 : 0.8
pickled: dry	1 : 0.5

It is suggested that all countries should collect and release production data for hides, skins and fur skins. Data should be given in terms of green weight, except for fur skins which should be reported in numbers.

Countries reporting production expressed in numbers or in dry, cured or salted weight, should provide appropriate conversion factors to green weight.

4.3 Concepts - Livestock Products from Live Animals

4.3.1 Milking Animals and Milk Production

(i) Milking Animals

The definition of milking animals varies considerably between countries: from those which include in the count all females in reproductive age, to those which include only dairy females, bred specially for milk production, which were actually milked during the year.

In view of these differences, it is recommended that countries report the number of milking animals along with milk production, and also that countries ensure at least that the concept of milking animals adopted is in line with the estimated average milk yield per animal.

It is recommended that countries define the concept of milking animals as animals actually milked during the year, and keep separate records for dairy females bred specially for milk production and for other females milked.

(ii) Milk Production

Two basic concepts are used: Gross production, which includes whole fresh milk actually milked and milk sucked

by young animals. This concept includes milk fed to animals as well. Net production, consists of whole fresh milk actually milked. It excludes milk sucked by young animals but includes milk fed to livestock. Two other concepts are also used: Production available for consumption, is net production minus milk fed to animals and waste at the farms. Production delivered to dairies or dairy plants, is production available for consumption less quantities retained by farmers for food, feed and for direct sale to consumers.

The concept of average milk yield per cow, i.e. milk productivity, varies among countries. For instance in the U.K., average yield is determined in terms of milking dairy cows. In Czechoslovakia, when assessing the average milk yield, every cow is involved irrespective of whether it is a dairy or a beef cow.

4.3.2 Milk Utilization and Dairy Products

As a minimum requirement, it is recommended that countries collect data on utilization of the whole milk produced according to the following uses: direct food, direct feed, processing, waste and losses. All data should be collected at least on an annual basis, preferably on a quarterly or monthly basis.

It is further recommended, as a minimum requirement, that countries collect data (annually at least) on the production of the following dairy products: butter, cream, yoghurt, cheese, evaporated milk, condensed milk, dry milk, casein and any other important products.

4.3.3 Eggs and Derived Products

(i) Laying Hens

Under the term "layers", some countries include all hens and pullets of laying age, whether laying or not, while in other countries the term has a much more limited meaning, to cover only hens and pullets of the egg-type breeds, which have laid eggs during the year. The recommended definition of laying hens is all hens and pullets of all types and from all sectors which have laid eggs during the year.

Hens are sometimes classified by type of race, according to the dominant characteristics of their eggs. There are egg-type hens, meat-type hens and mixed-type hens. They are also classified according to the agricultural sector in which they are bred: the traditional sector (widely scattered and individually owned small flocks in farms and backyards), and the modern sector (large scale, semi-intensive and intensive commercial poultry farms).

(ii) Egg Production

Egg production is generally reported by countries as total or gross production, i.e., production from all types of hens and from hens kept in all agricultural sectors. Few countries report net production, i.e., gross production minus eggs used for hatching. Certain countries report data for both categories.

Several countries report also figures for commercial production, i.e., the part of the net production which enters into commercial channels. Data on commercial production are easily obtainable from the modern sector which accounts for most, if not practically all, of commercial production. In certain countries, data on the traditional sector are based on assumptions of the number of hens and/or rates of egg laying, or are rough estimates based on food consumption surveys and similar indirect sources.

In reporting egg production, countries should use both numbers and weight, or provide a conversion factor from one unit to the other.

(iii) Hatcheries

An important role in the development of the poultry sector is played by commercial hatcheries. Countries should collect monthly data on various hatcheries' operations: number of eggs placed, chicks hatched and chick placements.

4.3.4 Other Products

Other livestock products include mainly honey, beeswax, wool, hair and silk. It is recommended that countries should collect data on these items. It is important to note that data on fine wool and hair production, such as cashmere and mohair, should be reported separately from common wool. Wool production figures should be reported on both a greasy basis and on a clean basis. When reported on one basis only, an appropriate conversion factor should be provided to convert one into the other.

Countries where sericulture is carried out should collect annual data on cocoons and raw silk produced.

5. METHODOLOGICAL CONSIDERATIONS CONCERNING STATISTICS ON LIVESTOCK PRODUCTS

5.1 Sources of Data

The sources of data on livestock products are the same as those for livestock numbers and livestock characteristics mentioned in Chapter 2:

- Census of agriculture.
- Livestock census.
- Periodic and ad-hoc sample surveys.
- Research institute and experimental station records.
- Administrative records and returns.
- Household income-expenditure survey.

In the following paragraphs the sources of data on each type of livestock product are indicated.

5.2 Slaughterings and Meat Production

Statistics of meat and meat products cover slaughterings in public slaughter-houses, meat packing plants as well as those of private households and butchers' shops in villages and towns.

5.2.1 Controlled/Inspected Slaughterings

Statistics of commercial production of controlled slaughterings are relatively easy to obtain. In most countries there is legal provision for compulsory reporting of weight of meat (generally as dressed carcass weight) and the number of animals slaughtered in public slaughter-houses and meat packing plants. In other countries the slaughterings are to be done in the presence of a meat inspector or veterinary surgeon. In both cases the figures of dressed carcass weight as well as the number slaughtered, are required to be reported to the government authority in a prescribed form. In some countries it is the Ministry of Agriculture, in others it is the Central Statistical Authority or Director of Veterinary Services. In many developed countries controlled slaughterings account for more than 90 to 95 per cent of total slaughterings, while in a few developed countries uncontrolled slaughterings of pigs, sheep and goats may account for as much 20 to 50 per cent.

5.2.2 Uncontrolled Slaughtering

The collection of non-commercial meat production figures poses problems. In many developed countries, the production estimate is based on a variety of sources and methods such as farm-accounts, household income-expenditure surveys, number of hides and skins collected. As for developing countries, some countries do not estimate meat production from the household sector nor from unlicensed butchers. To that extent, published production figures are underestimates. Some countries add a conventional percentage (figure varying from species to species) of the controlled slaughtering figures to the reported slaughtering to arrive at the total number of slaughtering. In other countries, local enquiries are made by the revenue or marketing or veterinary officials as to the number of slaughtering, with the village headman or some other knowledgeable person. These figures are then added to the controlled slaughtering figures to arrive at the total number of slaughtering. In all cases total meat production is estimated by multiplying the total slaughtering of each species by its corresponding average dressed carcass weight. It is, however, to be emphasized that average carcass weight should be a representative national figure based on objective and representative samples.

Good estimates of meat production in the non-commercial sector can be obtained through random sample surveys. ^{1/} If there are well defined meat zones where most of the meat production, processing and marketing are concentrated, they may form strata; otherwise strata for the survey may consist of administrative divisions. Villages/towns or cluster of villages/towns may form primary sampling units (P.S.U.). As the number of butchers in a village is usually small, all butchers in the selected P.S.U.s may be enumerated without any further sampling. The number of animals slaughtered during a particular period in a sample of farms or households could be recorded by interview. The carcass weight may be recorded by pieces on

^{1/} Singh, D., Maini, J.S., Goel, B.B.P.S. and Bassi, G.S. Sampling methodology for estimation of meat production, 1978. IASRI, New Delhi, 1978.

balances which are portable and easily available. The method of estimating meat production is to multiply the number of slaughtered animals classified by species, weight, sex and age by the average carcass weight appropriate for each class.

5.2.3 Meat Utilization Statistics

The supply balance of meat involves the following items:

- (a) Total meat production from all slaughterings.
- (b) Imported meat and meat equivalents of imported derived products.
- (c) Exported meat and meat equivalents of exported derived products.
- (d) Net change in stock of meat and meat products.
- (e) Meat fed to animals.
- (f) Wastage.

Generally, statistics of imports and exports are fairly well maintained in most countries. Statistics on stocks of meat (meat being a perishable product) at the beginning and end of the year can be obtained from cold storage establishments. Meat equivalents of derived products will be available from processing plants.

5.3 Milk Animals and Milk Production

5.3.1 Milking Animals

The main sources of information on milking animals are the census of agriculture, the livestock census and specific surveys. Most countries estimate the number of milking animals once (e.g. Federal Republic of Germany, Italy, Netherlands, Sweden) or twice a year (e.g. Belgium, Canada, Denmark, Finland, Spain, United Kingdom). Some countries collect data on milking animals each month through surveys (e.g. Austria and U.S.A.) or periodic reports of farms and dairies (e.g. eastern European countries).

It is common practice to collect the number of milking cows more frequently than the number of milking animals of the other species; the latter are collected from agricultural and livestock censuses only.

5.3.2 Milk Yields

Some countries collect direct information on milk yields mainly through surveys or periodic reports of farms. In most countries, yields are simply a ratio between the production of milk and the number of milking animals.

5.3.3 Milk Production

Statistics on milk production in many countries are based on information supplied from dairies, milk marketing boards, milk control organizations etc. It is, however, necessary to obtain milk production estimates from farms and households maintaining dairy animals for home consumption or for direct sale to customers to have the full coverage of milk production.

Production on small farms or in households is estimated by sample surveys, household income-expenditure surveys, farm accounts, etc. ^{1/} The survey design is usually one of stratified, multistage, random sampling. For operational convenience, the stratification is usually by administrative divisions, and by geographical sub-stratification in certain cases. A cluster of villages/towns forms a P.S.U., a cluster of households can serve as the second stage unit and animal in milk constitutes the last stage of sampling. All P.S.U.s should be visited by investigators once a month in rotation throughout the year to cover all seasons. All P.S.U.s can be sampled afresh each season to provide even better estimates of seasonal changes, a fraction of this could be replaced each season. At the commencement of each season, complete enumeration of all livestock would be made in each P.S.U.; only changes in stock being noted in subsequent months on the basis of a

^{1/} Singh, D., Murthy, V.V.R. and Goel, B.B.P.S. Monograph on Estimation of Milk Production. IASRI, New Delhi, 1970.

sample of households. The data on total milk production for the selected households can be recorded by enquiry if the producer maintained records and no biases are suspected. Otherwise it is desirable to record by direct weighing, the milk yielded by selected animals in milk in the selected households each time of milking. At the same time the quantity of feed given to animals, which is the most important input in milk production, can be recorded by weighing.

