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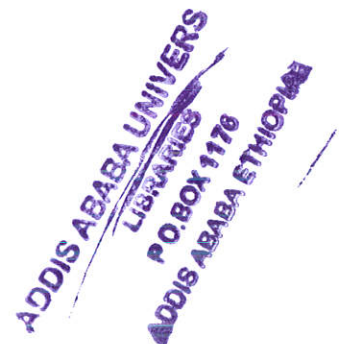
**FEED ANALYSIS INFORMATION RETRIEVAL SYSTEM FOR RUMINANT
LIVESTOCK IN SUB-SAHARAN AFRICA**

**A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT
FOR THE DEGREE OF MASTER OF SCIENCE IN INFORMATION SCIENCE**

BY

RACHEL ATIENO REGE

JUNE 1996



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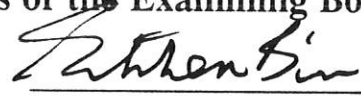
FEED ANALYSIS INFORMATION RETRIEVAL SYSTEM FOR RUMINANT
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By

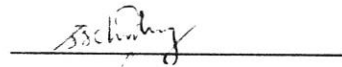
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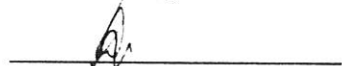
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DEDICATION

To Elizabeth and Sarah who involuntarily gave their time, so that mummy could accomplish her dream; and to Ed, a loving husband, whose impact is felt on every page in innumerable ways. Honour and Glory to God, whom all things belong.

ACKNOWLEDGEMENT

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ABSTRACT

Feed information is a valuable resource for animal production users which should be made available in the appropriate format to meet the user need. This study examined the need for an automated Feed Analysis Information Retrieval System for Sub-Saharan Africa, as a means for improving the overall animal production in the region.

To attain the objectives of the study, the existing feed information systems were reviewed and analyzed to identify factors which limit these systems' availability and use. A common phenomena identified was lack of standard formats for documentation and characterization of the animal feedstuffs in the region.

Additionally, most of the information on the composition of the indigenous African feedstuffs were mainly found at Research Institutions where their availability was limited to researchers of such institutions. Surveys undertaken as part of this work revealed that this information is important to individuals and groups involved in animal production and should be made widely available in the region; many institutions and individuals are currently depending on foreign Feed Tables which may not always be appropriate for the situation in Sub-Saharan Africa.

To enhance the use of, and accessibility to this information, a prototype feed analysis information retrieval system (FAIRS) has been developed using dBase IV.

FAIRS has two main components: the user interface and the Database. The Database structure has been designed using a relational data model. In the data structure, International Feed Standards and codes have been incorporated to facilitate standardization of the system, and information exchange at institutional and regional levels. The second component viz the interfaces has been designed to facilitate interactive system operations by both the experienced and novice users. The system's function and user interfaces are designed with simple user instructions at all levels.

It is recommended that available feed composition information be compiled and incorporated in this or similar databases, which can then be produced on CD-ROM and made available to National Agricultural Research Systems. Internet connectivity is increasingly becoming available to countries in Africa, a development which should be taken advantage. The possibility for providing feed information on the Internet should be examined by regional and international institutions like ILRI, with Information Technology capabilities.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND AND JUSTIFICATION

1.1.1 Livestock Production in Sub-Saharan Africa

Sub-Saharan Africa has very limited technological and industrial development. Agriculture as the economic mainstay of the region, contributing to about 21% of the total GDP, cannot keep pace with the unprecedented rise of human population estimated at 3.1% annually (Winrock, 1992; FAO., 1995). The agricultural production is declining; the dependency on external aid and food importation is increasing; and the economic stagnation, poverty, and political unrest are widespread. The performance of livestock as part of agriculture is below average, as a result of the seasonality of feed availability, drought threats, overgrazing and resource degradation in the major livestock producing areas of the Sahel and Eastern Africa (Jahnke, 1982). The overall availability and consumption per capita of livestock products like meat, milk and eggs for the human population is minimal, even though there is a high potential for livestock production improvement through utilization of indigenous feedstuffs in the region (Masiga, 1995).

Livestock have performed a wide range of economic and social functions in the region for centuries. These include food outputs such as meat and milk, crop inputs such as manure,

animal traction and transport, fuel power, assets in the form of livestock capital, employment provision and social use for feasts and ceremonies (Nyangito et al, 1994).

Urban population in the region is growing more rapidly than the general population. It is estimated that by 2025 A.D. nearly 55 percent of the region's population will be living in towns and cities as contrasted to 30 percent today. Urbanization and increased awareness of nutritional requirements will increase the demand for foods of animal origin. The result of these will be the increasing importance of livestock with urbanization, which in turn necessitates the stabilization and improvement of the feeding systems to ensure economic production of livestock in the region (Winrock, 1992).

1.1.2 Livestock Feeds and Feeding

Nutrition has been cited as one of the major constraints to livestock production in the region. It is a critical element in determining the animal potential and overall output (ILCA, 1995). Given that most livestock in the region depend on pastures, crop residues and agro-industrial by-products for their feed, it is important to characterize and establish the nutritional values of these feedstuffs in order to best use them.

Characterization would involve:

- . The determination of feed composition values;
- . Where it is available;
- . In what form; and
- . The characteristics which determine their value as livestock feed.

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- . The characteristics which determine their value as livestock feed.

This information form the basis of feed composition tables, which, if accessible and available in appropriate form to the livestock producers, would facilitate the use of readily available feedstuffs for the improvement of livestock production in the region.

The need for information on nutritive value of feeds in Sub-Saharan Africa was recognized as early as in 1960 by the agricultural and other government institutions involved in research. The earliest record on feed composition tables in the region are those of Kenya (Dougall, 1960), Nigeria (Oyenuga, 1968). These early tables lacked all physical, chemical and biological information about the feedstuffs which could be beneficial to the end users, (Harris and Kearn, 1976). Later, other tables were published in Ethiopia (Seyoum and Zinash, 1989), and Central and Southern Africa (Topps and Oliver, 1993). Since most of the recent work has been done to meet specific local needs and in isolation from the feed coding standards, these tables also have some deficiencies including:

- . Lack of standardized technology and coding system;
- . Inadequate description of feedstuffs;
- . Inefficient consideration and documentation of variations in quality of feed ingredients in relation climate, soils, stage of harvesting, and types of processing;
- . Inefficient documentation of analytical methods used; and
- . Lack of feed formulation information.

The feed composition tables are mostly available in limited numbers of hard copies with varying formats which make updating and report generation difficult (Ranjhan, 1983). Further

attempts are those by Bo Gohl. In 1975, with the help of the Agriculture and Food Organization of the United Nation (FAO), he published a monograph on the tropical feeds (Bo Gohl, 1975), which has been computerized into tropical feed database. In addition, FAO initiated the formation of the International Network for Feed Information Centres (INFIC), founded with the primary objective of facilitating regional and global communication and exchange of feed analyses information. INFIC proposed geographic distribution of responsibilities (Kearl et al, 1986), through which International Livestock Centre for Africa (ILCA), whose activities are now part of the global institute, International Livestock Research Institute (ILRI) and Ibadan University in Nigeria, are observer members, with the task of coordinating feed resource activities for Africa. However, due to shortage of funds, minimum progress has been achieved at the regional level (Harris and Kearl, 1976).

The technology and skills needed to provide up-to-date scientific information services are often lacking in the region (TAC, 1992). In addition, the absence of a well organized, computerized information system leads to scarce resources being committed to repetitive work. Thus, an information retrieval system is an advancement in the right direction towards improving accessibility, availability and management of feed resources information in the region. These benefits have been experienced in the developed countries, where considerable progress has been made in feed evaluation and storage of resulting data. To this end increasing reliance has been placed on the use of computerized databases (Everington et al., 1990). In addition to facilitating storage of large data and providing rapid retrieval, computerized systems enhance accuracy and efficiency in ration formulation.

These systems have made tremendous contribution towards livestock production systems which can be emulated in animal production research systems in Sub-Saharan Africa.

Reliable computerized nutritive value data on feedstuffs is probably one of the most important services the International Livestock Research Institute (ILRI) could provide to animal nutritionists working in sub-saharan Africa. There are immense benefits to be gained by all branches of the agricultural and animal feed industry, and government policy makers in having access to such data (Anindo et al, 1994). It is a highly valuable resource that would handle large quantities of data, provide rapid retrieval, accuracy and efficiency. Subsequently, the system would facilitate information exchange and cooperation through the provision of a standard system structure for the collaborating National Agricultural Research Systems (NARS) and other interested institutions which are financially not strong enough to meet their national research needs.

To ensure quality and accuracy of data from the proposed system, the initial input will be from ILRI's Animal Nutrition Laboratory in Addis Ababa. The data has been collected over the years as part of its own research and service to researchers in Africa. This information is unique as it represents the single largest collection of information on indigenous African feedstuffs, incorporating results of proximate analyses, mineral content and nutritive value (as measured by *in vitro* dry matter digestibility), all generated under the same laboratory conditions using standard procedures (Anindo et al, 1994). It is proposed that, once the computerized system has been developed, data from other sources like INFIC, other laboratories and/or from literature could be added as appropriate.

1.1.3 Importance of Feed Composition Tables

Feed composition tables are tables with compiled data generated through applied nutrition research, on the chemical, physical and biological values of feeds. These tables provide comprehensive information on:

- . The feed characteristics;
- . Values of feeds;
- . Toxic elements in feeds;
- . Feeding levels; and
- . Locations where the feeds are available

They are vital tools for those involved in animal production and feed formulation.

For a researcher and feed manufacturer, feed composition tables can be used as guidelines for the selection of materials to use in rations not only based on their availability and price, but also on their nutrient concentration and nutrient availability. The same is true for quality control of toxic materials. The information provided by these tables can, therefore, be used by any knowledgeable person to formulate economical and balanced diets appropriate for animal requirements.

As mentioned previously, livestock production in Sub-Saharan Africa depends mainly on pastures, crop residues and agro-industrial by products. The animal's selectivity, gastro-intestinal fill, economic maintenance and grazing behaviour all contribute to its performance

(Nitis, 1983). In this case, the feed tables can be used to determine when and how long to allow the animals to graze a certain pasture to obtain its nutritional requirement.

Research students in institutions without adequate laboratory equipment for analysis, can use the values in the feed composition tables to formulate diets for their feeding trials.

Feed composition tables are important in drought feeding strategies, a common phenomena in the Sahel and Eastern Africa livestock producing areas. Most of animal producing systems in these areas depend on feed supply *in situ*. In these systems, feed tables can be used to select and combine feeds to give nutrients required for the maintenance of non-productive animals and allow growth of younger animals, until compensatory growth is possible when feed supply is normal (Nitis, 1983).

For commercial animal production systems, the feed composition tables can be used to estimate both quality and quantity of the animal product based on the intake value. This involves dietary restriction, adjustment of metabolizable energy, crude protein ratio and supplementation where necessary. The intake determines the levels of meat and milk production, which can be adjusted according to the demand and supply in market.

To all individual groups and institutions enumerated above, there is need for standardized feed composition data to compound least cost rations, improve animal production, and optimize cost benefit ratios. The development of an automated feed composition table would bring Sub-Saharan Africa region to the limelight where she can share and exchange

information not only within the region but also globally with other INFIC members.

1.1.4 Justification of the Study

Nutrient content and nutritive values of feedstuffs vary depending on a number of factors.

These factors include, *inter alia*:

- . Species and/or varieties of feedstuffs;
- . Where they have been cultivated or produced;
- . Environmental factors which include temperatures, soils, precipitation, altitude etc.;
- . The part of feedstuffs eaten by the animals;
- . The stage of maturity, especially for roughage; and
- . The processing method

Location specificity of some of these factors necessitate development of country-specific or region-specific feed composition tables (Kang, 1982).

The other regions, like Latin America, North America, Europe, the Middle East and countries like Australia, Korea, Japan, Canada, U.S.A., have developed feed composition tables/standards as a step towards improving livestock production in these specific regions/countries (Kearl et al, 1979). These international databases are excellent sources of information on developed countries, but are poor sources for African location-specific national/regional information which is important for the African researcher (Hailu, 1994).

Moreover, Nitis (1983) asserts that since most developing countries have their livestock production systems dependent on crop residues, pastures and agro-industrial by-products, contrary to the production systems in developed countries, the feed composition table for the developed countries are not relevant for the developing countries.

For the Sub-Saharan African region, comprehensive regional information on indigenous feedstuffs is almost non existent, or contained in external databases to a smaller extent that are neither easily accessible nor readily available to the regional researchers (Bo Gohl, 1981). Given that the situation is still the same, the solution, therefore, lies with the NARS and the IARCs (International Agricultural Research Centres) in Sub-Saharan Africa to develop databases and information systems with a good coverage of materials from Africa. This is a challenge whose answer lies in the establishment of both bibliographic and full text databases for African materials.

Besides, Sub-Saharan Africa, with her limited resources, cannot afford isolation from the rest of the world, since this would result to duplication of research efforts. The establishment of an information retrieval system with a coordinated mechanism to centrally handle the feed information, would facilitate cooperation and resource sharing to meet the existing demand for information on feed composition.

1.2 OBJECTIVES OF THE STUDY

The planning and efficient utilization of the available feed resources to meet the requirements of production depends on the development of a computerized information system. It is hypothesized that a computerized feed analysis information retrieval system would facilitate the coordination, management, and provision of precise, up-to-date and efficient information on the available feedstuffs, and thus would help researchers improve the overall livestock production in the region.