Other data on particulars of animals such as the number of lactations, breed, age, calving interval, age of the animal at first calving, management practices, utilization of milk could all be recorded by enquiry. Data on fat content and specific gravity of milk can be taken on a sub-sample of milk yielded by selected animals.

5.3.4 Utilization of Milk

Utilization data of milk and milk products are useful for assessing the amounts available for human consumption and animal feeds, and for checking estimates of production and consumption. Data on utilization become particularly important in countries where only milk production data from commercial dairy plants are available. In such cases, per capita consumption of milk multiplied by the total population, gives the estimate of milk available for human consumption. If to this is added milk fed to animals and wastage, estimates of total production are obtained.

5.4 Layers and Egg Production

5.4.1 Layers

Statistics of poultry population are collected as part of the collection of livestock numbers through periodical censuses and surveys. The information collected generally refers to number which can be classified by age and end uses. In some countries, data on layers in the modern sectors are collected through periodic questionnaires. In developed countries, quarterly or even monthly surveys are conducted to obtain detailed information on poultry and poultry products in order to take care of large seasonal fluctuations.

5.4.2 Egg Production

Estimation of egg production involves three components, namely (a) number of laying hens, (b) average number of eggs laid per hen, and (c) average weight of an egg. Data on these components should be collected separately for different breeds through special sample surveys, to get representative averages for these components at the national levels. Data on egg production from the commercial sector can be obtained by mail questionnaire or by interview. Estimates of egg production from the non-commercial sector should be made by means of sample surveys. 1/

The sampling design to be adopted will be one of stratified two-stage random sampling, a stratum being roughly equivalent to a district in size; clusters of adjoining villages or a town/ward within stratum can be chosen as first stage units and clusters of households in a village as second stage units. In each season a sample of three or four clusters of villages/town/ward may be selected at random from a stratum. The first stage units may be retained throughout the season whereas ultimate sampling units would be selected afresh in each round, a round being roughly of a month's duration. From the selected cluster of villages/town/ward three clusters of 5 or 6 households each could be selected in the first round of the season for the collection of primary data. In each of the subsequent rounds 7 such clusters of households will be selected from a cluster of villages in a season for collection of detailed data. In addition, a sample of 7 clusters of 12 households each will be selected in the second round of the season and this sample will be used for estimating changes in the number of poultry birds from round to round.

5.5 Wool Production

Developed countries in general collect information and data on wool production by mail questionnaire on a complete enumeration basis of producers. In the developing

1/ Singh, D., Goel, B.B.P.S., Garg, J.N. and Rao, D.V.S. Monograph on Sample Survey Techniques for Estimation of Egg Production, IASRI, New Delhi, 1975.

countries, usually the Directorate of Marketing or similar agency collects such information through annual or special surveys. However, these are also collected based on ad-hoc enquiries from the related trade organizations, cooperatives or producers. In developing countries the collection of data can be through a well organized random sample survey. 1/

Shearing of sheep generally takes place once or twice a year in fixed seasons. If the production estimate of wool is to be based on direct observation on fleece weight, visits have to be paid to the flocks at the time of shearing. Hence surveys can be confined only to certain seasons of the year. Since the flocks are maintained on grazing, it is not necessary to observe them through the year to gather data on factors of production. The design may be stratified, multistage, random sampling. Administrative divisions may form the strata, clusters of villages the P.S.U.s, flocks would form the second stage sampling units and sheep selected in the flock would form the third stage of sampling. A complete enumeration of all sheep in all the flocks in the selected clusters of villages would provide the necessary information for estimating total number of sheep. From each selected flock, two rams (adult male sheep), two ewes (adult female sheep) and two lambs may be chosen for recording individual fleece weight as well as body weight after shearing. The estimate of average wool yield per sheep (ram, ewe and a lamb) in a season will be obtained. The estimate of annual wool yield per sheep, in a stratum would be obtained by adding the wool yield of a sheep in the two seasons. The annual wool yield per sheep would be obtained by weighing them suitably with sheep population as per the previous livestock census.

For estimating the annual wool production, first the wool production for a P.S.U. would be obtained by adding the estimated wool production for ewes, rams and lambs. The estimate of wool production during a season and over the seasons in a stratum would then be obtained. The

1/ Singh, D., Rajagopalan, M. and Maini, J.S. Monograph on Estimation of Wool Production. IASRI, New Delhi, 1970.

estimates of annual wool production are obtained by adding the wool production over all the strata.

Other data on breed of sheep, age, sex, composition of flock, feeding and management practices, utilization of sheep and wool could also be collected at the time of shearing. In the case of nomadic flocks also they are taken to predetermined places for shearing as flock owners usually have contracts to sell wool to dealers or brokers. Hence nomadic flocks would not pose any problem.

Data collected relate to greasy fleece weight. Therefore to obtain estimates of clean wool it is necessary to ascertain, on the basis of representative samples of greasy wool, the clean wool content. From commercial wool dealers, grades based on the quality of fibres may be determined. In addition to shorn wool, "pulled wool" from dead sheep also contributes to total production in a small way. The average weight of pulled wool may be obtained from case studies or from experimental station records.

5.6 Integrated Sampling Approach for Meat, Milk, Eggs and Wool

The sample surveys developed separately for estimation of milk, eggs, wool and meat are quite suitable for adoption when the products are to be covered individually. The increase or decrease in output of these products in subsequent years however, cannot be estimated unless sample surveys are repeated every year on each of the products which would be somewhat costly. Therefore, a need exists to develop an integrated sample survey for estimation of milk, eggs, wool and meat every year through one single survey.

The sampling design adopted in India for this purpose ^{1/} is one of stratified multistage random sampling. The strata are formed by suitably combining tehsils/taluk and the P.S.U.s are clusters of two villages each. The sampling units at the subsequent stages also are more or

^{1/} Prem Narain, Goel, B.B.P.S., Garg, J.N. Handbook on Methodology of Sample Surveys for Estimation of Live-stock Numbers and Products, IASRI, New Delhi, 1984.

less similar to those in the case of a survey on individual products. A fraction of the primary sampling units in the sample is matched over the 3 years in each of the seasons. One product (the main product) is studied on an intensive scale in a year whereas the other products are covered on a smaller scale, so as to provide indices of changes over the years. Successive sampling procedure, namely retention of some of the P.S.U.s and replacement of others between seasons within a year, is used when a livestock product (namely milk, egg, wool or meat) is the main product under investigation. A double sampling procedure is adopted in a year when the product is covered on a reduced scale by using the information collected on a large scale in the earlier/later year. Information on more than one product is obtained from the same sample of P.S.U.s.

5.7 Hides and Skins

For the great majority of developing countries, no reliable production and supply statistics of hides and skins exist. The reason for this lack of output data is the fact that the proportion of recorded slaughtering is usually small in relation to the total kill. In many countries slaughterings are only recorded if they take place in municipal slaughter-houses and abattoirs, and slaughterings on the farm or in the bush, which may be in fact much greater, are usually not registered. The proportion of such unrecorded slaughterings varies from country to country; it generally tends to be highest for goats, a little lower for sheep and lowest for cattle and calves. In addition to output from unrecorded slaughterings, output of hides and skins from fallen animals is also statistically ignored, which may be considerable in countries where livestock is kept primarily for social status.

In the absence of recorded slaughter data one usually relies heavily on estimates of a production rate composed of the following elements:

$$\text{Production rate of hides or skins} = \frac{(\text{Recorded slaughterings} + \text{estimated bush slaughterings} + \text{estimated natural deaths}) \times 100}{\text{Total livestock population} + \text{live imports} - \text{exports}}$$

This formula permits the derivation of an average hides and skins output in numbers which, multiplied by a unit weight, gives total production in weight. This concept may be unsatisfactory to the extent to which it is mechanical, i.e. it does not take sufficient account of intra-seasonal fluctuations owing to diseases, pastoral conditions, changes in unit weights of hides and skins owing to structural changes in the slaughter of different breeds, sex and age of animals, etc. It may nevertheless in some cases be the only approach yielding reasonable approximations.

Alternatively, another method can be applied which is also suitable for cross-checking of the results of the above formulae. There is some correlation between the weight of animals and meat produced and the weight of hides and skins. However, this correlation is closer for bovines than for sheep and goats because of wool and hair distorting the ratio. Again, more than approximations probably cannot be expected.

The ultimate figure desirable for the planner is not only domestic output but the available supply. Output data will therefore have to be adjusted by factors covering waste, hides and skins used for non-tanning purposes and by those smuggled across borders. Frequently, hides and skins deteriorate on the fallen animal, rot may set in before they are cured and in remote areas where there is no incentive for marketing they may be left to decay. It has been estimated that in some countries up to 25 per cent of the domestic output of hides and skins may thus be lost. In certain heavily populated areas hides, being a collagenous, protein-rich product, are eaten as a substitute for meat. Finally, smuggling of hides and skins is very common, particularly in areas where national borders run across the principal livestock breeding areas. In fact, trade flows have been observed to change with black market currency rates and the respective purchasing power of currencies. These factors have to be taken into account when estimating the annual available supply for tanning or export, which can be expressed as follows:

Domestic supply		Domestic output - waste
of hides and	=	- hides and skins used for non-tanning
skins		purposes + smuggled hides and skins

6. COST OF PRODUCTION STUDIES

6.1 General

This chapter is devoted to estimating the cost of rearing livestock and of producing certain livestock products. In countries where livestock products are produced on well organized holdings, the maintenance of records for inputs and outputs relating to livestock products is easier. However, in developing countries, production units are often scattered and poorly organized, and the producers are not well acquainted with recording data. In developed countries, production cost data are often collected from production units by a mail survey. Each production unit should maintain systematic accounts of inputs and production and provide the required information at regular intervals, in accordance with regulations. In developing countries, the data required for estimating production costs can be kept on only a limited number of modern farms and sample survey techniques have to be used. In India some studies have been carried out using a methodology developed by the Indian Agricultural Statistics Research Institute (IASRI) in New Delhi. Methodologies have been developed for estimating the cost of production of important livestock products such as milk, wool, poultry and eggs. Methodologies have also been developed for estimating the economics of rearing calves, sheep, goats and pigs. A brief description of the methods used is given below.

6.2 Milk

The cost of milk production can be estimated using sample surveys. The data are recorded for a sample of production units for at least one complete seasonal cycle. A cost accounting approach for the collection of data from these small units may be costly but it is unavoidable. 1/

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- 1/ Panse, V.G., Amble, V.N. and Puri, T.R. Cost of milk production in Delhi. ICAR Report Series No 6, 1961.
 - 2/ Panse, V.G., Amble, V.N. and Raut, K.C. Cost of milk production in West Bengal. ICAR Report Series No 28, 1967.

If a list of milk producer units/holdings is available, then a random sample of producing units within each stratum can be selected. If such a frame is not available, a list based on a random sample of villages will have to be prepared. The field investigators visit and collect data from the selected units for one day each fortnight. The items of information which should be recorded are: quantities and type of feed fed to milk stock, the labour utilized (for feeding, milking, cleaning stalls, etc.) and labour wage rates, prices of feed and fodder, recurring expenses, investments, acquisition/disposal of stock, milk yield, income from dung, etc. As the milk producers in rural area may not be able to express quantities in standard measures, data on the milk yield and feed need to be obtained by weighing.

The overall cost includes that of feed, labour (both paid and family labour), depreciation of animals (i.e. replacement cost), miscellaneous recurring expenditure, depreciation of capital investment and interest on capital. From the gross cost so obtained, income from sources other than milk (mainly dung) is subtracted to obtain the net cost. The maintenance cost per milch animal per day divided by milk yield gives an estimate of cost per unit of milk.

Studies carried out in India have shown that feed cost account for about 55 to 60% of the gross cost of milk production; labour accounts for another 25 to 30% and each of the other components accounts for 5% or less.

6.3 Wool

The management conditions on modern farms are quite different from those in villages. Migratory flocks add to the problem of collecting data. 1/

1/ Raut, K.C. and Nadkarni, U.G. Cost of rearing sheep and goats under migratory and stationary conditions. Ind. J. Anim. Sci., 44(7), 1974.

Random sample of flock, for migratory and stationary flocks respectively, should be taken. For each selected flock, information needs to be collected on items such as number of sheep, the quantity and nature of work carried out by paid labour and members of the family, the amount of feed fed and their rates, grazing practices and charges, valuation of stock, records of purchase and sale, income from milk, folding and manure, and wool yield at each shearing. Data may be recorded on stationary flocks at regular monthly intervals but in the case of migratory flocks, the field investigators have to move with the flock. The data need to be collected for the full year, covering all the shearing seasons.

The overall cost of rearing sheep includes the following items: paid and unpaid labour, feed, depreciation of assets and equipment and interest on capital. To obtain the production cost of wool, the income from sources other than wool (i.e. from dung, manure, folding, skins and milk) is subtracted from the gross cost. The estimate of production cost per unit of wool is obtained by dividing the total cost by the wool yield.

Studies carried out in India have shown that labour constitutes the major component of cost, accounting for 70 to 80% of total cost, irrespective of whether the flock is stationary or migratory.

6.4 Poultry and Eggs

This concerns the production cost of table-eggs and hatching eggs and the cost of rearing birds up to various ages, from day-old to adult, and the cost of maintenance of layers and cocks. Data need to be collected from the selected poultry farms, using a cost accounting approach, by means of weekly visits by trained investigators. The required items of information include number of birds, egg production, feed consumption, labour utilization, cost of medicines and other miscellaneous expenditure, price of feeds and labour wage rates etc. Utilizing the recorded information, the production cost is estimated from the cost of feed, labour, management, depreciation of assets and equipment, depreciation of layers and cocks and miscellaneous expenditure.

The maintenance cost per year of an adult bird (layer/cock) is obtained from the total of costs during the period less miscellaneous income. The cost of an egg is calculated by dividing the total of the cost of maintenance of layers, expenditure on collection of eggs, management, additional depreciation cost of assets and equipment etc. by the total number of eggs produced. The cost of hatching-eggs is obtained by adding the cost of maintenance of cocks to the cost of eggs. The production cost of a day-old chick is calculated by dividing the total expenditure on eggs set for hatching, expenditure on labour and management as regards hatching, by the number of chicks produced. The cost of a 2-month, 4-month or mature bird is obtained by adding to the cost of a day-old chick, the cost incurred during the subsequent period.

6.5 Meat

In order to estimate the cost of rearing animals, cost items such as feed, labour, depreciation of assets and equipment, interest on capital and miscellaneous recurring expenses need to be estimated. This cost is required from birth to the age at which the animal is to be slaughtered. Before slaughter, the body weight of the animal (weight on hoof or live weight) is measured. In addition, the dressing percentage is required for each category of animal. The quantity of dressed meat is calculated from the live weight and dressing percentage. Income from the skin, hide, hooves, horns, blood, tail, etc. of slaughtered animals, needs to be calculated and subtracted from total costs to obtain the net cost of producing the meat. Dividing the net cost by the quantity of dressed meat gives the cost per unit of meat production.

In the majority of cases, cattle and buffaloes are not fattened initially for meat production. The females, after giving milk for a few lactations, when no longer fit for breeding or economic, are sent for slaughter. The males are sent for slaughter when no longer useful as draught animals. In general, it is only in developed countries that certain of cattle are fattened from birth for meat production. In these cases the cost of rearing from birth till slaughter can be estimated. The cost of rearing

calves can be estimated using sampling techniques. 1/ The sampling plan and method for the collection of data and the procedure for estimating the various cost components are similar to those for estimating the cost of milk production except that the rearing costs are estimated for different age groups.

Goats may be reared separately or together with flocks of sheep. In Mediterranean, African, Asian and South American countries, goats are kept purely for meat production, and the cost of rearing from birth to slaughter is estimated as for calves. If the goats are raised with sheep, the costs are apportioned on the basis of number of head of sheep and goats, giving equal weight to each. As in the case of sheep, the cost of labour accounts for about 70% of the gross cost.

The data required for estimating cost of rearing pigs should be maintained regularly. In the case of scattered units, sample surveys have to be conducted. 2/ The cost of feed, labour, interest on capital, depreciation of equipment, miscellaneous expenses are estimated up to different stages of growth.

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- 1/ Raut, K.C., Amble, V.N. and Singh, D.: Economics of raising cattle and buffaloes in Hissar area of Haryana. IASRI Project Report. India, 1973.
- 2/ Nadkarni, U.G. et al: Cost of maintenance of Pigs. Ind. J. Anim. Sci. 53(8). 1983.

7. FEED AND FODDER STATISTICS

7.1 Importance

In order to assess feed resources, supply and utilization, in terms of quantity and quality, and the nutritional requirements of animals if production targets are to be achieved, it is necessary to estimate feed availability and the measures required to improve nutrition. This requires the construction of a Feed Balance Sheet, the aim of which is to determine the quantity of animal feedstuffs and the consumption of various types of animal feed, by animal production sector. The aim of feed statistics is, therefore, to obtain estimates of feed requirements/utilization on the one side, and of feed availability/resources on the other. This may be done at different levels, from a farm to a country.

7.2 Types of Feed

Feeds can be classified in various ways, using different criteria. For example, by the origin of the product: plant, animal, mineral; or by the product's physical condition: primary, processed. For the present purpose, feed is classified into (i) concentrates, (ii) dry roughages, (iii) cultivated and uncultivated green fodders and (iv) other.

7.2.1 Concentrates

These include: primary cereals (wheat, rice, maize, barley, oats, rye, sorghum, millet, etc.); cereal by-products (brans, middlings, brewery residues, distillery residues, gluten, starch, etc.); starchy root products (cassava chips and pellets, dried roots and tubers, flour of roots and tubers, potato pulps, etc.); sugar products (sugar, beet pulp, molasses, sugar residues, dextrose, glucose, etc.); pulses (beans, peas, lentils, vetches, lupins, etc.); oilseeds (soybeans, groundnuts, sunflower seed, rapeseed, melonseed, cotton seed, etc.); oil cake (groundnut cake, rice bran cake, maize cake, soybean cake, copra cake, palm kernel cake, sunflower cake, rapeseed cake, etc.); fats and oils (animal, fish and vegetable oils and fats, etc.); high-nutrient fruits, vegetables and derived products (carobs, dates, fruit and vegetables,

dried fruit and vegetables, fruit and vegetable pulp flours, seaweed meal, etc.); processed green fodders (lucerne meal and pellets, cassava leaf meals, etc.); by-products from meat processing (whale meal, whale solubles, meat meal, blood meal, bone meal, offals, feather meal, etc.); milk and dairy products (fed whole milk, suckled milk, skimmed milk, butter milk, whey milk, dry whole milk, dry skimmed milk and butter milk, dry whey, etc.); and fishery products (fish meal, fish waste, fish silage, fish solubles, etc.).

7.2.2 Dry Roughages

Dry roughages include harvested by-products (straw and chaff of cereals and pulses, etc.); hay (clover, lucern and other dry leguminous and non-leguminous grasses, etc.).

7.2.3 Green Fodder

Green fodder includes pasture grasses; green forage/silage crops (green maize, green sorghum, rye and other green cereals, berseem, lucern, green clover, other green pulses, other green fodder crops, etc.); roots, tubers, sugar crops and fruit bearing vegetables (potatoes, cassava, taro, forage beets, sugar beets, sugarcane, carrots, cabbages, gourds, cucumbers, etc.); non-fruit-bearing vegetables (asparagus, lettuce, spinach and other leafy vegetables, etc.), and tree leaves.

7.2.4 Other Feed

In addition to above-mentioned types of feed, compound feeds are prepared to provide balanced rations for dairy and other cattle, pigs, poultry and other animals. Feed minerals and additives, non-protein nitrogen and feed supplements, etc. may also be included.