Therefore, the general objective of this study is to develop a prototype feed analysis information retrieval system for Sub-Saharan Africa that would render effective and efficient storage and retrieval services to the users. This overall objective will be met by addressing the specific objectives mentioned below:

1. To survey user requirements so as to determine what information they have access to, its existing format and expected outputs.
2. To look into the available feed composition tables so as to identify the gaps, and to propose a system that would meet the user needs.
3. To look into the existing international composition tables and databases so as to get an idea on how best to solve the problems related to feed information need in Sub-Saharan Africa.
4. To study the ILRI manual on the chemical composition and nutritive values of feedstuffs for ruminant livestock in Sub-Saharan Africa in order to design a computerized system, with appropriate databases and interfaces.

5. To examine the information seeking behaviour of the users and how they relate to the system in order to design an efficient and effective information storage and retrieval system.
6. To conduct a survey of the existing information technology infrastructure at ILRI and its research zonal sites in sub-saharan Africa with a view to proposing a system which would be appropriate at national and regional levels.
7. To propose, design and develop a prototype computerized information retrieval system for Sub-Saharan Africa feedstuffs, which would enable quick and efficient access to information on feed composition.

1.3 SCOPE AND LIMITATIONS OF THE STUDY

The foundation of this study is based on the International Livestock Research Institute's manual on the chemical composition and nutritive values of feedstuffs for ruminant livestock in Sub-Saharan Africa. The study is done in order to design a prototype information retrieval system with appropriate databases and interfaces to meet the needs of the potential users.

Sub-Saharan Africa has been chosen as the area of investigation. All the forty seven countries have been given equal chance of consideration, except that there were low responses to questionnaires sent to:

1. The French speaking countries like:
 - . Zaire
 - . Congo

- . Ivory Coast
 - . Bennin
 - . Gabon
 - . Cameroon
 - . Mali
 - . Djibouti
 - . Central Africa Republic
 - . Guinea etc.
2. War torn countries like:
- . Somalia
 - . Rwanda
 - . Burundi
 - . Angola
 - . Liberia
3. The west African countries generally due to unreliable and slow postal system.

The viewpoint is that of an information professional with agricultural background. The main concerns are:

- . The review of the feed information;
- . The design of an information retrieval system;
- . The Prototype development;

An implementation plan for the system; and

To recommend an overall improvement of accessibility and availability of this resource as a means to enhance livestock production in Sub-Saharan Africa through ILRI's collaborators in NARS and institutions of higher learning, who would in turn communicate this information to feed manufacturers, extension workers and farmers.

The conclusions reached on general terms may need specific assessment to determine applicability to specific situations and local adaptation.

1.4 SIGNIFICANCE OF THE STUDY

The degree of development achieved by a country or a region largely depends upon the extent and utilization of its resources. Relatively little can be done to increase supplies of the natural resources, but there are innumerable ways to improve their utilization. The natural and cultivated forage that can be utilized by wild and domestic livestock is an important resource in the production of animal products, but this resource is often mismanaged. Primary attention must be given to assist the national and regional organizations to achieve efficient use of their resources. Automation of the feed information system, is a solution to one of the major constraints. The system is expected to contribute to a more efficient animal production system throughout Sub-Saharan Africa region, by enhancing accessibility and availability of reliable information on the composition, nutritive value and strategic use of feeds for ruminant livestock in the region. It will generally, facilitate the appropriate utilization of the feed

resources in improving the animal production.

The proposed feed analysis information system is expected to collect centrally, as much information as possible about available feedstuffs with due regard to quality of data and propose effective exchange of feed information amongst established databases in Sub-Saharan Africa through the existing networks. The system will thus facilitate regional cooperation and resource sharing amongst animal scientists and the industry.

The information generated by this system will be of particular value to those involved in research, education, feed industry and practical animal producers in the categories enumerated below:

1. Nutrition researchers

These research workers are considered the generators of information in the database, and also users of the database to generate reports, for teaching purposes, for generation of experimental diets and for identification of areas that require more research in the field. The system is expected to provide the researchers with a tool for selection of appropriate feed resources for specific ecological zones.

2. Feed manufacturers

They require access to latest information on feedstuffs to enable them make informed decisions regarding commodity purchase and sale, together with information which will allow them to formulate nutritionally adequate diets or compound feeds within the prevailing economic restrictions.

3. Extension workers

These users require reliable information on the nutritive value of feedstuffs, which they convey to the farmers. Their role is to facilitate efficient and effective dissemination of information to improve agricultural production in remote, rural areas.

4. Farmers

These are the ultimate users of feed information data either directly or through the extension/advisory personnel.

5. Government policy makers

These users rely on the research results to facilitate the formulation of policies on the utilization of national feed resources, and to appreciate the interrelationships in the feed-livestock economy.

6. Students

These are users of the data at colleges/universities to meet their course requirements in nutrition and agriculture, and to appreciate the available feed resources of their countries/regions.

Not all of these user groups will have direct access to the proposed system, except the nutritional researchers at ILRI and ILRI's sub-stations. The other user groups at the NARS and collaborating institutions will receive information through the research networks, and then pass it to their local, and national users. Institutions with computers will receive frequent

updates on diskettes, while institutions without computers will receive frequent print outs, on request.

The proposed Feed Analysis Information Retrieval system for Sub-Saharan Africa will utilize the information technology infrastructure to perform the following functions which are limited in the manual systems:

- . Establish a regional database to handle large regional data;
- . Utilize the micro-processing power and speed of the computers to process and generate reports according to the user needs;
- . Facilitate data input, updates and manipulation when there is need; and
- . Facilitate easy electronic information exchange with other feed information systems.

These are some of the functions of the proposed system which will improve both the availability and accessibility of feed information to the user in the region.

1.5 ORGANIZATION OF THE THESIS

The thesis begins with an introduction on livestock research and its significance in Sub-Saharan Africa. As an introductory chapter, it places emphasis on the problems of feed information, the importance, objectives, justification, scope and limitations of the study.

Chapter two describes the materials and methods used during the course of the study. The specifics of the chapter discusses the preliminary study, sampling methods, survey instruments, data analysis methods, and systems analysis and design.

Chapter three follows on literature review. It places emphasis on the global historical evolution of the feed tables. This sets the stage for the description of the Sub-Saharan Africa scenario in relation to the feed information systems, participating institutions and the limitations of these systems in view of availability and accessibility of this information to the regional users.

Chapter four analyzes and discusses the survey results. This forms the basis for the design of the proposed feed analysis information retrieval system. The analysis, design, and implementation details of the system are presented in chapters five, six and seven respectively.

The last chapter, chapter eight, deals with conclusion and recommendations. The conclusion is the assessment results of the present system, its limitations and constraints; while the recommendation deals with the specific actions that should be taken to alleviate the constraints of the existing system. The role of the International Network of Feed Information Centres (INFIC), International Livestock Research Institute (ILRI) and National Agricultural Research Systems are discussed.

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CHAPTER TWO

MATERIALS AND METHODS

2.0 INTRODUCTION

This chapter describes the materials and methods which were used in data collection, analysis, systems analysis and prototype design.

2.1 PRELIMINARY STUDY

This study is based on feed information for ruminant livestock, that is cattle, sheep, goats and camels in Sub-Saharan Africa, a region made up of forty seven countries, see appendix A and B on the regional countries surveyed and Sub-Saharan Africa regional map. In order to conduct the research, a preliminary study was done to:

- . Gather information to describe the present feed analysis information system, to identify problem areas and to set research priorities for the study;
- . Get a background understanding of the organization, objectives, functions and activities of ILRI;
- . Determine the extent of the problem and need for an information retrieval system for Sub-Saharan Africa feedstuffs;
- . Examine similar studies in the area of feed tables development; and
- . Highlight what has been accomplished, and what needs to be done, especially in Sub-Saharan Africa

The results of the preliminary study provided the framework within which this research is designed, and highlighted limitations of the previous studies to be addressed by the present study.

2.2 MATERIALS

The mailing lists of the three main research networks of ILRI were used as sample frames to identify the user groups, considered in the survey. These networks are:

- . Cattle Research Network made up of 240 members;
- . African Small Ruminant Network made up of 370 members; and
- . African Feed Resources Network made up of 240 members

The 850 members of these networks fall into the following categories:

- . Many are researchers from national agricultural institutes, agricultural ministries, and universities;
- . Lecturers and other instructors from agricultural and technical colleges;
- . Administrators and policy makers from national research institutions, Ministries, colleges and universities;
- . Information and documentation specialists from agricultural institutions; and
- . Experts in animal nutrition, management and production systems, within Africa and abroad involved in training courses or workshops as resource persons.

Thus the majority were from NARS (National Agricultural Research Systems) in Sub-Saharan Africa. The individuals included in the survey were selected according to the sampling procedure outlined in the next section.

2.2.1 Sampling

The total population of 850 network participants were from forty seven countries. Sampling was conducted to ensure that the final sample size was manageable given the scope, time and financial resource constraints under which the study was conducted. The procedure included the following steps:

1. Acquired the three network mailing lists from the network coordinators based at ILRI, Addis-Ababa and Nairobi. The lists were delivered on diskettes;
2. Merged the three lists into one list;
3. Listed the countries represented and checked for omissions. Fortunately all the forty seven countries of the region were represented;
4. Eliminated redundancies and ineligible units: units from countries out of the Sub-Sahara Africa region, except for individuals involved in the other regions feed analysis tables;
5. Compiled the primary sampling unit of a population of 800 participants following the above editing;
6. Sorted the list into countries, institutions and user groups;
7. Selected and compiled a final secondary sample unit of 250 participants. The selection was done with an objective of having all the countries in the region

represented, and selecting a number that is economically manageable. The sampled users fell into the following groups:

- . Researchers mainly from national agricultural institutions;
- . Policy makers from the agricultural ministries;
- . Students from agricultural colleges and universities;
- . Technicians from agricultural laboratories; and
- . Researchers involved in extension work mainly as advisors

A stratified random sampling procedure was used with the strata consisting of countries and user groups. Five samples (users) were drawn from a combination of the above user groups. Ten ILRI representatives from the ruminant nutrition group both in Addis Ababa and the other research locations were also included in the sample.

2.3 SURVEY INSTRUMENTS

The survey instruments used in this study are described below.

2.3.1 Questionnaires

Questionnaire method was chosen as the most appropriate, because the study covered a vast geographical region (forty seven countries). The questionnaire method has the following advantages:

- . It can be distributed over a wide geographical area, in this case the forty seven countries of the Sub-Saharan Africa at the same time;
- . It facilitates the survey of many people in different places at the same time; and
- . It is more economical when compared to interviews and observations

The questionnaires were administered through postal mail and by hand through the research networks to the sampled user groups.

2.3.1.1 Questionnaires Design and Administration

Questionnaires were designed to obtain information on:

- . User requirements in relation to the availability and accessibility of feed analysis information;
- . User qualification;
- . User institutional affiliation;
- . Sources of information, other than the feed tables; and
- . Information technology availability, accessibility and use.

The questionnaire design was based on the methods documented by Kothari (1990), Battacharrya (1993), Seltiz, Wrightman and Cook (1976) and Geshaw (1992). However, modifications were made on the content to suit the subject area and objective of the study.

A single three part questionnaire was designed. The contents of each of the three parts is described below.

1. **Part one:** This was designed to obtain information on the user requirements or needs. The specific information sought were:

- . User awareness and frequency of use, of the tables;
- . Availability and accessibility to the tables;
- . Precision of the information provided by the tables;
- . Types of reports generated from the tables; and
- . Limitations of the manual tables

2. **Part two:** This section was designed to collect information on the:

- . Institutional affiliation of the users;
- . Availability and accessibility of information technology to the respondents; and

3. **Part three:** This part was designed to obtain information on other sources of information, i.e., sources other than the tables.

2.3.1.2 Pilot testing

After the design, the questionnaires were pilot-tested at two locations:

1. Addis Ababa University, SISA: Four students, and three faculty members were surveyed with an intention of checking the design

aspects including clarity and simplicity of language.

2. At ILRI, Addis Ababa: Two research scientists, and two laboratory technicians were surveyed in order to validate the subject area and content.

On the basis of the pilot-tests, some adjustments were made on the subject matter area and content to improve quality and clarity of the questions.

2.3.1.3 Questionnaire distribution

Questionnaires were distributed to a total of 250 users in the region mostly through postal mail (150), and by hand (100) through the network coordinators. It was not possible to send addressed envelopes with paid postage, because of the disparity of national currencies and postal systems. Information obtained from ILRI Training and Conferences organizing unit made it possible to hand-deliver questionnaires to some individuals when they came to ILRI, Addis Ababa.

A sample questionnaire is presented in appendix C.

2.3.2 Interviews

Informal interviews were used to clarify certain aspects of the data and issues which were not covered in the questionnaires about the present system, and situations prevailing in different countries. These were done through informal discussions held with the staff at ILRI, Addis

Ababa (4), other stations like Nairobi (2), Kaduna (1), Debre-Berhan (1), Debre-zeit (2) and visiting researchers from NARS. The NARS researchers interviewed included researchers from Cameroon (1), Sudan (1), Kenya (2), Tanzania (1), Zimbabwe (1), Malawi (1), Swaziland (1) and Nigeria (2). Some interviews were carried out before the questionnaires were received back to solicit the opinions of the respondents; and others were carried out after receiving some responses back.

This was done to clarify, cross check, and validate the data collected and to identify possible sources of additional information. Most of these interviews were carried out as and when a scientist from the other stations visited ILRI, Addis Ababa.

2.3.3 Observations

This was used to supplement interviews and the questionnaires. The first step of observation was of the feed analysis information system. This was for the purpose of understanding the background information on what the feed composition information is and how it is used. The other stages of observation were the procedures of feed sample reception, registration, laboratory analysis, analysis results output and documentation. This was for the purpose of validating the data input, processes and output involved. Most these observations were on the data input, processing and output of present system.

2.3.4 Enquiries

Enquiries were made on the standards, operations and information systems established elsewhere. This was done through letters, faxes, e-mail and telephone conversations to identify the standards, forms, and structures which have been used in existing systems and which could be applied in the design of the proposed system.

2.4 DATA SOURCES

The data sources used during the study included:

- . ILRI's Pagot library;
- . PADIS (Pan African Development Information System) project profiles and databases;
- . Addis Ababa University Libraries;
- . Searches on agricultural CD-ROM databases at ILRI;
- . ILRI's Research Network reports;
- . Ethiopia's Institute of Agricultural Research (IAR) library;
- . British Council Library in Addis Ababa; and
- . Surveyed scientists

Other centres which were contacted through e-mail and postal mail for information included:

- . International Centre for Research in Agroforestry (ICRAF), Nairobi, Kenya;
- . Kenya Agricultural Research Institute (KARI), Nairobi Kenya.

- . International Institute of Tropical Agriculture (IITA), Ibadan , Nigeria;
- . International Network for Feed Information (INFIC), Brussels, Belgium;
- . Food and Agriculture Organization of the United Nations (FAO), Rome, Italy;
- and
- . Regional feed information centres in Latin America, United Kingdom and Hohenheim, Germany

2.5 DATA ANALYSIS

The data collected from different sources were analyzed using both manual and automated methods, where appropriate. Literature review involved Information analysis and consolidation methods. These methods facilitated the collection, consolidation and summarization of information from different sources to form a basis for argument, and support for the research objectives.

The survey data were coded and tabulated using dBase IV. The subsequent analysis were done using SAS. These analysis run in SAS utilized data processing, analysis and presentation facilities which include the following:

- . Performance of frequency and percentage of occurrences on each question;
- . Performance of calculations on two dimensional relations between responses to particular questions; and
- . Presentation of results on two dimensional tables with percentages, frequencies and totals.

These functions provided by the system facilitated data presentation and ease in drawing inferences in relation to the users' requirements, information sources, information technology availability and use, feed information systems in Sub-Saharan Africa, and limitations of these systems, so as to design a system that is appropriate.

Other software facilities used were:

- . For graphical data presentation: Harvard Graphics and Lotus Freelance;
- . For word processing: Word Perfect 5.1; and
- . For application, prototype development and sample data presentation: dBase IV.

2.6 SYSTEMS ANALYSIS AND DESIGN

A detailed analysis of the data input into the manual feed information system at ILRI was done, so as to develop an automated system. This was conducted with a view to designing a system that would work optimally in an automated environment.

The systems life cycle formed the framework within which the activities of the present system were analyzed, organized and coordinated. Data Flow Diagrams (DFD), Data Dictionary, and Data models were used for the documentation of the system at the analysis stages.

During the systems design, prototype procedures were used to develop both functional requirements and the data model of the proposed system.

CHAPTER THREE

LITERATURE REVIEW

3.0 INTRODUCTION

Information has been defined as "data that has been processed into a form that is meaningful to the recipient and is of real value or perceived value in current or perspective decisions" (Davis 1985). Feed composition information contained in the feed tables have real value to different user groups involved in animal production. Its value lies in the information input to different livestock production systems to improve the quantitative and qualitative production through the utilization of readily available, local feedstuffs (Nitis 1983).

There are national and sub-regional feed tables and data available in Sub-Saharan Africa. However, there is no comprehensive and standardized regional feed composition table published, except for the chemical composition and nutritive value of feedstuffs for ruminant livestock in Sub-Saharan Africa by Anindo et al. (1994), which is not yet released. Thus, the limited number of such documents is making it difficult for users to have access to information on feeds and their nutritive values. This situation has forced farmers, researchers, feed manufacturers, extension workers and other potential users of this information in the region to use composition tables from other countries/regions, which are not appropriate for the African situation.

This chapter reviews the evolution of the feed composition information tables; highlights the recent and emerging structures for feed information exchange, status of information technology and the state of the art in feed composition information systems in Sub-Saharan Africa.

3.1 EVOLUTION OF FEED COMPOSITION INFORMATION TABLES

The need for information concerning the nutritive value of feed was recognized long ago. Thaer (1803) was the first to publish such tables in which the values of different feeds were compared with the value of hay. The hay values used were classified according to content of acid and alkali soluble material. Most of this early work depended on personal experience with few experiments. Later, Boussingault (1843) published a table of "hay equivalents" that compared feeds on the basis of their nitrogen content (Harris and Kearl, 1976).

Wolff (1874) and Lehmann (1899), German scientists working in Hohenheim, first compiled extended tables on crude nutrients, nutrient requirements, digestibility and feed prices in 1861, and in 1871 published the first table containing mineral values. Later, in 1894, they also published a table including feed digestibility. Kellner (1905) in Germany and Armsby (1903) in the United States of America, working independently, observed and categorized differences between feeds in the amount of energy lost during metabolism (Kang, 1982).

The work of Wolff (1874) was expanded by Atwater (1874) and the methods were modified by Henry and Morrison (1910) and became known as the total digestible nutrient (TDN) system. The concepts of digestible, metabolizable and net energy were the out-growth of the work of Armsby (1903) and Kellner (1905), and Harris and Kearl (1976). Since then, a number of feed composition tables have been published in many developed countries, and succeeding scientists have supplemented their publications by including formally published tables as appendices (Kang, 1982).

In 1952, the United States National Academy of Sciences recognized the need for review of feed composition information. This resulted in two publications: one (NRC, 1956) on the composition of concentrates and the other (NRC, 1958) on the composition of forages and grains (Harris and Kearl, 1976).

Since the beginning of the 1970's, worldwide interest has been focused on the preparation of more sophisticated and reliable feed composition tables, as a result of which many such feed composition tables have been published (NAS, 1971; McDewell et al., 1974; Gohl, 1975; ARC, 1976; Arab & Middle East, 1979; Korean, 1982; Australian, 1982; UK, 1987) to meet the various region-specific needs of animal producers.

The scenario in Sub-Saharan Africa, in terms of need for this information, is not different from that of the rest of the world. The need for information on the indigenous feedstuffs was realized as early as the 1940's when the earliest records on feed analysis in the region were reported. Gohl (1981) cited the following as some of the earliest records:

- . Henrici (1940): South Africa
- . Anon (1942): Rhodesia
- . Scant (1959): Congo
- . Dougall (1960): Kenya
- . Chavan (1961): Niger
- . Oyenuga(1968): Nigeria

The most recent tables in the region include those by:

- . Seyoum and Zinash (1989): Ethiopia
- . Topps and Oliver (1993): Central and South Africa and
- . Anindo et al. (1994): Sub-Saharan Africa - unpublished.

Most of these tables are in the form of brief handbooks. They provide summaries on the analyzed feed as appropriate for the needs of the researcher(s), thus lacking a standard format, detailed feed description, and technology for updating and manipulation of the data to meet the users' requirements.

In 1971 at Food and Agriculture Organization of the United Nations (FAO), Rome, new methods of classifying and naming feeds was proposed by Harris (Harris 1968 and Harris et al., 1968) and adopted by scientists of many countries. The proposed system was expected to provide a framework for standardization of the feed tables, these were the international feed vocabulary and the international feed nomenclature. At the same time, representatives

from several feed information groups formed the International Network of Feed Information Centres (INFIC). The operations of INFIC are described below.

3.2 INTERNATIONAL NETWORK FOR FEED INFORMATION CENTRES (INFIC)

International Network for Feed Information Centres is a global information institution made up of several regional Centres. INFIC was mandated to coordinate and to facilitate feed information exchange internationally through use of information technology, and thus is involved in the analyses, documentation, storage and exchange of feed information. INFIC centres are classified according to the internal organization and the functions they perform. Currently, there are three types of centres as described below (Harris and Kearl, 1976).

1. Type I Centres

These are the processing centres which perform the following functions:

- . They cooperate with analytical laboratories in the exchange of information and chemical data concerning nutritive values of feeds;
- . They cooperate with biological laboratories in acquiring information on the utilization of feeds by various species of animals;
- . They check and validate the data;
- . They code and process the data into data banks;
- . They ensure that the data output is in forms applicable to user demands, for instance, feed tables and on-line acquisitions; and

. Exchange data with other INFIC centres.

2. Type II Centres

These centres collect and disseminate feed information and perform the following functions:

- . They cooperate with analytical laboratories in the exchange of information and chemical data concerning nutritive values of feeds;
- . They cooperate with the biological laboratories in acquiring information on the utilization of feeds by various species of animals;
- . They check and validate the data;
- . They forward data to a type I centre for processing and entry into a data bank;
and
- . They disseminate information received from type I centres on request to their users.

3. Observer Centres

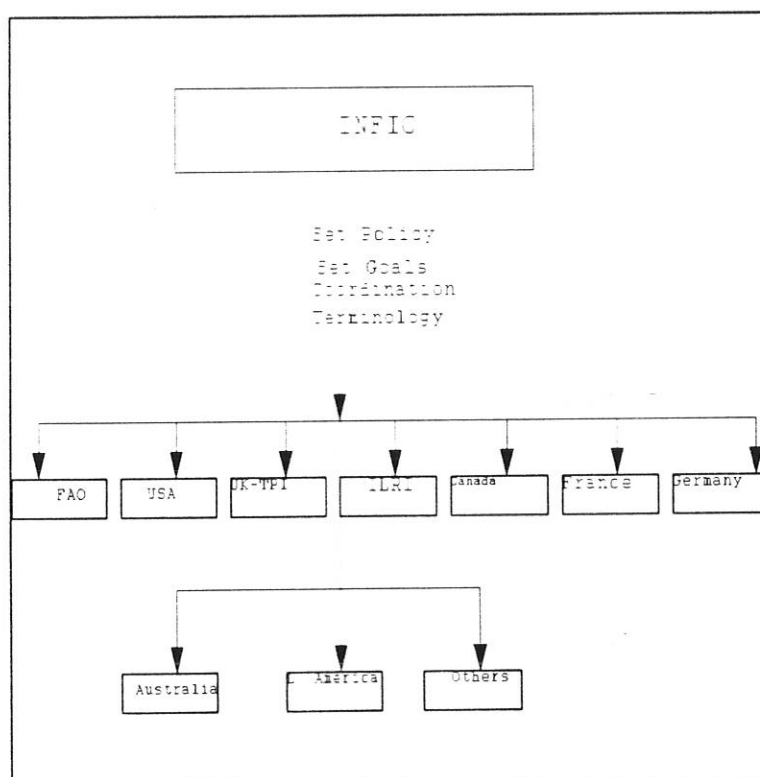
These centres are dissemination centres. They perform the following functions:

- . They observe the functions of the other centres and assist in establishing contact with laboratories and other institutions providing pertinent information;
and

They disseminate information received from types I and II centres, on request from their users.

It is worth noting that membership to INFIC is open to all organizations concerned with feed information, so long as the centre can function independently with regard to funding, personnel, data exchange, research and publication. These resources enumerated above, are limiting in Sub-Saharan Africa, they are the constraints faced by the two observer members in the region -Ibadan University in Nigeria and ILRI in Ethiopia.

Figure 3.1: The Organization of the International Network of Feed Information Centres (INFIC)



3.2.1 The Aims of INFIC

The general objective of INFIC is to contribute to a more efficient animal production throughout the world by improving access to reliable information on composition, nutritive value and practical use of feeds for animals. The specific aims can be summarized as follows:

1. To acquire, process, store and disseminate reliable information on feed composition throughout the world paying particular attention to the needs of less developed countries;
2. To provide a mechanism for the exchange of information between existing centres concerned with the documentation of feeds;
3. To assist in the establishment of new centres for the collection and documentation of information on feed composition in the different regions of the world, particularly those which are less developed;
4. To liaise closely with the scientific organizations in defining and standardizing the chemical and biological entities of feeds, preferably, promoting the adoption of the INFIC International System for describing and recording information on feeds, in order that the information may be exchanged and disseminated in a simple, uniform and unambiguous manner within and between countries;
5. To improve communication between those responsible for animal production and those engaged in research on animal nutrition; and
6. To encourage the development and use of improved standard methods for analysis of feeds.

3.2.2 Roles and Operations of INFIC

3.2.2.1 Information Transfer Services

In the past few decades, there has been an information explosion in all scientific and technological disciplines, including feed composition information, as evident in the publication of feed tables. However, due to the volume of information and information technology trends, information handling and processing need to be automated.

The outputs of the automated systems are often in electronic forms, and the developing countries lack the necessary trained personnel and financial resources to purchase the hardware and software to handle this information. As a result, there is limited accessibility and availability of information to the workers in the developing countries.

INFIC, has in respect to this need, assisted in the publication of several regional tables, and encouraged organizations to join the network so as to facilitate information collection, processing, storage and dissemination.

3.2.2.2 Acquisition Services

Access to feed information has been a problem and still is. Most feed analysis results in Sub-Saharan Africa are in the form of research reports and isolated publications. These documents lack a common standard; cover limited scope in relation to what is locally available; lack detailed description of feeds in relation to varying growing conditions and processing

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procedures. There was thus a need for a system which would facilitate information transfer, standardization, and cooperation of feed information centres at International levels. It is this need which led to the formation of INFIC.

3.2.2.3 Input Services

INFIC system accepts data input from different sources, so long as the quality of the data is maintained. The three main approaches accepted for data collection include:

- . Generation of data especially for this purpose by analysing feeds;
- . Extraction of relevant data from literature, and databases; and
- . Collection of data from laboratories which carry out analyses for their own purposes.

None of these approaches are perfect but each has a role to play in certain circumstances. In practice, some combinations of these approaches are common (Leche, 1983).