7.3 Estimation of Feed Other than Green Fodders

For estimating total feed, it is necessary to have data on: (a) the proportion of cereals, pulses and other crops utilized as animal feed, (b) total production of grains, oilseeds, etc., (c) extraction rates to assess production of by-products such as bran, oil cake, (d) the amount of straw, hay and silage available, (e) the quantity of

nutrients available through grazing and pastures, (f) the amount of nutrients available from by-products such as blood meal, fish meal, buttermilk and skim milk, and (g) the amounts of animal feed imported and exported.

Assessment of the supply/utilization balance permits the estimation of missing industrial feed statistics (for example, the output of cakes can be estimated from the output of vegetable oils, for which statistics are usually available) and for determining the proportion of primary food products available for non-food purposes. This system does not, however, provide statistical information on the availability of household rubbish, which is an important source of feed for poultry and pigs in many countries.

In the developed, and many developing, countries, data on feed and fodders are usually available from the reports and records at experimental stations and research institutes. Data are also available from studies or special surveys concerning feeds and feeding. In countries where range feeding of livestock is practised, appraisal of range feeding condition may be effected by agriculture/animal husbandry departments, in conjunction with the meteorological departments, as in U.S.A. (monthly). In Canada a semi-annual cattle feed survey is conducted. Range feeding appraisals, although subjective, give an indication of the extent of feed available for grazing. Similarly, surveys are conducted for assessing the area and condition of pastures.

In many countries where the fattening of livestock is practised systematically, data are collected through sample surveys on (a) the number of animals raised only in feed lots, (b) those on pasture as well as on supplementary feed, (c) those on pasture only, (d) type of fattening ration, and (e) number of livestock marketed. In countries where animals are stall-fed, data are sometimes collected on the quantity of feed and its composition, partly by enquiry and partly by direct observation.

Estimates of dry fodder can be obtained using grain-to-straw ratios. Since the production of grain is estimated regularly, estimates of by-products can be obtained using grain-to-straw ratios. Sometimes a certain proportion of by-products of human food is destined for livestock consumption. For example, sometimes it is stated

that, of the total production of cereals and pulses, about one per cent and three per cent respectively are kept for livestock consumption. The availability of bran, husks and straw is estimated by assuming conversion factors, such as 5 per cent for rice bran, 15 per cent for wheat bran, 25 per cent for rice husk, 15 per cent for other husks, 2:1 ratio for straw to grain in the case of paddy and wheat, 8:1 ratios for jowar and millets and 3:1 ratio for gram. The seed-to-lint ratio is taken as 2:1 and the extraction rate of cake from cotton seed as 20 per cent.

In most developed countries, animals are fed according to their requirements. In developing countries, however, the animals are often fed by farmers according to their means and resources. It is only on modern farms that animals are fed according to their requirements.

In order to estimate the availability of feed, the feed consumed per animal may be estimated from relevant data collected through sample surveys. Livestock numbers may be obtained through either censuses or sample surveys. In sample surveys on livestock and allied subjects, a stratified multi-stage sampling design is generally used. The primary sampling unit is a village or a cluster of villages. The household or stall is the second stage unit and sometimes animals in the stall comprise the third stage unit. In these surveys, data on feed consumption by different categories of animals are recorded. The samples are taken from both urban and rural areas. Utilizing the quantity consumed by a category of animal and the number in that category, total consumption for each feed constituent can be calculated. In the surveys, information can also be collected on animals fed only through stall feeding, or through grazing, or through both stall feeding and grazing.

7.4 Estimation of Fodder Crops and Pasture Grasses

7.4.1 General

Cultivated fodder crops fall broadly into two classes, those in which one cut is usually taken and those in which a number of cuts is taken. Crop cutting experiments, similar to those for crop estimation surveys, can be carried out to estimate the yield of fodder crops. If

there are repeated cuts, measurements need to be made for each cut. The area under each fodder crop can be obtained either from the records of land use or through sample surveys. Total production can be calculated from the area and the estimated average yield.

The most difficult problem related to fodder supplies is in the estimation of grassland production, forest grazing, seasonal grazing of stubble, leaves, etc. Camels and goats derive a major portion of their sustenance from leaves, which are either browsed or cut.

Many methods of estimating grassland production and utilization exist, but none is entirely satisfactory. A reasonable estimate of grassland production and utilization may be obtained by a combination of some of the methods suggested below.

7.4.2 Grassland Estimates Based on Livestock Production

The amount of grassland utilized (i.e., the energy supplied by pastures and other grazing) may be estimated by converting the principal livestock products (e.g., gains in live weight and milk production of the grazing animal) into the feed input. The resulting figure is allocated between the various sources of feed. The main difficulties lie in obtaining the relevant data on livestock products, and in determining appropriate conversion factors to link the livestock products to the feed input.

7.4.3 Grassland Estimates Based on Stocking Rates

In this approach, grassland utilization is estimated by multiplying the actual stocking rates (i.e., number of animals grazed on a hectare of grassland) by the amount of pasture required to productively maintain one head of livestock, or one livestock unit, per day, or per year. Mainly for convenience, the livestock population is converted into livestock units. Grassland production is similarly estimated by using potential stocking rates, or carrying capacity, instead of actual stocking rates. However, obtaining precise estimates of stocking rates and pasture consumption involves certain difficulties.

7.4.4 Grassland Estimates Based on Area and Yield

When the area and yield of grassland are known, pasture production is obtained by multiplication of these factors. But information on these factors is insufficient in most countries, and also this method is deficient in that it does not indicate the amount of grassland actually utilized.

Estimates of the area of pastures available for grazing can be obtained through sample surveys. For example, in India, sample surveys were undertaken in typical areas, to assess the area and condition of pastures. Primary sampling units were villages, second stage units were "grazing areas" in the villages and the third stage units were "one square metre cuts" within a grazing area. Separate sample villages were selected in different seasons, with a probability proportional to the bovine population in villages and with replacement. Village grazing areas were divided into two to three sub-areas depending on area of grazing. Generally, two sub-areas were selected in each village and during each month in a season, 10 cuts (one square metre each) were taken both before and after grazing. In addition, in each grazing area, one square metre of herbage area was chosen at random and the herbage collected from the sample plot was classified botanically, and analysed to determine its chemical content. Data on the number of animals of different species grazed per day were also recorded. The difference in weight of herbage before and after grazing provided the estimates of herbage grazed by animals. 1/

7.5 Nutritive Values of Various Feeds

The ingredients of livestock feed provide different amounts, per unit quantity, of dry matter, protein as measured by their digestible crude protein (DCP) and energy as measured by total digestible nutrients (TDN). Knowledge of the nutritive values of feedstuffs available in a region

1/ Raut, K.C., U.G. Nadkarni, P.R. Sreenath and B.C. Saxena: Estimation of area of grazing land and its utilization. IASRI Report, 1978.

will be extremely useful in estimating their availability and requirements for any improvement programme. Some of the most common measures of the nutritive value of feedstuffs are explained below.

7.5.1 Dry Matter

Dry matter is essential in satisfying an animal's appetite in the process of digestion.

7.5.2 Crude Protein Unit

The crude protein content (proteins, amino acids, non-protein nitrogen) of a feedstuff is obtained by multiplying by 6.25 the total amount of nitrogen determined in accordance with the Kjeldahl method.^{1/} Physiologically, evaluation in terms of digestible crude protein is preferable, but various species of animals have different capacities for digesting proteins. Evaluation in terms of crude protein helps to determine the protein value, and is valuable additional information. This evaluation, however, does not indicate the quality of the proteins supplied to the animals.

7.5.3 Digestible Protein

This is the part of the available protein in a feedstuff that is digested by the animal, and is calculated by multiplying the available quantity of protein nutrient in a feedstuff by the corresponding digestibility coefficient.

7.5.4 Protein Equivalent Unit

This is the mean of digestible crude protein and digestible pure protein.

^{1/} In this method, the feed is oxidized with hot, concentrated sulphuric acid, whereby the nitrogen of the protein is converted into the ammonium ion, which is readily estimated. The multiplier 6.25 is based on the assumption that food protein contains 16% nitrogen by weight. For cereal grains the multiplier is 5.7.

7.5.5 Total Digestible Nutrients Unit (T.D.N.)

This is the sum of all the digestible organic nutrients (protein, carbohydrates including fibre and fat) calculated by multiplying the quantity of each nutrient by its digestibility coefficient. The fat nutrient is further multiplied by 2.25 (or 2.3) because its energy value for animals is 2.25 (or 2.3) times that of protein or carbohydrates. The metabolizable energy concept is used in the T.D.N. calculation. The metabolizable energy of a feed or nutrient is the amount of energy, left after deducting from the total or gross energy of the feed, the amount of energy lost in (a) faeces, (b) combustible gases, (c) urine; a further deduction of the heat lost in the (d) "heat increment" or "work of digestion" gives the net energy used for productive purposes.

7.5.6 Starch Equivalent Unit

This unit serves as a measure of the productive energy value (i.e., the net energy available for production of meat and fat, work, milk, etc.) which an animal can assimilate from the feed intake. It is a measure of the energy for such purposes expressed in terms of the quantity of pure starch which would yield an equivalent quantity of energy. Strictly speaking, starch equivalent measures the fat-producing value of a nutrient for cattle, expressed in terms of the equivalent weight of starch; however, the term has been used, less accurately, for a measure of milk and work values. The Starch Equivalent Unit can be directly related to the Grain Feed Unit. For example, 1 Grain Feed Unit expressed in terms of barley equals 0.7 Starch Equivalent Units.

7.5.7 Grain Feed Unit

This is a measure of the productive value of barley grain (or oats, maize, etc.) used as the basis for comparing the value of other foodstuffs.

7.5.8 Nutritive Ratio

This is the ratio of digestible crude protein to the energy value of the digestible carbohydrates, and fats (ether extract); given the Digestible Crude Protein (DP)

and the Total Digestible Nutrients (TDN), the Nutritive Ratio (NR) is calculated as:

$$NR = \frac{TDN - DP}{DP}$$

Protein-rich feedstuffs are referred to as possessing a narrow nutritive ratio, and low-protein feedstuffs as having a wide nutritive ratio.

Another important concept is the digestibility coefficient, which is the percentage of the quantity of a nutrient actually digested by an animal (determined by an intake-faecal output analysis) related to the available quantity of the nutrient (e.g., protein) in the feedstuff.