3.2.2.4 Output services

INFIC provides funds for the publication and organization of the analysis data into feed composition tables. These tables are then circulated on request to members free of charge. The information stored in the data banks of INFIC provide ready access to:

- . All relevant values for chemical, physical and biological data of existing and potential animal feeds;

- Information on factors which affect nutritional value of feeds (e.g. age of plant, soil, fertilizer, and method of processing); and
- Information relevant to the incorporation of feeds into diets and rations (e.g. physiological restrictions of the animal, intake levels, efficiency of utilization and toxicity levels).

3.2.3 Limitations of INFIC

INFIC is an international organization, which depend on donations for most of its operations. Its budget is not large enough to cater for human resource training and information technology acquisition for the developing countries, items which are critical for the achievement of the goals of INFIC. This has been responsible for the slow rate of development of appropriate databases and information systems in the developing countries.

INFIC is expected to establish a policy of exchanging data, and protecting the right of the information originator. Otherwise, the fears of losing rightful ownership might inhibit participation from certain organizations. This it has not been able to do due to limited financial and personnel resources.

The accomplishment of INFIC's objectives depends largely on the availability of information technology, and the level of technological development in a region. The following section describes the status of information technology in Sub-Saharan Africa, and how collaboration

and networking with the regional and international organizations in the region can improve the situation

3.3 INFORMATION TECHNOLOGY IN SUB-SAHARAN AFRICA

Information technology refers to the creation, acquisition, storage, dissemination, retrieval, manipulation and transmission of vocal, pictorial, textual and numerical information by a microelectronic based combination of computing and telecommunication (Langley and Shain 1985, in Chisenga, 1995).

The development trends indicate that IT has impact on almost all the spheres of human life and his environment, especially in education, homes, training, health, defence and security, finance and commerce, industry, office, libraries and information centres, and research.

The impact of information technology in research has been on activities concerned with simulation models, data storage and retrieval, and data analysis. To a large extent IT has also been used for word processing. However, the present trend is towards the utilization of online databases, electronic networking and electronic mail services as promoted by international organizations like FAO of the United Nations, INFIC, Pan African Development Information System (PADIS), International Development Research Centre (IDRC) and United Nation Education, Scientific, and Cultural Organization (UNESCO), just to mention a few.

Computer technology has been in use in Africa since the 1960s (Chisenga, 1995). Initially, the use of IT was confined to the processing of numerical data. However, since early 1970s the trend has changed with more applications in information storage and retrieval, literature searches through Compact Disk - Read Only Memory (CD-ROM) services, networking, library management systems, expert systems and artificial intelligence systems. Computer technology is therefore not a new phenomenon in Africa. The problem of computers in Africa centres around their under utilization, lack of indigenous maintenance capability and their being exclusively foreign (Zulu, 1994). The development of IT in Africa is inhibited by the following factors:

- . Inadequate and unreliable supply of electricity;
- . Harsh climatic conditions, which require additional care and facilities to provide suitable IT environment;
- . Low level of telecommunication infrastructure and regulatory barriers (Lishan, 1995);
- . Lack of qualified expertise to maintain equipment;
- . Low IT literate population;
- . Lack of national information policies;
- . Lack of financial resources; and
- . Lack of a common language.

To overcome these IT problems facing the region, Sub-Saharan Africa has to prepare itself to take advantage of the favourable technological advances, for instance the:

- . Utilization of microcomputers;

- . Use of optical technology;
- . Use of expert systems in agriculture, medicine and community information systems;
- . Use of microwave transmission media for data transmission, television and broadcast signals for radio; and
- . Utilization of Solar energy, which is abundant in most of the region throughout the year.

Since the region experiences problems with both financial and human resources limitation, the above solutions can be effected with assistance and collaboration from the international organizations. The following could be targeted:

- . Utilization of database facilities provided by international organizations like FAO, Commonwealth Agricultural Bureau International (CABI), UNESCO and United Nation Development Programme on CD-ROMs at subsidised prices;
- . Utilization of the education grants offered by the international organizations to train personnel;
- . Involvement in the regional projects like the Pan African Development Information System (PADIS) of the United Nations, to acquire the necessary IT and training;
- . Formulation of national information policies; and
- . Development of own databases and systems for management of African information resources, using software like Micro-Computer Documentation

System/Integrated Set of Information System (Micro-CDS/ISIS), distributed free of charge by UNESCO.

The IT development trends in Africa has improved a lot. The international organizations, institutions of higher learning, private sector, Banking systems, with financial capabilities and foreign assistance, use advanced hardware and software applications, which if shared with other national systems would provide a mechanism for the dissemination and exchange of vital information in the region.

There are several international and regional centres in Sub-Saharan Africa which have taken advantage of the information technology development, and in recent years have developed information retrieval systems. While these systems are not necessarily for feed information, they indicate that there are capabilities and potential for the management and development of a feed information retrieval system. The following section summarizes such centres and what has been developed.

3.4 RECENT AND EMERGING STRUCTURES FOR FEED INFORMATION EXCHANGE IN SUB-SAHARAN AFRICA

There are several international research institutions which operate and could be used as information exchange centres in the region. These centres include:

1. The global centres with major activities in Africa. Examples include ILRI and FAO;

2. The Sub-regional centres, these include:

ITC: International Trypanotolerance Centre;

CIRDES: Centre International de Recherches et Developpement
sur l'Elevage en Zone Subhumide;

ICIPE: International Centre of Insect Physiology and Ecology.

3. The regional Centres like:

SACCAR: South African Centre for Cooperation in Agricultural research;
and

IGADD: Intergovernmental Authority on Drought and Development.

There is also an increased tendency of countries grouping themselves to regional economic clusters, examples include Economic Commision for West African Countries (ECOWAS) and Southern African Development Coordination Committee (SADCC). Some of these institutions have developed agricultural databases or information systems, others are relevant for providing the mechanism for networking and collaboration, which indicate the capacity that exists in Africa as exemplified by the existing information systems and research networks.

Of all these centres, only ILRI has a livestock-specific mandate covering the whole of Africa and other developing regions of the world and with substantial activities in animal nutrition. ILRI operates within the funding and management framework of the Consultative Group for International Agricultural Research (CGIAR), supported by about 40 countries and international agencies and foundations (ILCA 1991).

The mission of the CGIAR which forms the basic objective of the International Agricultural Research Centres (IARCs) is:

" through international research and related activities, and in partnership with national research systems, to contribute to sustainable improvement in the productivity of agriculture, forestry, and fisheries in developing countries in a way that enhance nutrition and well-being, especially among low income people".

The other CGIAR centres with major activities in Sub-Saharan Africa are:

- . IITA: International Institute of Tropical Agriculture;
- . ICRISAT: International Crops Research Institute for the Semi-Arid Tropics;
- . ICRAF: International Council for Research on Agroforestry; and
- . CIMMYT: Centro Internacional de Mejoramiento de Maiz y Trigo.

IARCs are expected to conduct strategic and applied research of international nature that complement and support the national agricultural research system (NARS) efforts. Their main clients are the NARS, which utilize their research findings. IARCs assist in strengthening national research capacities through training programmes and information services (ILCA, 1995).

3.4.1 International Livestock Research Institute (ILRI)

ILRI was formed in 1994 as a result of the merger of former ILRAD (International Laboratories for Research on Animal Diseases) and former ILCA (International Livestock Centre for Africa).

ILRI has adopted a more holistic approach towards the improvement of animal production in Sub-Saharan Africa and the World at large, as both animal health and animal production have a common platform. The regions covered by ILRI are those enumerated below:

- . Sub-Saharan Africa;
- . Asia;
- . North Africa;
- . Latin America; and
- . The Caribbean

ILRI's approach is based on the following operational objectives (ILCA, 1995):

1. Strengthening the ability of national agricultural research systems to conduct technical and policy research in livestock related fields, and thus to develop their own technical solutions to production and marketing problems, and to promote livestock and rural development.

2. To develop, through ILRI's own research and that of other organizations, technologies for increasing both livestock output and the contribution of livestock to sustainable agricultural production and income.
3. To contribute to scientific knowledge in a way conducive to solving livestock production and marketing problems. Such knowledge may relate to the understanding of production constraints and opportunities, or to research methods and techniques.

It should be noted that ILRI has a well established information system that serves the whole of Sub-Saharan African Users. This system is supported by well trained and qualified staff, with the latest information technology facilities:

- . Microcomputer systems: All being replaced with 486 and pentium systems connected to a LAN, with access to the global CGNET;
- . Laser jet printers, Scanners, and photocopiers;
- . CD-ROM drives;
- . Overhead projectors;
- . Microfiche readers;
- . Tape reader;
- . Printing and publishing facilities; and

Software used in different departments include:

- . Word processing: Word perfect, and wordstar;
- . Graphics: Havard graphics, Freelance, and Power Point;

- . Data Analysis: SAS and SSPS;
- . Database Management System: dBase III++, dBase IV, FoxPro, Access, Micro CDS/ISIS and Clipper;
- . Spread Sheet: Lotus and Excel; and

Additionally, the LAN provides the following facilities for sharing the available resources among users (Godard, 1995):

- . Remote device access through sharing of computer peripherals, databases and CD-ROM facilities;
- . Electronic Mail facilities; and
- . Mailing and distribution facilities through mailing list.

These facilities and the information structures at ILRI has facilitated the exchange of research information in the region and provided access to the bibliographic databases. Attempts are now being made to develop subject specific databases which can also exploit the available technologies to disseminate and exchange information with the regional users. An example of such a database is the feed analysis information system, which would use the ILRI's information structure to implement the basic objectives of INFIC in encouraging information exchange and system standardization. The section below describes some of the information retrieval systems in the region as an indication of the existing potential to develop, run and manage region-specific information retrieval systems.

3.4.1.1 Livestock Research Information Retrieval Systems in Sub-Saharan Africa

The concept of information retrieval systems has been in existence for many years. Many agricultural systems have been developed. Despite this, very few have been extensively used and evaluated. Mostly, the reports in this area of livestock research are concentrating on feed budgeting and associated models (Nuthal and Hurley, 1995).

There are two major types of information retrieval systems in the region. These are the bibliographic and textual information retrieval systems.

3.4.1.1.1 Bibliographic Information Retrieval Systems

The Bibliographic information retrieval systems in the region are those belonging to institutional information and library systems. The major one in livestock systems in the region is that of ILRI. It has a wide bibliographic collection drawn from its own publications, regional collections from research centres, international organizations and databases. Examples of the databases held at ILRI's Pagot Library are tabulated below:

1. International CD-ROM databases:

Table 3.1 International CD-ROM Databases.

Title	Description	Dates of coverage
AGRIS (FAO):	World agricultural information (FAO)	1975-1995
AGRICOLA (USA):	World agricultural information (NAL)	1970-1995
CAB(Commonwealth):	World agricultural information	1984-1995
CIARL:	Institutional publications	1962-1986
CD-ROM Directory:	Directory	-----
Computer Select:	Computer related products and topics	1991-1994
SESAME (French):	Agricultural information	1989-1993
Books in print:	Directory of books in print	1993-1995
URICH:	World periodical directory	1991
Statistical Yearbook:	39th edition	1993

2. In-house Developed Databases:

- ILRIB: Bibliographic database;
- ILRIT: Livestock statistics database (Source FAO);
- Expert: African Livestock Experts database;
- AFLIV: African Livestock research database;
- CONF: Forthcoming conferences database;
- DBLIC: Institutions profile database;
- MAIL: Mailing list database; and
- NARS: African National Agricultural Research systems database

All the in-house developed databases are run on Micro CDS/ISIS version 3.0, and networked to a Local Area Network (LAN). The main reasons for the use of micro CDS/ISIS is that:

- . It is a readily available software free of charge from UNESCO.;
- . It can handle both structured textual databases; and
- . There has been training and promotion of its use by international and regional organizations like IDRC, UNESCO, ILRI and PADIS. This has built enough confidence in the users in the region.

3.4.1.1.2 Textual Information Retrieval Systems

There are several information retrieval systems developed and used in agricultural research centres in the region, but applications for livestock production system are mainly available or developed at ILRI. These systems have used dBase III for programming and database design because it is a widely distributed software in agricultural institutions in the region, which are targeted as potential users or contributors to the systems.

3.4.1.1.2.1 ILCA Data Entry and Analysis System (IDEAS)

This was the first attempt by ILCA to develop a computer program to aide in collection and analysis of livestock production data. IDEAS's limitation was in the fact that it had fixed data structures and its built in analysis module was relatively inflexible, largely reflecting the limitations of computers and software available in the mid 1980's. IDEAS was based on dBase III.

3.4.1.1.2.2 Livestock Information Management System (LIMS)

In 1990, ILCA started the development of LIMS to overcome the limitations of IDEAS. This program was completed in 1991. It is now available and used for several small and medium data sets, including data from a large dairy farm, on-farm performance surveys with sheep and several on-station experiments. LIMS has recently been introduced in an animal traction project and a study investigating the genetics of endoparasites resistance in sheep and goats. These examples illustrate the flexibility of LIMS system. The LIMS system is made up of five integrated modules of compiled CLIPPER programs and a generic set of files for sorting animal performance data. This file consists of pre-defined files and variables (fields) within the files, which can be modified by the individual users. Raw data are stored in standard dBase files (ILCA, 1991). LIMS is a flexible system.

3.4.1.1.2.3 Domestic Animal Genetic Resources Information Database (DAGRID)

This is an integrated system using dBase III and Micro CD/ISIS. It can either be run on stand alone PC or on network environment. DAGRID was developed in 1993 with the main objective of maintaining information on the various domestic animal breeds, their characteristics, relevant sources of information, and experts profile.

3.4.1.1.2.4 Gene bank Database

The database is developed for the management of the forage germplasm held at ILRI. It maintains registration records, and interface to allow downloading from diskettes and other systems. The programs were developed in dBase III.

3.4.1.1.2.5 Laboratory Analysis System (LAS)

This program was developed to aide in data entry at the nutrition lab, perform calculations of various determinations and to print results of the analysis. LAS is a menu driven system designed for ease of use and simplicity. The hardware configuration for the system is IBM PC AT or compatible personal computers.

The following databases are developed by ICRAF, a research institution focusing on agro-forestry, and former ILRAD:

3.4.1.1.2.6 FTCOMP and Multipurpose Tree Databases

These databases were developed by the International Council for Research on Agro-forestry (ICRAF). They contain information on feed values of over five hundred woody plants and trees (Were, 1990). These plants could be used for animal feeds in the region, especially in situations where the land area is diminishing with the growth of human population.

3.4.1.1.2.7 Technology Impact Evaluation System (TIES)

ITM is a farm evaluation system which was tried on small holder farms in Uasin Gishu, Kenya. It is used for the treatment of East Coast Fever in cattle. The ITM method depends on a whole farm simulation model, the Technology Impact Evaluation System (TIES). TIES is a computerized simulation model that consists of accounting equations for animal production, marketing, financial management and household consumption of small holder farms. The system is used to estimate the financial and economic payoff of small farms (Nyangito et al., 1995)

3.4.2 Non-CGIAR Centres

3.4.2.1 The International Centre of Insect Physiology and Ecology (ICIPE)

The International Centre of Insect Physiology and Ecology, (ICIPE) is based in Nairobi, Kenya. It maintains a vital research programme on basic and applied aspects of biology and ecology. The institution's objective is based on ensuring food and economic security, especially in tropical regions, through limiting damages caused by insect pests to crops and livestock (ICIPE, 1993). This centre has been recognized as one of the important centres contributing towards the improvement of livestock production through its research program on vector-borne diseases, which address this as one of the most important constraints to animal production in the region (Winrock, 1992).

ICPIPE has a well established library and an information network, PESTNET. This network is being used for the dissemination of research information to the collaborating institutions and NARS. It can provide a mechanism that would facilitate the exchange of feed information to the NARS and the Collaborating centres in the region.

3.4.2.2 The International Trypanotolerance Centre (ITC)

It is located in Gambia and is devoted to the task of dissemination of genetic stocks of trypanotolerant livestock. This is an important contribution towards the improvement of livestock performance in tsetse infested regions. It has established collaboration networks for both genetic resource distribution and information dissemination. ITC has already established a network, which could also be used for feed information dissemination and exchange.

3.4.2.3 Centre International de Recherches et Developpement Sur l'Elevage en Zone Subhumide (CIRDES)

This centre was originally known for its research programs on trypanosomiasis, but has changed its mandate to additionally include the following activities:

- . Applied and adaptive research;
- . Technology transfer; and
- . Training in broad aspects of animal production and health.

The centre's activities are designed to complement the functions of the NARS and thus the feed information availability and exchange.

3.4.3 The Regional Research Programmes In Sub-Saharan Africa

Before independence, Sub-Saharan Africa had agricultural research entities established by the colonial governments to address regional problems. These institutions were incorporated into national systems after independence. However, to forge regional cooperation, new programmes have been established and others are being developed, not only to disseminate information, but also to provide the necessary funds for the purchase of required technologies and maintenance facilities for the smooth operation of the existing systems. The institutions in this category are described below.

3.4.3.1 The Special Programme for African Agricultural Research (SPAAR)

The Special Programme for African Agricultural Research (SPAAR) was established in 1985 by a group of twenty three donors, through their belief in collaborative donor action, region orientated and nationally motivated research programs in Sub-Saharan Africa region. SPAAR has the following main objectives (SPAAR, 1989):

- To strengthen African Agricultural research systems in the public and private sectors and, through them, the development and testing of relevant technologies in support of sustainable agricultural development.

To increase the effectiveness of donor assistance to the African agricultural research systems through better coordination of existing resources; avoidance of duplication of effort; exchange of information on past, current and future activities; and, collaborative initiatives to address particular problems in agricultural research.

To achieve these objectives, SPAAR has emphasized the identification of problems at national and regional levels. SPAAR has developed a framework for the following purposes:

- . Strengthening the NARS;
- . Established an information system on planned and proposed agricultural research projects;
- . Conduct studies on forestry research, education and training for agricultural scientists;
- . Develop country-specific donor coordinating groups;
- . Address research needs; and
- . Funded a small-grants program for African agricultural scientist.

Within SPAAR's framework, there are anticipated cooperation and collaboration with the following regional organizations:

1. CEDEAO: Communaute' Economique des Etats de l'Afrique de l'Ouest. It covers the following countries: Mauritania, Mali, Niger, Nigeria, Benin, Togo, Ghana, Burkina Faso, Ivory Coast, Liberia, Sierra Leone, Equatorial Guinea, Guinea Bissau, Gambia, Cape Verde, and Senegal;

2. CILSS: Commite Permanent Inter Etats de Lute Contre la Se'cheresse dan le Sahel. CILSS covers: Chad, Niger, Mali, Burkina Faso, Guinea Bisau, Gambia, Cape Verde, and Senegal;
3. CEEAC: Communaute' Economique des Etats de l'Afrique Centrale. CEEAC covers: Rwanda, Burundi, Zaire, Central African Republic, Congo, Gabon, Sao Tome and Principe, Equatorial Guinea, Cameroon and Chad;
4. IGADD: The Intergovernmental Authority on Drought and Development. IGADD member countries are: Ethiopia, Kenya, Uganda, Somalia, Sudan, Djibouti and Eritrea (IGADD, 1993);
5. SADCC: The Southern African Development Coordination conference. SADCC member countries are: Zimbabwe, Tanzania, Malawi, Zambia, Angola, Botswana, Mozambique, Swaziland and Lesotho;
6. OAU/IBAR: The Organization for African Unity/Inter African Bureau of Animal Resources. OAU/IBAR covers all OAU member countries.

3.4.3.2 South Africa Centre for Cooperation in Agricultural Research (SACCAR)

This centre acts as a coordinating mechanism for agricultural research conducted within the SADCC member countries. Its activities include:

- . Joint research planning and program design;
- . Allocation of research tasks to member NARS; and

Decision of sharing research costs.

SACCAR does not maintain research facilities or a cadre of research personnel, but provides a model for the coordination of research activities between SADCC member countries.

3.4.3.3 National Agricultural Research System (NARS)

The term NARS ordinarily is used to include all of a country's public, parastatal, and private nonprofit making institutions, such as universities, that conduct research or contribute innovatively to the development or adaptation of technology and policies that support agricultural and rural development (Pardey et al., 1991).

The NARS in the Sub-Saharan Africa conduct strategic, applied, and adaptive research and on-farm trials to verify the effectiveness, practicality and economic viability of new technologies generated through research. It is through the NARS that a country is kept abreast on developments in agricultural science throughout the world (Winrock, 1992). In some countries the NARS are organized as departments in ministries of agriculture and/or livestock. Some of these institutions are semi-autonomous research institutions or university-based institutes or departments of agricultural research (Taylor, 1991).

Most animal oriented NARS in Sub-Saharan Africa are experiencing difficulties in the following areas:

- Maintaining relevant and productive research programmes;

- . Uncertainties and inadequacies in funding;
- . Excessive bureaucratization;
- . Lack of facilities;
- . Equipment shortages in the local markets;
- . Insufficient number of trained specialists;
- . Scientific isolation;
- . Difficulties in communication,

The above constraints could be alleviated through the following activities:

- . Active collaboration between researchers, to reduce duplication of efforts and utilize the limited resources economically;
- . Collaboration with the IARCs, to share the facilities and resources available at the IARC's centres which are limited at the national level;
- . Establishment of regional research and information networks to keep abreast with the regional and global research and development trends;
- . Motivation of the African researchers through better pay, and training opportunities; and
- . Formulation and liberalization of policies on importation of research equipment and materials.

3.4.4 Role of Regional and International Organizations

These centres make significant contributions to the livestock production in the region, mostly through collaboration and information exchange. Other aspects of their contributions worth noting are:

- . Establishment of communication and interaction among African scientists. This has assisted in the elimination of scientific isolation caused by lack of adequate library resources, especially current scientific journal;
- . Establishment of research networks that link the institution to the national programmes. For example, ILRI has established seven networks that cover most, if not all, of the animal production aspects;
- . Dissemination of information about animal production, health and other disciplines relevant to animal agriculture to the NARS. This can be achieved through the development of a mechanism for information communication and exchange. This involves the establishment of information exchange formats, electronic networking and capacity building as a means to improve accessibility to information;
- . Training and education of professionals in the field of agriculture;
- . Provision for better coordination of programmes. This is to ensure that the programs of IARCs synchronize with those of the NARS;
- . Provision for facilities for data analysis; and
- . Collection and distribution of forage germplasm.

For the feed information systems, these institutions provide mechanisms for dissemination and exchange of feed information, the ultimate objective of any information system in reaching the users and meeting their needs. However, information exchange and networking can be a reality only if there is effective information exchange and development of common tools and products for use in each participating institution. For this purpose, the feed analysis information retrieval system is developing a standard structure using the INFIC coding system to facilitate information exchange and remove incompatibility and technical barriers between feed systems in Sub-Saharan Africa.

The section below describes the present feed analysis information retrieval systems in the region, and presents their limitations.

3.5 FEED ANALYSIS INFORMATION RETRIEVAL SYSTEMS IN SUB-SAHARAN AFRICA

At present, the feed analysis information retrieval systems used in the region are in two forms.

3.5.1. Manual Systems

These consist of documents, which are compiled from local analyses. They are mostly done to meet the specific needs of the researcher(s). They are often in limited copies and are kept in the research units, responsible for the work. Examples of these are: Nigerian feeds (Oyenuga, 1968); Average nutritive value of Kenya feeding stuffs for ruminants (Dougall, 1960); and South and central Africa feed table (Topps and Oliver, 1993), these are also produced in limited numbers.

3.5.2. Semi-Computerized Systems

These are the systems whereby the analysis results are keyed in using Data Base Management systems (DBMS) for storage and retrieval purposes. These systems lack user interfaces and report generation features. Such systems have been developed by Seyoum and Zinash (1993), and Anindo et al. (1994). Laboratory Analysis System (LAS), discussed earlier falls in this category. It is used for:

- . Data input;
- . Printing of raw data;
- . Performing Calculations;
- . Indexing or re-indexing of database files; and
- . Exiting from the system.

The main objective of LAS is to produce analysis results for the various researchers at ILRI.

3.5.3 Limitations of these Systems

The manual and semi automated information retrieval systems have the following limitations in meeting the needs of the regional users:

- . The documents/tables are not readily available;
- . The documents are difficult to update;
- . Generation of reports from the tables are difficult;
- . The scope of their contents are limited to specific user group;
- . They lack a common standard which could facilitate data communication and exchange; and
- . They lack detailed characterization and description of the feedstuffs, in relation to quality, harvest stage and coding system.

These are the main problems which have necessitated the development of a fully automated system, given that the regional users need readily available and accessible information, a necessary input for the improvement of livestock production systems in Sub-Saharan Africa. Additionally, the advent of microcomputer and the networks like the CGNET, INFONET, PADISNET, PESTNET, HEALTHNET and the other networks in the region which implies the use of faster, cheaper and powerful computers, and better communication systems that can transmit much higher volumes of information to many more locations. These facilities can be used by the proposed system for information dissemination and exchange.

CHAPTER FOUR

ANALYSIS OF THE PRESENT FEED INFORMATION SYSTEM

4.0 INTRODUCTION

The analysis of the present system involves the investigation of the current activities and operations with a view to understanding what the system does, why and how it does it, who the users are, current problems and how best to improve the current activities.

The activities carried out involved:

- . Gathering and interpretation of facts about the current system with the aim of building a detailed representation of the current physical system; and
- . Understanding the user requirements, as a fundamental basis for the design and development of the proposed system.

This chapter focuses on analysis of the functions and current problems of the *chemical composition and nutritive value of feedstuffs for ruminant livestock in Sub-Saharan Africa table*. This system is investigated to establish the requirements in a broader context so as to identify the functional and non-functional requirements of the proposed computerized system in the following chapter.

In describing the existing system, the results are documented using Data Flow Diagrams (DFD) and other documentation tools to highlight the essential features of the existing system as pointed out by the actual users and potential users of the system.

4.0.1 The Primary Advantages of Analyzing the Present System

The following are some of the advantages of analyzing the present system, especially in this situation where there is an information system to be improved.

Effectiveness of the present system: Feed information system has been in existence for sometime. The analysis of this system provides the analyst with an opportunity to determine whether the system is satisfactory, is in need of minor repairs, requires major overhaul, or should be replaced. This, therefore, determines the scope of work involved;

Design ideas: Analysis of the present system provides the analyst with design ideas through identification of relationships and functions. In the case of the feed information system, it is through the analysis that the systems relationship to LAS and other information sources would be determined so as to establish the necessary links and improvements;

Resource recognition: The analysis of the feed information system would also facilitate the identification of available resources. These include management talents, clerical talents, technical talents, equipment currently owned and operational.

Common starting point: In general terms the overall analysis of the system provides knowledge on what is to be done and where to start. It facilitates the analyst's capacity to identify and isolate areas of change and development to meet the information objectives.

The following section describes ILRI's Research Programmes Organizational structure, which provides the framework within which the feed information system operates.