7.6 Accuracy and Coverage of Nutritive Values

7.6.1 Determination of Chemical Composition

Chemical analysis determines the quantities of nutrients present in a given sample of feedstuff. The nutrients contained in animal feedstuffs are expressed in terms of proteins (true and crude), crude fibre, carbohydrates (sugar, starch, etc.), and vitamins. The quantity of each nutrient varies according to the type of feedstuff, and other related factors such as soil conditions, for maturity, locality, and moisture content.

There are different methods and techniques for determining the chemical composition of feedstuffs, these are gradually becoming standardized and approved by chemists. Such methods include the taking and preparing of samples, the number of trials, and the development of specific analytical techniques for the particular components in the feedstuffs. For example, the "method by difference" of carbohydrates determines separately the fraction of other nutrients by direct analysis; the carbohydrate content is obtained indirectly by subtraction from the total nutritive content. The nature of data on nutritive contents of feedstuffs is dependent also on other factors; the data may represent the analysis of only one sample, or the mean of several samples differing by type, region, season, and the physical and chemical properties of the feedstuff.

7.6.2 Digestibility of Feedstuffs

Digestion experiments determine the digestibility and relative value of each nutrient in animal nutrition. The total, or gross, energy of feedstuffs may be found by burning them in a calorimeter; but this does not give a measure of the energy that the body can derive from these feedstuffs, as the nutrients consumed are not completely digested, and the digested fraction is not completely burned in the body. The metabolizable energy of each nutrient may be determined by feeding an animal measured quantities of the feed or nutrient and then measuring the maintenance needs, heat increment (work of digestion), and the animal's gains in body weight, milk production, etc. In certain cases, the metabolizable energy is determined by subtracting, from the gross energy of the feedstuff or nutrient, energy losses in urine, combustible gases, indigested fraction in the faeces, and heat increment.

Thus, data on the composition and nutritive values of feedstuffs are essentially experimental in origin; and, as with similar data, their accuracy depends largely on the quality, standard and design of the experiments. In the collection and compilation of nutritive values, consideration should be given to these factors and to other problems affecting the reliability and comparability of the data.

The statistics of concentrate feedstuffs are well developed, owing to their commercial value, and to advances made in the science of human nutrition. The composition and nutritive values are well documented, and variation in these values among countries is not as extreme as that of roughages; occasionally, the difference is negligible.

Despite the fact that roughages constitute the chief source of feed supply in most countries, the statistics on roughages are not as developed as those on concentrate feedstuffs.

7.7 International Tabulations of Nutritive Values

Different feed units are used in evaluating feedstuffs for ration formulation in different countries. These units fall into two main categories. One category is a measure

of the productive or net energy of feedstuffs, and includes the Starch Equivalent and its derivatives (the Grain Feed, and Feed Fattening Units). The second category of feed units consists primarily of the Total Digestible Nutrients Unit, which is a measure of the available or metabolizable energy value of feedstuffs.

Switzerland and several other countries use the Starch Equivalent Unit in the nutrition of ruminants. The Oat Unit is used in the USSR, and other eastern European and Scandinavian countries; some Scandinavian countries use the Barley Unit. In the United States, the Corn Unit is widely used, while the member countries of the European Common Market have adopted the Barley Unit and the Crude Protein Unit.

7.8 Feed Balance Sheets

7.8.1 General

As with any balance, the Feed Balance Sheet has two sides viz. Resources and Utilization. Such a balance sheet helps to indicate a shortage or surplus of feed supply. If there is a shortage, efforts will be made to increase feed supply by improving the yield per hectare or acre, by a change in land use or by both. In the case of a surplus in feed supply, steps can be taken for using land in different ways (e.g. by growing more cash crops and less feed crops), increasing the number of livestock and/or selling feed to other parts or farms. If feed supply and requirements are well balanced, producing more feed for increased livestock production or for sale can be attempted.

7.8.2 Resources/Availability

The resources side of the feed balance sheet covers all feedstuffs, whatever their origin (home-produced or imported), consumed in whatever form (product as such, compound feedstuffs, etc.), during the reference period. As mentioned earlier, the number of constituents of feedstuffs is very large, covering all the by-products of primary crops, most of the vegetable crops, many animal products, etc. These are generally grouped taking account of various aspects viz. classification according to quality (concentrates, low-nutrient density feeds and compound

feeds), their nature (primary agricultural products, processed products, etc.), purpose for which they were produced (fodder crops, by-products of food industries, etc.), and the animal nutrition physiology (i.e. including feedstuffs with similar or substitutive properties).

7.8.3 Feed Requirements/Utilization

The utilization side of the feed balance sheet shows the breakdown of resources by animal production sector, and the ingredients of the feedstuffs for each animal production sector. The basic problem in establishing the utilization side of the feed balance sheet is to record the utilization of the feedstuff resources entered on the resources side. It must show the production or output area in which the available feedstuffs were consumed, and the feedstuffs comprising the overall consumption in the separate production sectors. To achieve this, breaking down feedstuff utilization, and assigning it to each of the various sectors of animal production, is necessary. For constructing the utilization side we must tackle the following problems:

- (a) Calculation of feed requirements.
- (b) Breakdown of the consumption of feedstuffs by production sectors.
- (c) Distribution of feedstuffs by utilization sectors.

(a) Calculation of feed requirements

For the purposes of feed balance sheets, the basic data on livestock should be sufficient, in detail and scope, to provide information by species on the structure of the livestock population (with regard to fertility and mortality rates, type and yield of livestock production, etc.). The existing livestock data should permit an assessment of a livestock balance, expressed in the following equation:

$$\text{Ending Numbers} = \text{Beginning Numbers} + \text{Births} + \text{Live Imports} - \text{Exports} - \text{Slaughter} - \text{Other Utilizations} - \text{Losses}$$

(This is useful as a periodic consistency check if applied to a different livestock species.)

The above equation can be further refined by providing, for each applicable term of the equation, a complete breakdown by age and sex; live weight; carcass or dressed weight; use or purpose; type and yield of livestock products (including milk production and milk yield per cow); egg production and laying rates; wool production; work production, etc.

For the calculation of current and future feed requirements for maintenance and production, these bio-economic factors may be fitted into a comprehensive livestock herd model. However, this model is rarely possible. As the main source of livestock data in most countries is usually a census of agriculture, the required details cannot be obtained. These details can best be furnished by livestock surveys, to account for the various fluctuations in the structure and production of the livestock population during the year.

When discussing the subject of feed requirements, it is appropriate to mention maintenance requirements, production requirements and feed utilization.

(i) Maintenance requirements

Calculation of these requirements involves the estimation of the feed required to keep an animal in a state of non-production, with no loss in body weight. The problem in this calculation lies in developing suitable methods of expressing the proportion of the ration intake allocated to this purpose, while simultaneously considering the national herd. The quantity of a maintenance ration is closely correlated to the liveweight of the animal (or to the power of the liveweight), and varies significantly, according to environment, region, season, temperature and the species, age, sex, and use of the animal. The liveweight figures used in the calculation of the maintenance requirement should be as detailed and accurate as possible.

(ii) Production requirements

Production requirements include pregnancy requirements, lactation requirements, growth and fattening requirements, and requirements for egg, wool, work, etc. For determining these requirements, accurate data on calving and lambing rates, culling rates, milk yield per animal, gains in liveweight of growing and fattening animals, and other factors are needed.

(iii) Feed utilization by animal species

In the utilization factor of the feed balance sheet, the feed supply must be distributed by animal species and type of feed requirement. The following is a commonly adopted classification:

Cattle and buffaloes

- maintenance requirements;
- production requirements;
- pregnancy;
- growth; and
- lactation

Sheep

- maintenance of males;
- maintenance of breeding ewes;
- growth requirements for replacement ewes;

Goats

- maintenance of males;
- maintenance of breeding females;
- growth requirements for replacement females;
- lactation requirements.

Pigs

- maintenance of boars;
- maintenance of breeding sows;
- pregnancy requirements;
- lactation requirements;
- maintenance of piglets (up to 6 months); and
- maintenance of pigs (from 6 months to 1 year).

Poultry

- laying requirements;
- growth requirements for replacement layers;
- growth requirements for broilers; and
- growth requirements for other birds.

Horses, asses, mules, camels

- maintenance requirements for horses over 2 years old; and
- growth requirements for horses less than 2 years old.

(b) Breakdown of the consumption of feedstuffs by production sectors

There are important quality limits to the calculation of feed requirements, because comprehensive livestock herd models do not exist; but in most countries, evaluating consumption by using information from census results and current statistics is still possible. Very little information on the breakdown of feedstuffs consumption by production sector is available. This breakdown requires extensive use of estimates or the establishment of criteria for the derivation of estimates.

(c) Distribution of feedstuffs by utilization sectors

Objective data on feed consumption by various utilization sectors are not available in most developing countries. Estimation of feedstuffs fed to different species of animal is necessary. These estimates may be based on sampling techniques or questionnaires. For example, in India quantity of feed available to different categories of cattle and buffaloes is obtained from the Integrated Livestock Product Surveys, the details of which were discussed earlier. It may be possible to obtain some estimates while conducting an animal census or other agricultural enquiries. Often, these results are not readily available, and assumptions must be made to obtain preliminary figures on the utilization of the various feedstuffs by species of animals and sectors.

For example, restricting the use by sector of the various feeds or groups of feedstuffs is possible, by elimination. Fish and meat meal are not fed to horses and

cattle. Milk is not fed to horses. Crude fibre and fresh forage (i.e., in effect, the whole of feed from arable and grassland, and products associated with arable farming), are not fed to poultry and rarely, or in relatively insignificant amounts, to pigs. Potatoes are fed mostly to pigs, in lesser amounts to cattle, and not at all to horses and poultry. If this elimination procedure is thorough, the use by sector of the various feedstuffs can be narrowed considerably.

Therefore, when allocating feedstuffs to animal species, using the animal nutrition physiology aspect is vital. For example, checking feedstuffs allocated to pigs is necessary to see if the "feed mixture" possesses a sufficiently high digestibility (80-85 per cent), with a correspondingly low crude fibre content in the feed composition. With poultry, a high nutrient or energy concentration to match the conversion rate, and the performance capacity of the birds, must be taken into account so that an optimum balance between feed and performance can be achieved. "Poultry feed mixtures" which do not conform to these requirements are probably incorrectly mixed; there is probably a mistake in the assignment of the individual feedstuffs to this species.

The most important aid in distributing the individual feedstuffs to the possible utilization sectors, however, is the statistical material or compound feed manufacture. The current composition of these compounds is not always known, because the composition and the recipes used in the manufacture of compound feeds depend greatly on the movement of prices of the basic ingredients. Nevertheless, in collaboration with the compound feedstuffs industry or its trade associations, it is normally possible to obtain some indication of the main components of compound feedstuffs and the types of compounds themselves.

Compound feedstuffs production is statistically recorded according to the various utilization sectors. Thus, the individual feedstuffs for the various animal species can be allocated precisely or allocated by determining the separate components, through the proportion of total feed consumption supplied by compound feedstuffs. This method also provides information on the form in which individual feeds are consumed and permits the determination

of the ratio between the amounts of the separate feedstuffs used in compound or "straight" form. Very useful conclusions can be drawn from this.

The consumption of compound feedstuffs varies enormously between the different animal species and production sectors. In intensive types of farming, particularly in egg and broiler production, the feed consists almost exclusively of compound feedstuffs specially adapted to the performance capability of chickens. However, in pig farming, and especially in cattle husbandry, the proportion of compound feedstuffs is lower. For poultry, analysing the composition of compound feeds by individual feedstuffs should certainly be possible. The estimation of the composition of feed consumption in pig farming is easier and more accurate if the separate ingredients in compound feeds for pigs are determined through consultation with the compound feeds industry. For cattle, it might be possible to obtain important points of reference for allocating at least the commercial compound feeds, by analysing the composition of compound feedstuffs used for producing milk, and for fattening cattle and calves.

Study of compound feeds and their essential ingredients can make it feasible to attribute the separate feedstuffs to the various utilizing animal production sectors. Other estimates can then be made more easily and accurately. If particular feeding methods are taken as reference points, and the elimination procedure is used, the identification of other points of reference for the allocation of feeds may be possible. Finally, the distribution of feedstuffs among the various use sectors may be checked by applying nutritional physiology criteria (digestibility and nutrient or energy concentration).

CASE STUDIES

AUSTRALIA

1. Organization of Statistical Services

The Australian Bureau of Statistics (ABS) is responsible for the collection, compilation and publication of official statistics generally, including those relating to agricultural industries, such as livestock statistics, and for the co-ordination of various governmental statistical activities and services. It was established under the Australian Bureau of Statistics Act 1975 as a statutory authority responsible directly to a Minister of the Australian Government (currently the Treasurer). The Act also created the office of Australian Statistician, empowering him to take over the functions, powers, and duties expressed in earlier relevant legislation. The Act also established the Australian Statistics Advisory Council, the functions of which are to advise the Minister and the Statistician on matters pertaining to the provision of official statistical services in Australia, including annual and longer term priorities and work programs of the ABS.

The Australian system provides an example of departmental centralization with geographical decentralization. Offices of the ABS are situated in the capital city in each State and the Northern Territory. The Central Office is in Canberra, the national capital. Each State Office is responsible not only for the collection, compilation and publication of statistics in that State, but also for providing the principal avenue of contact between State government agencies and other State users and suppliers of statistical information. The Central Office has the responsibility for co-ordinating these collections, for publishing statistics for Australia and for formulating statistical policy for Australia, as well as serving the needs of the Commonwealth Government. Australia's representation at international statistical conferences and meetings is also handled by the Central Office.

Prior to 1957, the collection of statistics was carried out mainly by staff of the State governments. Under a series of agreements concluded between the Commonwealth and the States in 1958, the States transferred

their statistical staff to the Commonwealth and statistics are now provided under an integrated system. Under these agreements, each State has retained its power to collect statistics under State laws, whilst the Commonwealth has undertaken to provide statistical services to State governments. Under a series of agreements concluded between the Commonwealth and the States in 1958, the States transferred their statistical staff to the Commonwealth and statistics are now provided under an integrated system. Under these agreements, each State has retained its power to collect statistics under State laws, whilst the Commonwealth has undertaken to provide statistical services to State governments of the same kind and quality provided before integration.

This integrated statistical service is administered by the Australian Statistician, as head of the ABS, and in each State by a Deputy Commonwealth Statistician. In three of the six States the Deputy Commonwealth Statistician has been appointed as State Government Statistician.

2. Sources of Information

The annual Integrated Agricultural Commodity Census (IACC) is one of the principal sources of information on livestock statistics. The other principal sources are the monthly collections of livestock and poultry slaughtering and receipts of taxable wool. Outside the ABS, statutory marketing boards are important sources of statistics on dairy products, wool, honey and eggs.

3. The Annual Integrated Agricultural Commodity Census

The basic source of Australian agricultural commodity statistics is the Agricultural Census, conducted at the end of March each year for each of the six States and two Territories. The scope, coverage, collection and processing procedures are standardised so that it is possible, despite the variations in farm activity throughout the country, to provide relatively comparable and consistent State tabulations, which can be aggregated to statistical totals for Australia as a whole. While this high degree of uniformity has largely been achieved as a result of the integration of the various State statistical services, annual agricultural censuses have been conducted by some States for some 140 years.

A wide range of items is currently collected by mail in the census from about 180,000 individual landholders. The items include area, production and varieties of crops, numbers of livestock, wool production, area of agricultural establishment, land usage, artificial fertiliser usage and the incidence of irrigation. The list of items collected has been developed over a long period and has been adjusted to suit changing conditions in the agricultural sector, necessitated by technological advancement, as well as to meet the needs of government, business, and private users of statistics. For some commodities not harvested by 31 March, the census collection date, production data are collected on a specific supplementary questionnaire despatched at a later, more relevant time.

To maximize the cost effectiveness of resources devoted to the agricultural census project a system of "rotating" the collection of certain items has been adopted for the census. Sections such as irrigation, fertilizer usage, breeds of sheep and cattle, and use of pesticides, are collected periodically. This reduces the content of each census form and thus the processing cost and also the informant burden.

The units for the collection of agricultural commodity statistics in Australia are all establishments which have an Estimated Value of Agricultural Operations (EVAO) of \$2,500 or more. Establishments with less than \$2,500 (EVAO) do not contribute significantly to agricultural output.

A computer system is used to print address labels for despatch of forms, to mark-in returns received and generate sets of reminders as necessary. Intensive telephone reminder action, followed in some cases by personal visits is also required for some respondents.

Upon receipt, returns are subjected to initial clerical examination for accuracy, internal consistency, and comparability with the previous year's operations and are then transcribed into machine readable form for subsequent computer editing and tabulation.

The entire census project involves just over 180,000 returns annually, which undergo several processing stages and are subjected to detailed edits to ensure the highest possible quality in the resulting statistics.

4. Type of Data Collected

The range of data collected for each livestock species varies in proportion to the importance of the particular species in the agricultural sector, e.g. details concerning cattle are collected every year while details of certain items on sheep, such as breeds, are gathered triennially.

Species covered are:

- (i) cattle;
- (ii) sheep;
- (iii) pigs;
- (iv) poultry;
- (v) buffaloes (in the Northern Territory);
- (vi) goats;
- (vii) horses.

5. Classification of Livestock

Sheep

Details for sheep and lambs comprise age classification, breed and sex. Age classification is "under one year" and "one year and over". There are over 20 recognized breeds classified by numbers in addition to Merino comebacks (finer than half breed) and cross-breeds.

Sheep and Lambs

- Rams, 1 year and over
- Breeding ewes, 1 year and over
- Other ewes, 1 year and over
- Wethers, 1 year and over
- Lambs and hoggets, under 1 year

Cattle and Calves

Milk Cattle

Dairy Breed Bulls Used or Intended for Service

- Bulls, 1 year and over
- Bull calves, under 1 year intended for service

Dairy Cows and Heifers

- Cows, in milk and dry
- Heifers, 1 year and over
- Heifer calves, under 1 year

House Cows and Heifers (in milk and dry)**Meat Cattle****Beef Breed Bulls Used or Intended for Service**

- Bulls, 1 year and over
- Bulls calves, under 1 year intended for service

Other Cattle and Calves Mainly for Meat Production

- Cows and heifers, 1 to 2 years
- Cows and heifers, over 2 years
- Heifer calves, under 1 year
- Other calves, under 1 year
- Other cattle, 1 year and over (steers, bullocks, spayed cows, etc.)

Domesticated Buffaloes

- Bulls (1 year and over)
- Cows and heifers (1 year and over)
- Calves (under 1 year)
- Other buffaloes (1 year and over)

Pigs

- Boars
- Breeding sows
- Gilts intended for breeding
- Other pigs (including suckers, weaners, growers, etc.)

Poultry**Live Poultry**

- Fowls
 - egg strain hens and pullets for egg production for human consumption

- egg strain pullets contract grown and replacement stock for egg production for human consumption
- meat strain chickens grown on contract
- meat strain chickens grown on own account
- day old chicks sold
- breeding stock (hens, pullets and cockerels)
- Ducks
- Turkeys
- Other poultry (including geese, game birds, etc.)

Dressed Poultry

- Reared on this holding
- Other dressed poultry sold

6. Changes in Livestock Numbers

Information on births is collected in all states only for sheep while for cattle it is restricted to some states. Detailed information on births is collected on lambs marked during the year ending 31 March and number of ewes mated to produce marked lambs. In the case of cattle, number of calves born and number of cows and heifers mated are collected in most States.

Some information is collected on numbers of livestock sold in quantitative terms. Data on value of livestock purchases are collected by survey. Farm deaths of livestock are not collected in all States.

7. Reproductive Rates

Data required to calculate reproductive rate are collected by all States for sheep and some States for cattle. For other species, the information is not collected.

8. Take-off Rates

There is no systematic collection of information on take-off rates. But information on disposals of livestock from holdings is collected for sheep, cattle, pigs and goats and horses.