4.1 THE RESEARCH PROGRAMME STRUCTURE AT ILRI

ILRI forms the structural basis within which the feed information system is established. The information technology, space and personnel resource facilities used by the unit is provided by the institution. It is therefore, appropriate to give a brief overview of the organizational structure and the environment within which feed information system operates.

ILRI has a new organizational structure. The research programmes are divided into six main programmes as illustrated in Figure 4.1. The feed information system is presently

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under Conservation of Biodiversity Programme, specifically under Plant Genetic Resources.

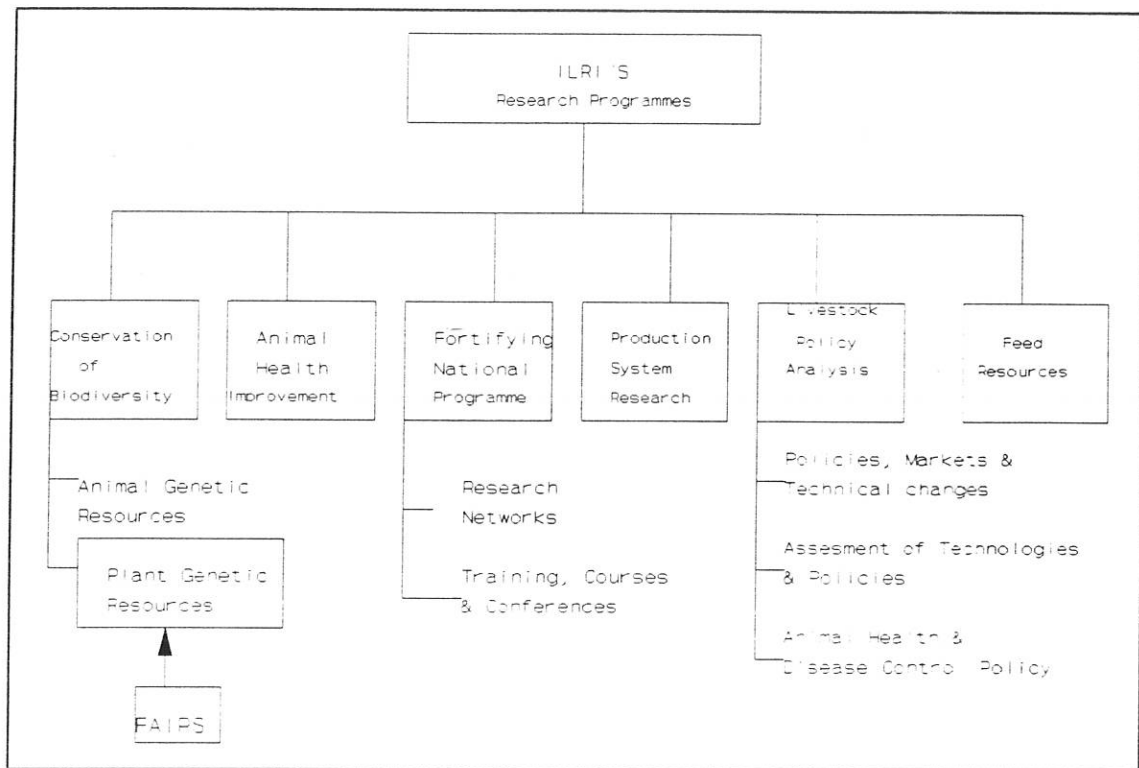


Figure 4.1: Organizational structure of ILRI's Research Programmes

4.2 THE FEED INFORMATION SYSTEM

The current feed information system is a semi-automated system. The system's operations and functions highlighted in this section are those dealing with the data flows, processes, outputs and storage procedures preceding the compilation of the *chemical composition and nutritive value of feedstuffs table*. Figure 4.2 illustrates a data flow diagram of the present system.

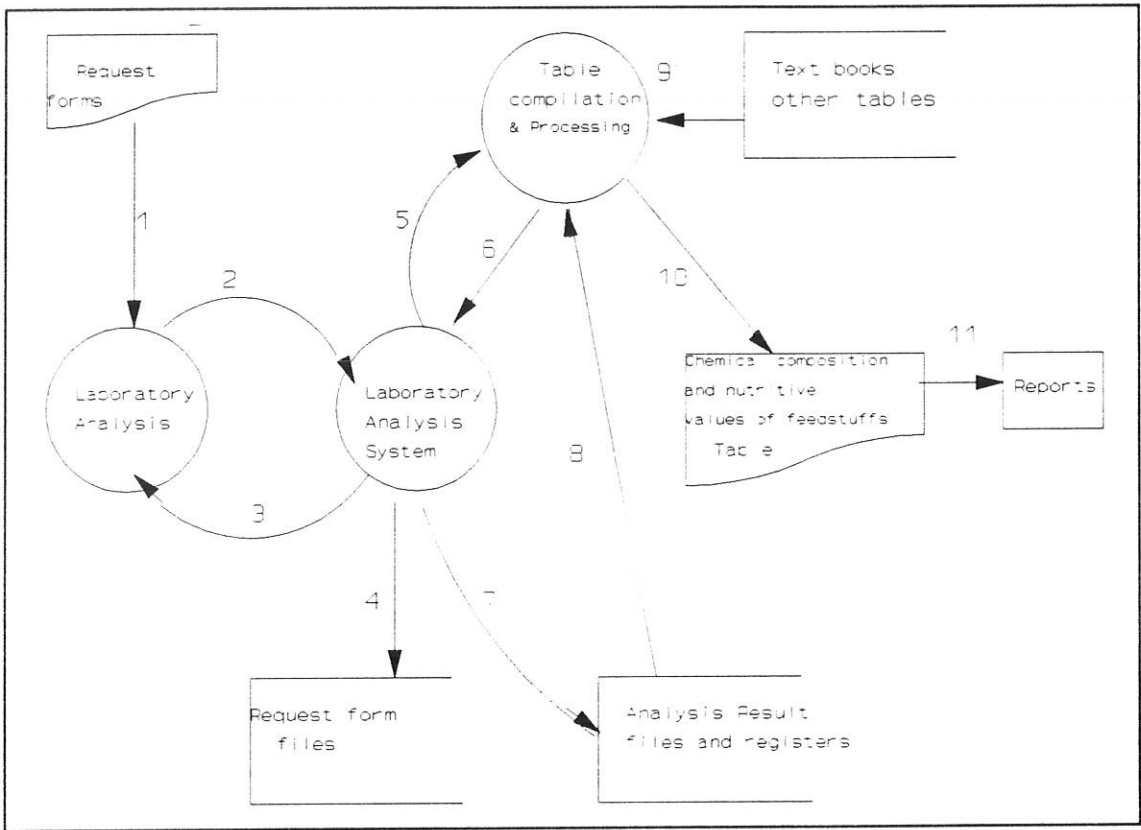


Figure 4.2: DFD OF THE FEED INFORMATION SYSTEM

The description of flows shown in Figure 4.2 is as follows:

1. Laboratory analysis request forms and samples are received from the requesters, and are registered at the analysis laboratory. The data elements in the request forms structures are described in detail in the Data Dictionary.
2. Results from the analysis are sent to the Laboratory Analysis System (LAS), for further calculations to be performed on the derived data element parameters.
3. Requests for further analysis are sent to the laboratory from the LAS.
4. Completed request forms are sent from the LAS to the request form files.
5. Input sheets are filled from the LAS to the table compilation and processing unit. The data elements in the input sheet structure are similar to those in ILRI laboratory analysis request forms, except for the year and date of recording data fields. On the other hand, the Table also contains additional data structures. These include international stages of maturity terms of plants, some anti-nutritional factors and means of reducing the effects on ruminant animals, recommendation on the maximum limits of inclusion of some ingredients of feedstuffs for ruminants, and the international feed classes.
6. From the Table's compilation unit, more information and clarifications may be requested from the LAS.
7. Printouts are produced in form of tabulated results from the LAS to the analysis result files and registers.

8. Earlier analysis results are sent to the table's compilation and processing unit from analysis result files and registers.
9. Research findings from text books and other tables also form input to the composition table through the compilation and processing unit.
10. The table compilation and processing unit produces the chemical composition and nutritive values of feedstuffs table.
11. From table, feed composition elements are used to produce different types of reports in form of tabulated printouts.

The automated aspects of the feed information system are run on dBase III programmes. It should be noted that the LAS system is fully automated while the feed information system is semi-automated. The LAS generate information that forms the major input to the feed information system. It is therefore, important to investigate the LAS system so as to identify ways through which the gap between LAS and the feed analysis information system could be filled to optimize the functions of the information system. The functions and processes of the current feed information system could be illustrated separately as in figure 4.3.

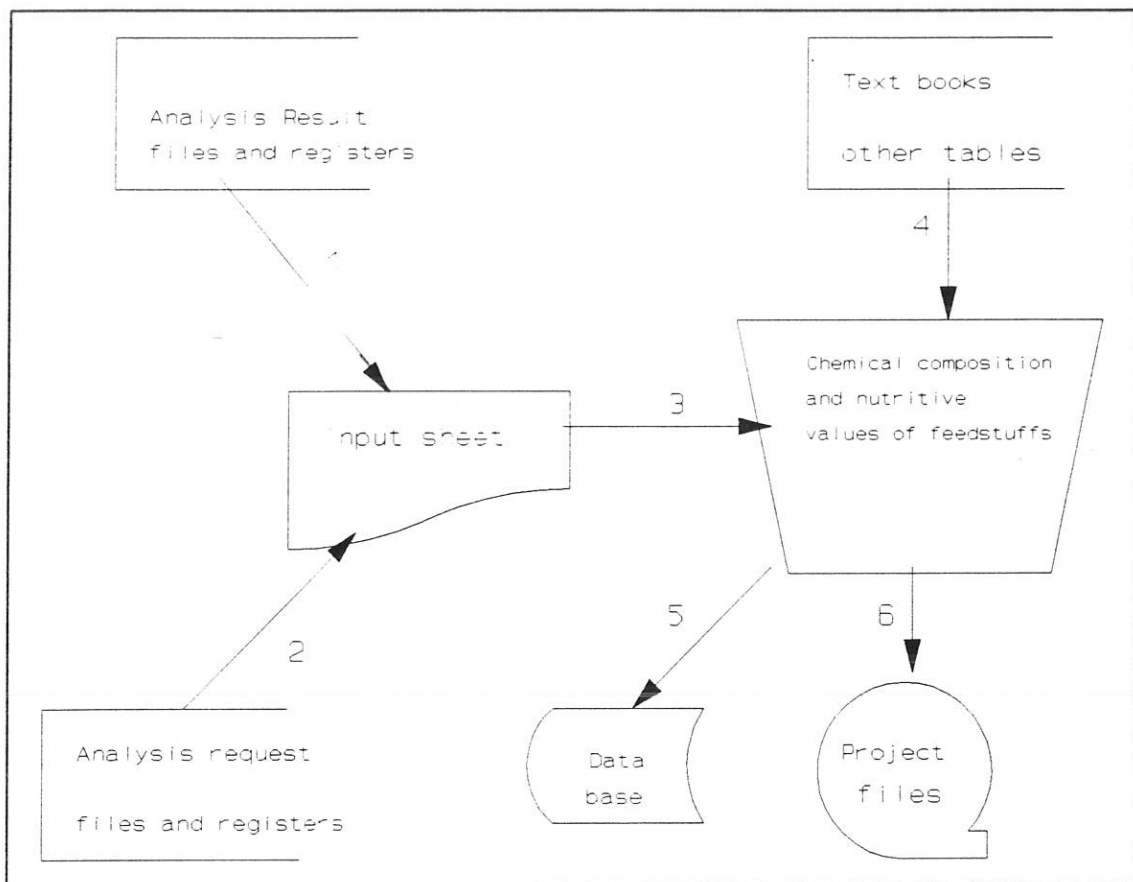


Figure 4.3: DFD of the System's Processes

The system processes indicated in Figure 4.3 by numbers from 1 to 6 illustrate the following:

1. Data input from analysis result files and registers are entered to the input sheets;
2. Data input from the analysis request files and registers are entered to the input sheets;

3. Input to the composition tables are received from the input sheets;
4. Input from textbooks and other tables are sent to the composition table;
5. Link between the composition table and the database. Both the data base file and the feed table, need the development of formats and standards to facilitate use of user friendly interfaces and facilities; and
6. Project files stored in floppy disks.

4.2.1 Inputs

As pointed earlier, data input to the feed analysis information system are generated from several sources. The sources identified during the system analysis are:

- . Laboratory analysis system;
- . The earlier analysis result files and registers; and
- . Other text books, journal articles, and tables.

Data from all these sources are validated, edited and filled in the input sheets for the system before making final entries into the system. The processes are described below.

4.2.2 Processes

The main processes highlighted are those by the LAS as an information generator for the feed analysis system, and other processes in the feed information system which is the object of this study.

4.2.2.1 The LAS System

The LAS is fully automated, with the objective of meeting the needs of the analysis laboratory. The following operations are performed by the LAS.

When samples are received at the laboratory along with the request forms specifying the analysis to be carried out, the sample are registered, details are recorded on the same request forms and laboratory registers. The request form contains information on date the sample is received, project from which the sample is received as a cost centre, sample weight, the laboratory number where the sample should be analyzed, and other composition parameters.