9. Details of Herd Size

Annual details of composition and size of herd are collected in the census. Preliminary estimates of herd numbers are produced around May and September while detailed statistics are published a few months later.

The following publications are issued:

Principal Agricultural
Commodities (Preliminary) May-Annually (Cat. No 7111.0)

Selected Agricultural
Commodities (Preliminary) Sept-Annually (Cat. No 7112.0)

Livestock and Livestock
Products March-Annually (Cat. No 7221.0)

Livestock Products Monthly (Cat. No 7215.0)

10. Livestock Products

Meat: Concept of meat production is defined as "total meat production from slaughtered livestock originating in Australia and passed for human consumption". Livestock carcasses condemned by health inspectors at slaughterhouses as unfit for human consumption would not be included in production. Imported meat would be classified as "Imports". There are no live animal imports and animals exported are not included in meat production statistics.

11. Definition of Terms

"Carcass Weight"

Weight of carcass after hide, skin, feet, head, tail, blood and entrails have been removed. The only part included in the carcass is kidney. With the pig, the head and the skin (less hair) form part of the dressed carcass.

Inedible Offals

All offals with the exclusion of kidneys, liver, heart, sheep and cattle tongues, sheep brain and tail.

There is no definition to distinguish edible and inedible slaughter fats.

Lamb

Sheep which has not yet cut its incisor teeth. This tallies with agricultural census definition as being under 1 year.

12. Slaughtering Data

All slaughter-houses must be registered and licensed before they slaughter for commercial purposes and hence such a list is readily available. Slaughter-houses provide information both on monthly and annual basis. Once a year, information on number of animals slaughtered is sought from all slaughter-houses and from the larger slaughter-houses on a monthly basis. Total number slaughtered and total carcass weight are reported. There is no extraction rate of dressed carcass weight to liveweight as information on liveweight prior to slaughter is not collected. Coverage of slaughtering is close to 100 percent.

13. Milk

There is no commercial production of buffalo, sheep or camel milk; goat milk production is of minor significance so national production of milk comprises only cow's milk. Milk production statistic are collected by the Australian Dairy Corporation on a monthly basis in two categories:

- (a) Whole milk intake of factories (including the whole milk equivalent of farm cream intake).
- (b) Market milk sales by factories (including white, flavoured, high and low fat milk and UHT milk).

Category (b) represents human consumption of milk. There are no statistics on the amount of milk fed to animals.

14. Milk Products

The Australian Dairy Corporation also collects data on butter, cheese, milk powders and casein production on a

monthly basis. Domestic sales, stocks and export statistics are also collected and published as national aggregates.

15. Poultry

The annual Agricultural Census collects details of poultry kept on agricultural establishments. These comprise numbers of birds at 31 March and the numbers disposed of during the year. Categories of data collected may be read in Section N^o 5 above. Slaughtering statistics and the dressed weight of birds are collected on a monthly basis from all slaughtering establishments comprising broiling, frying and roasting chickens, ducks and drakes and other fowls and turkeys. While many, very small producers are excluded from the census, the statistics nevertheless represent a high level of coverage.

Statistics on egg production, available from Egg Marketing Authorities, are not complete as they exclude non-commercial production which is currently not available.

16. Production of Honey and Beeswax

Registration requirements for beekeepers vary from State to State. Statistics, however, are collected from beekeepers with 40 or more beehives.

17. Wool

The importance of the wool industry to Australia had led to the development of a comprehensive statistical system for all facets of the industry. Data for estimation of wool production are collected at points of production, marketing, consumption and export.

The annual Agricultural Census collects data on sheep and lamb shearings and the quantity of wool produced, on a greasy basis. Multiple shearings and variable shearing times introduces an element of uncertainty as to numbers and production, so census data are adjusted against taxable receipts of wool brokers and dealers, a collection conducted by the Australian Bureau of Statistics on a monthly basis.

An increasingly important segment of the wool industry is the publication of data relating to the forecast of Australian wool production. These data are made available to world wool forums such as the International Wool Textile Organization.

18. Hides and Skins

There are no data on classification of quality, nor on average weight and size of hides by species, nor any ratio statistics between hides and skins produced to number of slaughterings.

19. Feed

Annual Agricultural Census returns give details of hay, green feed and seed obtained from pastures, area of sown pastures, clovers and grasses at 31 March, pastures cut for hay and green feed and area and production of lucerne cut for hay, green feed and seed.

CANADA**1. Statistical Organization**

Statistics Canada's Agriculture/Natural Resources Division is responsible for co-ordinating the collection, and publication of a comprehensive set of national livestock statistics. Information on the trade and processing of livestock products are prepared by the Trade and Industry Divisions of Statistics Canada while the major source of marketing and slaughter data is Agriculture Canada, provincial departments of agriculture and marketing boards.

2. Sources of Information

- (a) Census of Agriculture held quinquennially;
- (b) Probability and non-probability sample surveys and census surveys undertaken by the Agriculture/Natural Resources Division of Statistics Canada;
- (c) Administrative information obtained from various federal and provincial governments and agencies and
- (d) Other divisions in Statistics Canada which provide trade and processing data on agricultural commodities.

3. Cattle and Calf Statistics

Cattle and calf numbers are estimated semi-annually, the reference dates are January 1 and July 1. The universe includes all cattle and calves in Canada and the information is available on a national, provincial and sub-provincial level. Numbers are available for dairy and beef cows, bulls, dairy and beef heifers kept for breeding, steers and heifers for slaughter, and calves. In addition, information is available on calving expectations and calves born in the last six months.

The numbers are estimated by using supply-disposition balance sheets combining survey inventory numbers, imports, exports and slaughter along with historical calf survival and birth rates. The survey information comes from two sources: the National Farm Survey (NFS) and the National

Livestock Survey (NLS). The NFS is a complex, multi-frame probability survey of farms conducted annually on July 1; a combination of mail, telephone and personal interviews are used to ensure high response rates. The sample is stratified by size and type of operation within each province using information from the most recent census of agriculture. Since it is a sample survey, estimates are subject to sampling and non-sampling errors. These errors are minimized however through rigid control of data collection and an extensive edit and data validation process. Co-efficients of variation are estimated for survey variables to provide an indication of the quality and reliability of each estimate.

The NLS is a probability survey of livestock farms conducted annually on January 1. A sample is selected from producers on the July 1 National Farm Survey. Information on livestock is collected by mail with a telephone follow-up of non-respondents.

4. Pig Statistics

Pig numbers are estimated quarterly, the reference dates are January 1, April 1, July 1 and October 1. The universe includes all pigs in Canada and the information is available on a national, provincial and sub-provincial level. Numbers are available for sows and boars, market pigs under 20 kg, 20 to 60 kg. Information on farrowings and expected farrowings, pigs born and pigs weaned is also available.

The numbers are estimated by using supply-disposition balance sheets combining survey inventory numbers, imports, exports and slaughter along with farrowing and survival rates of young pigs. The survey information comes from the January National Livestock Survey and the July National Farm Survey.

In an effort to reduce response burden, October and April pig surveys were discontinued in 1983. Pig estimates for April 1 and October 1 are arrived at using supply-disposition balance sheets and historic trends.

5. Sheep and Wool Statistics

Sheep and lamb numbers are estimated semi-annually, the reference dates are January 1 and July 1. The universe is all sheep and lambs in Canada and the information is available at the national and provincial level. In addition, annual information is available on sheep shorn, wool production, value of wool production and the domestic disappearance of wool. The source of this data is the Sheep and Wool Survey. Conducted annually on July 1 by mail with no follow-up, questionnaires are sent to all known sheep producers across Canada. The survey is used to indicate change in the sheep population during the past year and update an estimate benchmarked to the most recent census of agriculture.

6. Poultry Statistics

The majority of Canadian chickens and turkeys are raised in what are called registered flocks. These are generally flocks where numbers exceed 300 to 500 birds. For the registered flocks production is estimated using administrative information from slaughter plants. Estimation of production among small flocks, for which there is little administrative information, is done using data from the July National Farm Survey, the Quarterly Egg Survey, the Census of Agriculture and administrative information available on chick placements from hatcheries.

The chicken and turkey production estimates are calculated monthly to estimate farmer cash receipts but the production is only published annually.

7. Egg Statistics

Egg production is estimated monthly using an econometric model. The model estimates production by combining administrative information available on registered egg producers from the Canadian Egg Marketing Agency and hatchery chick placements from Agriculture Canada with data from the Quarterly Egg Producers Survey.

The Egg Producers Survey estimates production among non-registered producers and the rate of lay for the Canadian flock. It is a probability survey conducted

quarterly in January, April, July and October. The sample is stratified by size of flock and by province and includes approximately 2 percent of all producers. It is a list frame survey and is conducted using a combination of mail and telephone techniques. An extensive edit, imputation and data validation process is used to minimize sampling and non-sampling errors.

8. Dairy Statistics

Nearly all the surveys conducted to obtain dairy statistics are the responsibility of provincial government agencies or milk marketing boards. A monthly census of the factory production of butter, cheese, concentrated milk products and other dairy products are conducted by these agencies.

Administrative data from provincial milk marketing boards provide the basis for monthly provincial estimates of the volume of milk sold by farms and the associated value of the milk.

Information from the surveys, administrative data and the Canadian Dairy Commission is assembled at Statistics Canada. The results are the basis for the preparation of the monthly national and provincial dairy reports.

Surveys of milk consumed on farms or fed to livestock are no longer conducted and thus an estimate of the total production of raw milk is no longer available. The estimate now produced represents only milk sold off the farm.

9. Fur Statistics

Fur production, both wildlife and ranch production, is estimated annually. An annual survey of fur farms provides the basis for farm production by province and by colour with both the number and value of pelts being estimated. The survey is a census of farms which reported fur production during the most recent census of agriculture and is conducted by mail with telephone follow-up of non-respondents.

Administrative and survey information from provincial and territorial governments provides the data for the estimates of wildlife pelt production.

10. Meat Statistics

The total domestic production of beef, veal, mutton, lamb and pork is estimated by multiplying the total number of cattle, calves, sheep, lambs and pigs slaughtered by their average carcass weights. The average warm, dressed, carcass weights for animals slaughtered under federal inspection services are published on a monthly basis by Agriculture Canada.

Total slaughter includes commercial slaughter, animals slaughtered on the farm and sold as meat and animals slaughtered on the farm for home consumption. In provinces where not all commercial slaughter is available from administrative information, a mail survey is conducted on a quarterly basis to obtain the data. The survey is conducted by mailing questionnaires to slaughter establishments to collect data on the number of cattle, calves, pigs, sheep and lambs slaughtered. The survey estimates are not published but are added to the slaughter data available from administrative records and then used in the supply-disposition balance sheets.

Meat stocks in cold storage and other warehouses are collected and published monthly on a product weight basis, however, they are converted for per capita consumption purposes, to a cold dressed carcass weight. Import and export data on meats are collected and published on a monthly basis and converted to cold dressed carcass equivalent as required.

Total domestic consumption is arrived at for each species of animal by taking the estimated cold dressed carcass weight of the animals slaughtered and adding the beginning stocks and imports to arrive at a total supply. From the total supply, exports and ending stocks are deducted to arrive at total domestic consumption.

11. Livestock and Animal Product Price Statistics

The Farm Income and Prices Section of the Agriculture/Natural Resources Division, Statistics Canada,

is responsible for estimating farm prices. In addition, Agriculture Canada reports the weighted average prices of animals sold through public stockyards weekly in the Livestock and Meat Trade Report. The Department of Agriculture publishes figures for eggs and butter on a weekly basis and the Prices Division of Statistics Canada also collects price data for poultry, cheese, milk and beef hides from processing plants. Wool prices are collected from the Canada Wool Grower's Association while the rest of the livestock and animal product prices are collected using a non-probability monthly mail survey of farmers.

12. Processing and Publication of Data

Pig, cattle, sheep and fur statistics are published within 6 to 8 weeks of the survey reference date. Monthly estimates of dairy, poultry, eggs and foods held in cold storage are published 15 to 30 days following the survey reference date.

13. Selected Publications

- Monthly: (1) Dairy Review
 (2) Production and Stocks of Eggs and Poultry
 (3) Stocks of Frozen Meat Products
 (4) Stocks of Frozen Fruit and Vegetables
- Quarterly: (1) Report on Livestock - Hogs
- Semi-annual: (1) Report on Livestock - Cattle and Sheep
- Annual: (1) Dairy Statistics
 (2) Production of Poultry and Eggs
 (3) Livestock and Animal Products Statistics
 (4) Shorn Wool Production
 (5) Wool Production and Supply
 (6) Fur Production (Wildlife)
 (7) Fur Farm Production
 (8) Estimates of Production and Disappearance
 of Meats
 (9) Stocks of Food Commodities in Cold
 Storage and Other Warehouses

APPENDIX

Selected Terms

(A) Livestock and Poultry Number

Horses

1. Foal: young horse of either sex up to about 2 and a half years of age
2. Colt: male foal
3. Filly: female foal
4. Stallion: uncastrated male horse
5. Mare: female horse three years old and over
6. Gelding: castrated male horse
7. Stud horse: breeding stallion
8. Brood mare: breeding mare

Ass

1. Hinney: off-spring of she-ass by stallion
2. Mule: off-spring of mare by he-ass

Cattle

1. Calf: off-spring of a cow, from birth until 1 year old
2. Bull: uncastrated male bovine
3. Bullock: castrated male bovine
4. Steer: castrated male bovine between 12 and 24 months old
5. Heifer: year old female until first calf is weaned
6. Maiden Heifer: unserved heifer
7. Barren Heifer: heifer served but no calf
8. In-calf Heifer: pregnant heifer
9. Cow-heifer: cow that has had only one calf
10. Cow: female bovine which has had at least one calf

He-buffalo

She-buffalo

Pigs (hogs), (swine)

1. Pigling (piglet), (sucking pig), farrow: pig from birth to weaning
2. Weaner: pig from weaning to about 12 weeks
3. Barrow: young male castrated before breeding age
4. Gilt: young female pig
5. Boar: uncastrated male pig
6. Stock boar: service boar
7. Stag boar: boar castrated after breeding age
8. Sow: female pig after birth of first litter
9. Brood sow: female breeding pig

Sheep

1. Lamb: male or female sheep from birth to weaning
2. Ram: uncastrated male sheep
3. Wether: castrated male sheep
4. Ewe: female sheep
5. Cast ewe: aged ewe culled from breeding flock

Goats

1. Kid: young goat of either sex not exceeding one year
2. Buck: male kid
3. Billy goat: mature male goat

Poultry

1. Layer: adult female bird laying eggs
2. Pullet: adult female bird
3. Broiler: meat type fowls
4. Cock: male fowl
5. Hen: female fowl
6. Capon: castrated cock
7. Chick: young ones
8. Cockerel: young cock
9. Guinea fowl
10. Duck
11. Duckling: young duck
12. Goose
13. Turkey
14. Pigeon

Source: Vocabulary of Animal Husbandry Terms, FAO, Rome, 1959.

(B) Livestock Production/Products

Output of Herd

1. Net production (slaughtered production): this refers to all animals, of indigenous and foreign origin, slaughtered within the national territory.
2. Gross indigenous production: this refers to the slaughterings of indigenous animals plus exported live animals.
3. Total indigenous production (biological production): this refers to the slaughterings of indigenous animals, plus the exported live animals and plus/minus the change in size of the herd during the reference period. When expressed in weight, this concept also takes into account the change in the total live weight of all the animals during the period of reference.
4. Commercial production (CP): this refers to animals entering the trade channels, i.e. excluding farm-slaughters for household consumption.
5. Inspected production (IP): this refers to the animals slaughtered under official veterinary inspection.

Concept (1) is the one used in the FAO System of Supply/Utilization Accounts. Concepts (2) and (3) are derived by the same FAO System for the calculation of index numbers of production and of national accounts respectively.

Production of Milk

1. Gross milk production (primary material): this concept includes milk actually milked and milk sucked by young animals.
2. Net milk production: this concept includes only milk actually milked even if it is later fed to young animals.
3. Milk available for consumption: this concept includes milk actually milked excluding milk fed to young animals and waste at the farm.

4. Milk deliveries to plants: this concept includes milk delivered to milk/dairy plants, i.e. excluding the quantities used on farms and/or sold directly to consumers.

The FAO System uses concept (2).

Milk Products

1. Cream
2. Butter
3. Cheese
4. Casein
5. Yoghurt
6. Condensed milk
7. Evaporated milk (from whole or skim milk)
8. Dried or powdered milk
9. Butter milk
10. Standardized and homogenized milk
11. Whey
12. Ghee

Production of Eggs

1. Gross production (primary material): this concept includes the whole production, i.e. including the production of the traditional, semi-intensive and intensive modern sectors. This concept also includes the production of hatching eggs and waste at the farm.
2. Net production: this concept is the same as (1) but excludes hatching eggs.
3. Production available for consumption: this concept is the same as (1) but excludes hatching eggs and waste at the farm or at the poultry farm.
4. Commercial production: this concept covers the output passing through registered egg-grading stations, wholesalers, cooperatives, packing stations, etc.
5. Production of poultry farms: this concept covers the output of semi-intensive and intensive poultry farms.

The FAO System uses concept (1).

Production of Meat

1. Live weight of animals intended for slaughter is the weight taken immediately before slaughter. It is assumed that animals intended for slaughter are kept in the slaughterhouse premises for 12 hours and are not fed or watered during this time.
2. Killed weight is the gross weight of the carcass including the hide or skin, head, feet and internal organs, but excluding the part of the blood which is not collected during slaughter.
3. Dressed carcass weight is the weight of the carcass after removal of the parts indicated for each of the livestock listed below:

Cattle, Buffaloes, Horses, Mules, Asses, Camels

- hide or skin
- head where it joins the spine
- forefeet at the knee joint, and hind feet at the hock joint
- large blood vessels of the abdomen and thorax
- genito-urinary organs (other than the kidneys)
- offals (edible and inedible)
- tail
- slaughter fats other than kidney fats

Sheep and Goats

- skin
- offals (edible and inedible)
- genito-urinary organs (other than the kidneys)
- feet
- slaughter fats other than kidney fats

Pigs

- offals (edible and inedible)
- genito-urinary organs (other than the kidneys)
- slaughter fats other than kidney fats and back fat

4. Carcass weight is the weight of the carcass as defined above under (3) but including slaughter fats.

The definition used in the FAO System is that described in (3).

5. Dressed weight (small animals)

Thighs, legs (drumsticks)

Wings

Breast

Ribs

Back

= Ready-to-cook (oven ready)

+Heart

+Liver

+Gizzard

+Neck

= Ready-to-cook (incl. giblets)

+Feet

+Head

= Eviscerated weight

+Viscera (inedible offals)

= Dressed weight

+Blood

+Feathers

+Skin

= Live weight

Edible Offals

Head or head meat

Tongue

Brains

Feet (cleaned)

Tail meat

Heart

Heart bread

Throat bread

Spleen

Pancreas

Diaphragm

Thick shirt

Kidneys

Genital organs

Udder

Omentum

Sweetbread
Lungs
Liver

Stomach or tripes
Entrails
Blood

Fats

1. Total unrendered fat: this definition covers slaughter fats and butchering fats (edible and inedible).
2. Total unrendered edible fats: this definition covers edible slaughter fats and edible butchering fats.
3. Slaughter fats: this definition covers edible and inedible unrendered fats which fall in the course of dressing the carcasses or are recovered from discarded and fallen animals, guts, sweepings, hide trimmings, etc.
4. Edible slaughter fats (loose fats): this definition covers unrendered fats which fall in the course of dressing the carcasses, e.g. fats in abdominal and thoracic cavities.
5. Inedible slaughter fats: this definition covers unrendered fats from discarded and fallen animals, guts, sweepings, hide trimmings, etc.
6. Butchering fats: this definition covers unrendered fats obtained from the excess fat trimmed or removed from the wholesale and retail cuts during butchering. Kidney fats and flare fat (pig back fat) are also included in this definition.
7. Processed fat: this definition covers rendered fats such as lard, tallow, etc. obtained by melting or processing slaughter and butchering fats.

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