The next procedure undertaken is the analysis of the samples in the laboratory. This is done in relation to the specifications of the request form. The results are recorded on the same request form, which is sent to the laboratory documentation office where this information is fed into the feed analysis system (LAS). The feed analysis system performs the following functions by providing facilities for:

- . Data input from laboratory analysis results;
- . Printing of raw data (analysis results);
- . Performing calculations on the raw data to produce derived data element on:
 - . Dry Matter and Ash;
 - . Neutral Detergent Fibre (NDF);

- . Acid Detergent Fibre and Lignin (ADF);
- . In vitro Dry Matter Digestibility (IVDMD);
- . Digestible Organic Matter in the Dry Matter (DOMD);
- . Dry Matter Digestibility (DMD);
- . Ammonia in Rumen Fluid; and
- . Volatile Fatty Acid (VFA)
- . Indexing of database files

4.2.2.2 Generation of Feed Analysis Information Table

The Feed analysis information system is semi-automated. Its objective is to compile and make available reliable and timely information on the regional feedstuffs to the users.

The system performs the following processes:

- . Extraction of data from past result files, registers and textbooks;
- . Validation and editing of the data;
- . Data file updates;
- . Production of the table; and
- . Overall maintenance of the system.

It should be noted that most of the operations and processes of this system are manual. Thus, there is a need to modify the input formats and the overall system to optimize its use both in the institution and the region. These developments would facilitate efficient functioning of the system, and resource sharing through data exchange.

4.2.3 Outputs

The outputs from the present system are in two forms described below. These are:

4.2.3.1 Data Files

The data files are mostly kept for backup purposes on floppy diskettes and on printout identical to the feed composition analysis table.

4.2.3.2 Feed Composition Table

The feed composition table is the main output of the system. The document was compiled as a result of data that had been accumulated at the unit over the years. This resulted to lack of some analysis parameters like the amino acids and the vitamin composition elements, which are necessary for the feed information users.

The table also lacks the International Feed Number, which is necessary for searching and linking purposes in an automated system environment.

Other than the document, the unit maintains a soft copy on diskettes which is a replica of the hard copy for backup purposes.

The outputs are directed to the storage devices described below.

4.2.4 Storage

The main storage facilities of the present system are:

- . The feed analysis table;
- . The registers and files which were used between 1981, when the analysis started and 1991, when LAS was introduced; and
- . The hard and floppy disks.

4.2.5 Users of the Present System

The main users of the present system are ILRI researchers, and the regional NARS' researchers involved in the ILRI's Research Networks. These users usually request for analysis of feed samples to meet their project needs. The available resources of the present system are described below.

4.3 THE EXISTING RESOURCES

4.3.1 Information Technology Resources

The existing information technology facilities at the nutrition section which are accessible to the researcher and the assistant are:

- . Four microcomputers
- . One 286 Tandon plus;

- . One 286 Tandon;
- . One 386 AST; and
- . One 486 Gateway.

These facilities are used for data input, data processing, statistical analysis, and word processing.

- . Three printers
 - . One Epson LQ 1060;
 - . One Epson LQ 800; and
 - . One Hewlett Packard Laserjet series 2
- . One photocopier
 - . Xerox 1025
- . Communication facilities
 - . All the computers are attached to the LAN; and
 - . CGNET

These facilitate data and information exchange between the institute and other institutions.

4.3.2 Human Resources and Management Aspects

The chemical composition and values of feedstuffs for ruminant livestock was established by three animal nutritionists working at ILRI. Their objective was to compile the data that was available at the nutrition laboratory to provide information on the regional feedstuffs.

Previous activities were managed and coordinated by the head of animal production section. Currently, the feed information system is managed by one senior animal nutritionist. He handles the management aspects, while the input and updating of the system is being done by a senior research assistant. The word processing activities are handled by a secretary.

Both the researcher and the assistant have a good knowledge of the dBase software and the computer systems. Their responsibilities are enumerated below.

- . To ensure the conservation of the integrity of the data files through selection of only appropriate information to be input to the system;
- . To ensure frequent updating of the data files as analysis results are received;
- . Request for analysis of feed materials not yet included in the system; and
- . Maintain the normal functions and operations of the system.

The present system has some limitation which hinder its optimal operation in meeting the user and system requirements. These limitations and possible solutions are described below.

4.4 LIMITATIONS OF THE CURRENT SYSTEM

There are several parameters which are missing in the present feed composition table. The most critical of these is the International Feed Code or number, which is a significant field for indexing the different files and for the establishment of links and relationships for retrieval purposes. Additionally, the feed analysis information system lacks an established direct link to the LAS system, this implies that most of the input from LAS has to be manually entered onto the input sheets with different formats. For the optimization of the feed information system there is a need to establish a link which would support downloading of data directly from LAS; and the design of a standardized input sheet with multiple copies to different departments so as to reduce the response time.

Other major limitations identified are summarized as follows:

Most of the data from the system are mainly kept in data files in electronic forms and in the manual table. The soft copies are replicas of the manual table, meaning that both the forms lack information retrieval facilities and user interface systems;

The LAS system is developed to facilitate the operations of the nutrition laboratory analysis procedures not with the feed information system in mind. It therefore, lacks direct link to the feed information system. This implies that there is a lot of duplication in data input in both LAS and feed information system, which would otherwise be minimized through system integration and data downloading from LAS;

The system's output lack vital elements like the vitamins and amino acid components which are critical for the feed information system users of the region; and

The outputs from the system, if available, are in unfriendly formats and are not readily available to the general users, which cause hindrance to the timely and relevant flow of information.

4.5 FAIRS DESIGN CONSIDERATIONS

For the feed information system to meet its system's objectives and the needs of the users, the system should optimize its performance by enhancing the inputs, processes, storage and outputs through use of the available information technology. Additionally, the following aspects are be considered in the design of the new system to improve performance, and meet both user and system requirements.

- . Standardization of the system through the use of international feed codes, to meet the INFIC requirements, and to provide a standardized framework that could be used by other feed information systems in the region;
- . Inclusion of the missing data elements so as to fully meet the needs of the users in animal agriculture;
- . Use of data models to facilitate data manipulation, searching and retrieval;
- . Design of output formats; and
- . Design of user interfaces for both novice and experienced users to facilitate user friendly, interactive system operation.

The details of the design of the proposed system are discussed in chapter six.

CHAPTER FIVE

SURVEY RESULTS AND DISCUSSIONS

5.0 INTRODUCTION

In order to collect up to date information on feed information systems in Sub-Saharan Africa, questionnaires were administered to 250 users from forty seven countries and ILRI. Out of 250 questionnaires sent out, 69 users responded. Therefore, the response rate was 27.9%.

The main objectives of the survey are three fold:

1. Ascertain the information needs of the users in relation to the available sources and feed tables being used in the region;
2. To identify the available information technology resources, their capability and accessibility to the users; and
3. To find out the limitations of the present feed information system, if any.

In addition to the questionnaire responses, twenty animal nutritionist who visited ILRI, Addis Ababa from the different NARS were also interviewed. Additionally in drawing inferences, information from observations of the information system at ILRI, and

institutional relevant documents were used as supplements to the survey methods highlighted above.

This chapter, therefore, describes in detail results of the survey, particularly the questionnaire and interviews dwelling specifically on the survey objectives, the findings, and the implications of the results with proposition of the design alternatives, wherever appropriate.

5.1 RESULTS

5.1.1 Interviews

There were 20 animal nutrition researchers interviewed, 10 were from ILRI, while the rest 10 were from the NARS of different countries. All of them had their own feed analysis results either on hardcopies - 16 (76.2%), or/and in electronic Database files 5 (23.8%).

The electronic files were all in dBase III plus. The file lacked a standard format and user interfaces in all the cases. The interviewees expressed a need for a standardized, automated system, which could be established at a central location and its format distributed to the regional NARS.

5.1.2 Questionnaires

The questionnaire results are described in relation to the sections and sub-sections of the questionnaire as previously discussed in chapter two. The results are mostly tabulated in two by two matrix tables, giving frequency of occurrences and percentages of responses to each question. There are unique situations where only the positive responses are considered to simplify presentation and interpretation. In such cases, independent column total and percentages are given, this means that the given total does not tally with the actual total of 69 responses. This phenomena is also common in questions with multiple alternatives as in the awareness of composition tables, which had eight alternatives.

The following section present the results and interpretations of the questionnaire responses to various aspects.

5.1.2.1 Users Groups

The user group categories are distinguished by specialization, profession, qualification, status and institutional affiliation. These parameters are used to identify the nature of the work the users are involved in, their educational qualification level, institutional affiliation and how these relate to their information needs. Table 5.1 indicates the different user groups by specialization.

Table 5.1: Users' Specialization by Qualification

SPECIALIZATION	QUALIFICATION FREQUENCY				
	Dipl	BSc	MSc	PhD	Total
Agriculture	1 (1.45%)	1 (1.45%)	0 (0.00%)	1 (1.45%)	3 (4.35%)
Animal Breeding	0 (0.00%)	0 (0.00%)	1 (1.45%)	0 (0.00%)	1 (1.45%)
Animal Health	2 (2.90%)	1 (1.45%)	0 (0.00%)	1 (1.45%)	4 (5.80%)
Animal Nutrition	2 (2.90%)	1 (1.45%)	14 (20.29%)	26 (37.68%)	43 (62.32%)
Animal Science	2 (2.90%)	2 (2.90%)	2 (2.90%)	3 (4.35%)	9 (13.04%)
Forage Agronomy	1 (1.45%)	1 (1.45%)	1 (1.45%)	4 (5.80%)	7 (10.14%)
Pasture Agronomy	0 (0.00%)	1 (1.45%)	0 (0.00%)	0 (0.00%)	1 (1.45%)
Systems Analysis	0 (0.00%)	0 (0.00%)	1 (1.45%)	0 (0.00%)	1 (1.45%)
Total	8 (11.59%)	7 (10.14%)	19 (27.54%)	35 (50.72%)	69 (100.00%)

The above table indicates that majority (62.32%) of the users of Feed Information System are Animal Nutritionists; the other categories of users are: Animal Scientists (13.04%), Forage Agronomists (10.14%), Agriculturists (4.35%), Systems Analysts (1.45%), Pasture Agronomists (1.45%) and Animal Breeders (1.45%). This implies that most of the system users are involved in different aspects of animal nutrition and related fields.

The users are highly qualified. The table indicates that over 50% of the users are PhD holders; the other categories are: MSc holders (27.54%); BSc holders (10.14%); and Diploma holders 11.59%. This phenomena implies that majority of the users are highly qualified professionals.

The user groups identified above are very broadly defined and by no means exhaustive. The information needs of each group vary widely according to the objectives of their profession. For instance, the scientists working in colleges or universities use the feed

tables mostly for preparation of course materials and for the formulation of experimental rations, while scientists working in research institutions mostly use the tables as sources of information for their applied research projects.

The users have varying needs which are not met by the present feed information system. This limitation, therefore necessitated the identification of users' needs and requirements which are the basis for the design and development of a system with desirable features for all user groups.

Table 5.2: Users' Specialization by Status

SPECIALIZATION	STATUS FREQUENCY						
	Admin.	Lecturer	Professor	Scientist	Student	Technician	Total
Agriculture	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (2.90%)	0 (0.00%)	1 (1.45%)	1 (1.45%)
Animal Breeding	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (1.45%)	0 (0.00%)	0 (0.00%)	1 (1.45%)
Animal Health	1 (1.45%)	0 (0.00%)	0 (0.00%)	1 (1.45%)	1 (1.45%)	1 (1.45%)	4 (5.80%)
Animal Nutrition	1 (1.45%)	7 (10.14%)	6 (8.70%)	27 (39.13%)	1 (1.45%)	1 (1.45%)	43 (62.32)
Animal Science	0 (0.00%)	2 (2.90%)	1 (1.45%)	6 (8.70%)	0 (0.00%)	0 (0.00%)	9 (13.04%)
Forage Agronomy	0 (0.00%)	1 (1.45%)	0 (0.00%)	5 (7.25%)	0 (0.00%)	1 (1.45%)	7 (10.14%)
Pasture Agronomy	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (1.45%)	0 (0.00%)	0 (0.00%)	1 (1.45%)
Systems Analysis	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (1.45%)	0 (0.00%)	0 (0.00%)	1 (1.45%)
Total	2 (2.90%)	10 (14.49%)	7 (10.14%)	44 (63.77%)	2 (2.90%)	4 (5.80%)	69 (100.00)

Table 5.2 illustrates the different categories of users by specialization and status. The table indicates that by status, the scientists are a majority (63.77%), while the others user categories are rated as follows: Lecturers (14.49%), Professors (10.14%), Technicians (5.80%), Administrators (2.90%), and Students (2.90%). These results indicates that the feed information system has a wide range of users with varying requirements and needs.

Thus, the output from the proposed system has to be appropriate for all users involved in different professions in the field of animal agriculture, for example:

- . Administrators who use the information from the tables for decision making purposes;
- . Lecturers and professors who use the tables for the preparation of teaching materials and research application purposes;
- . Scientists who use this information for application in their research work;
- . Students who use the information for their course work; and
- . Technicians who are involved in both research and academic institutions.

Table 5.3: Users' Institutional Affiliation

SPECIALIZATION	INSTITUTIONAL FREQUENCY				
	IARC	Government Ministry	Research Institution	University/ College	Total
Agriculture	0 (0.00%)	0 (0.00%)	3 (4.35	0 (0.00%)	3 (4.35%)
Animal Breeding	0 (0.00%)	1 (1.45%)	0 (0.00%)	0 (0.00%)	1 (1.45%)
Animal Health	1 (1.45%)	1 (1.45%)	1 (1.45%)	1 (1.45%)	4 (5.80%)
Animal Nutrition	7 (10.14%)	3 (4.35%)	17 (24.64%)	16 (23.19%)	43 (62.32)
Animal Science	0 (0.00%)	0 (0.00%)	5 (7.25%)	4 (5.80%)	9 (13.04%)
Forage Agronomy	0 (0.00%)	1 (1.45%)	3 (4.35%)	3 (4.35%)	7 (10.14%)
Pasture Agronomy	0 (0.00%)	0 (0.00%)	1 (1.45%)	0 (0.00%)	1 (1.45%)
Systems Analysis	1 (1.45%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (1.45%)
Total	9 (13.04%)	6 (8.70%)	30 (43.48%)	24 (34.78%)	69 (100.00%)

Table 5.3 illustrates the user classification by institutional affiliation. The table indicates that majority (43.48%) of the users are affiliated to research institutions. The rest of the users are affiliated to: Universities and colleges (34.78%), International Agricultural Research Centres (IARC) (13.04%), and Government Ministries (8.70%).

The users are broadly distributed in national and international agriculture related institutions. These results imply that the feed information system already has a well established institutional system, which can be used by the proposed system at the national, regional, and international levels. The institutions are the target consumers of information outputs from the proposed system.

The following section describes the users' awareness and use of the feed tables.

5.1.2.2 Users' Awareness of the Composition Tables

The users' awareness of the composition tables was surveyed to ascertain the users' knowledge of tables as sources of feed information, frequency of use and availability of the tables, important composition elements expected in a regional table and limitations of the tables being used currently.

The results on users' awareness of the eight composition tables are presented in Table 5.4. The users' awareness of the tables can be rated in the following descending order: The American table is known among 66.67% of the users, while knowledge of the other tables are noted as follows: UK Table - 50.72%, Canadian Table - 31.88%, Australian Table - 23.19%, ILRI Table - 14.49%, Latin American Table - 10.14%, Arab and Middle East Table - 8.70%, and Korean Table - 1.49%. These results indicates that the American Table is the most distributed and known of all the tables followed by the UK Table,

Canadian Table, Australian Table, ILRI Table, Latin American table, The Arab and the Middle East Table, and finally, the Korean Table. The responses presented in this table had multiple alternative answers, meaning that one respondent might have been aware of more than one table. The overall total of the table therefore, does not tally with the actual total.

Table 5.4: Users' Awareness of the Composition table

SPECIALIZATION	AWARENESS FREQUENCY							
	ILRI Table	Arab Table	Canad. Table	Americ Table	L.Amer Table	Korean Table	UK Table	Austr Table
Ariculture	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (2.90%)	0 (0.00%)
Animal Breeding	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Animal Health	0 (0.00%)	0 (0.00%)	2 (2.90%)	3 (4.35%)	0 (0.00%)	0 (0.00%)	1 (1.45%)	0 (0.00%)
Animal Nutrition	6 (8.70%)	5 (7.25%)	17 (24.64%)	35 (50.72%)	7 (10.14%)	1 (1.45%)	27 (39.13%)	12 (17.39%)
Animal Science	1 (1.45%)	0 (0.00%)	2 (2.90%)	4 (5.80%)	0 (0.00%)	0 (0.00%)	3 (4.35%)	3 (4.35%)
Range Agronomy	1 (1.45%)	1 (1.45%)	1 (1.45%)	4 (5.80%)	0 (0.00%)	0 (0.00%)	1 (1.45%)	1 (1.45%)
Stature Agronomy	1 (1.45%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Systems Analysis	1 (1.45%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (0.00%)	0 (0.00%)
Total	10 (14.49%)	6 (8.70%)	22 (31.88%)	46 (66.67%)	7 (10.14%)	1 (1.45%)	35 (50.72%)	16 (23.19%)

Table 5.5: Frequency of Use of the Tables

TABLE	FREQUENCY OF USE			
	At least once a month	At least once in 2-6 months	At least once a year	Not at all
ILRI Table	2 (2.90%)	3 (4.35%)	1 (1.45%)	63 (91.30%)
Arab & Middle East Table	0 (0.00%)	1 (1.45%)	4 (5.80%)	64 (92.75%)
Canadian Table	3 (4.35%)	5 (7.25%)	10 (14.49%)	51 (73.91%)
American Table	11 (15.94%)	19 (27.54%)	7 (10.14%)	32 (46.38%)
Latin American Table	0 (0.00%)	1 (1.45%)	5 (7.25%)	63 (91.30%)
Korean Table	0 (0.00%)	1 (1.45%)	0 (0.00%)	68 (98.55%)
UK Table	7 (10.14%)	10 (14.49%)	12 (17.39%)	40 (57.97%)
Australian Table	2 (2.90%)	5 (7.25%)	5 (7.25%)	57 (82.61%)

The user groups awareness vary significantly from the frequency of use of the tables.

Table 5.5 illustrates the frequency of use of the feed composition table.

The results indicates that of these tables, the American Table is the most used with a total of 53.62%, while this table's awareness total is 66.67%. Comparison of the awareness againts use of the American table indicates a difference of 13.05%. This disparity between awareness and use is common to all the other tables. The frequency of use of the other tables are: UK Table - 42.03%, Canadian Table - 26.09%, Australian Table - 18.39%, ILRI Table - 8.70%, Latin American Table - 8.70%, Arab and Middle East Table - 7.25% and the Korean Table - 1.45%. The users' awareness and use of the tables imply that the users can explicitly evaluate the information provided by the tables

and recommend their expectations. In this case, the users recommendations and expectations are used in the design of the user schema in the proposed system.

5.1.2.3 Use of the Composition Tables

The frequency of use of the feed composition tables was surveyed to ascertain the availability and accessibility to the tables by the users. Additionally, use of the table would facilitate the users' response in giving objective evaluation of what the system provides against the limitations.

The infrequent use of the tables can be attributed to the limitations illustrated in Table 5.6.

Table 5.6: Constraints of the composition Tables by Specialization

SPECIALIZATION	CONSTRAINTS FREQUENCY			
	1.	2.	3.	4.
Agriculture	2 (6.2%)	1 (3.1%)	1 (7.1%)	1 (3.2%)
Animal Breeding	1 (3.1%)	1 (3.1%)	0 (0.00%)	0 (0.00%)
Animal Health	1 (3.1%)	23 (71.9%)	1 (7.1%)	1 (3.2%)
Animal Nutrition	16 (50.0%)	4 (12.5%)	8 (57.1%)	23 (74.2%)
Animal Science	7 (21.9%)	2 (6.2%)	2 (14.3%)	4 (12.9%)
Forage Agronomy	4 (12.5%)	1 (3.1%)	1 (7.1%)	2 (6.5%)
Pasture Agronomy	1 (3.1%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Systems Analysis	0 (0.00%)	1 (3.1%)	1 (7.1%)	0 (0.00%)
Total	32 (46.3%)	32 (46.3%)	14 (20.2%)	31 (44.9%)

The constraints indicated in each column by numbers ranging from 1 to 4 indicate the following:

1. The tables do not contain pertinent/relevant information for the user's purpose (46.3%);
2. If the tables are available, they are in unacceptable formats which are not easy to update and maintain (46.3%);
3. Generation of reports from the tables is not easy, because they are manual (20.3%); and
4. The tables are not readily available (44.9%).

This is an indication that the available information only meets the user needs partially.

Thus, implying the need for a system that:

- . Has an acceptable format;
- . Is appropriate for the varying users' needs;
- . Can generate appropriate reports; and
- . Can be readily available to all the user categories.

There is therefore, a need for an information retrieval system capable of solving these problems.

5.1.2.4 Important Composition Elements

The important feed information elements considered in this question are categorized into five main groups described below:

1. **Feeds' identification characteristics:** This include elements which describe the feed name - both scientific and common.
2. **Feeds' dietary elements:** This include information elements on the dietary values of each feedstuffs, such as the nutritive value, mineral content, amino acid content, chemical elements and vitamines content.
3. **Feeds origin:** This refers to the country, region and the Agro-ecological zone from which the feedstuff originates.
4. **Feeds ant-nutritional elements:** This section includes the limiting factors in feedstuffs' utilization and how best these can be eliminated or reduced.
5. **Feed description:** This section refers to the standard nomenclature of INFIC for feed description. It describes feeds by origin, stage of maturity and quality in terms of the standard grades.

The results on these elements are illustrated in Table 5.7. The table illustrates the frequency of the important information elements against the user groups by specialization.

The results indicate rate of elements importance as follows:

Chemical composition (DM, ASH, ADF, NDF, CP, EE, etc) - 91.3%, Digestibility (IVDMD, DOMD, ME etc)- 88.4%, Mineral content (Na, FE, S, Ca, Mg, Cu, K, expressed as DM% or ppm) - 84.0%, Characterization of feedstuffs (Anti-nutritional elements) - 82.6%, Feed Description (Processing, Part, and origin)- 81.1%, Both Botanical and common Name - 71.0%, Location/region from which feedstuff is collected - 59.4%, Feed Botanical Name only - 37.6%, Feed common Name only - 31.8%, and others (region specificity on forages, degradability and feeding levels) - 31.8%

These elements form the basis for the design the database elements and different user requirements schema. Therefore, the proposed system has to include these elements to meet the basic requirements of a feed information system.

Table 5.7: Important Information Elements for the Database

IMPORTANT ELEMENTS	SPECIALIZATION FREQUENCY								
	Agriculture	Animal Breeding	Animal Health	Animal Nutrition	Animal Science	Forage Agronomy	Pasture Agronomy	System Analysis	Total
1.	2 (3.17%)	1 (1.56%)	2(3.17%)	41 (65.08%)	9 (14.29%)	6 (9.52%)	1 (1.59%)	1 (1.59%)	63 (91.3%)
2.	2 (3.45%)	1 (1.64%)	2(3.28%)	40 (65.57%)	9 (14.75%)	6 (9.84%)	0 (0.00%)	1 (1.64%)	61 (88.4%)
3.	2(3.28%)	0 (0.00%)	2(3.45%)	41 (70.69%)	9 (15.52%)	3 (5.17%)	0 (0.00%)	1 (1.72%)	58 (84.0%)
4.	0 (0.00%)	1 (4.55%)	0 (0.00%)	0 (0.00%)	15 (68.18%)	3 (13.64%)	1 (4.55%)	1 (4.55%)	22 (31.8%)
5.	0 (0.00%)	1 (3.85%)	0 (0.00%)	19 (73.08%)	4 (15.38%)	0 (0.00%)	1 (3.85%)	1 (3.85%)	26 (37.6%)
6.	2 (4.08%)	0 (0.00%)	2 (4.08%)	32 (65.31%)	6 (12.24%)	5 (10.20%)	1 (2.04%)	1 (2.04%)	49 (71.0%)
7.	1 (2.44%)	1 (2.44%)	1 (2.44%)	27 (65.85%)	5 (12.20%)	4 (9.76%)	1 (2.44%)	1 (2.44%)	41 (59.4%)
8.	1 (1.75%)	1 (1.75%)	2 (3.51%)	41 (71.93%)	6 (10.53%)	5 (8.77%)	0 (0.00%)	1 (1.75%)	57 (82.6%)
9.	2 (3.57%)	1 (1.79%)	2 (3.57%)	36 (64.29%)	8 (14.29%)	6 (10.71%)	0 (0.00%)	1 (1.79%)	56 (81.1%)
10.	1 (4.55%)	0 (0.00%)	1 (4.55%)	15 (68.18%)	3 (13.64%)	2 (9.09%)	0 (0.00%)	0 (0.00%)	22 (31.8%)

The information elements of the above table are assigned as follows:

- 1: Chemical composition (DM, ASH, ADF, NDF, CP, EE, etc);
- 2: Digestibility (IVDMD, DOMD, ME etc);
- 3: Mineral content (Na, FE, S, Ca, Mg, Cu, K, expressed as DM% or ppm);
- 4: Feed common Name;
- 5: Feed Botanical Name;
- 6: Both Botanical and common Name;
- 7: Location/region from which feedstuff is collected;
- 8: Characterization of feedstuffs (Anti-nutritional elements);
- 9: Feed Description (Processing, Part, and origin); and
- 10: Others (Specify).

5.1.2.5 Outputs from the Tables

This section presents results on the types of reports generated from the composition tables against status of the user groups.

Table 5.8: Report Types generated from the tables against User group Status

STATUS	REPORT TYPE FREQUENCY			
	Research report	Management Annual report	Manufact report	Others
Scientists	31 (75.6%)	5 (83.3%)	3 (50.0%)	6 (46.2%)
Professors	2 (4.9%)	0 (0.00%)	0 (0.00%)	2 (15.4%)
Lecturers	7 (17.1%)	0 (0.00%)	2 (33.3%)	3 (23.1%)
Students	0 (0.00%)	0 (0.00%)	0 (0.00%)	2 (15.4%)
Technicians	1 (2.4%)	1 (16.7%)	1 (16.7%)	0 (0.00%)
Total	41 (80.39%)	6 (11.76%)	6 (11.6%)	13 (25.49%)

Table 5.8 indicates that a majority of the reports generated from the system are research reports (80.39%), followed by others (25.49%). Others include teaching materials, seminar papers and analysis reports. Management reports is next with a total percentage of 11.76%, and manufacturer reports (11.6%).

The different report types generated by the present feed information system indicates the report output formats, and gives an indication of what the proposed system should do in relation to the output forms and formats to meet the user needs.

The following section indicates computer availability and use at the various institutions in the region and by different user groups.

5.1.2.6 Availability of Computers and Use

The availability of computers and their use was surveyed to ascertain the availability of both hardware and software to the users at institutional level. The results indicated that computers are available at identified institutions and are either operated by the scientists or technicians. Table 5.9 indicate the results.

Table 5.9: Computer Availability in Institutions

INSTITUTION	COMPUTER AVAILABILITY FREQUENCY		
	Yes	No	Total
Government Ministry	6 (8.70%)	0 (0.00%)	6 (8.70%)
IARC	9 (13.04%)	0 (0.00%)	9 (13.04%)
Research Institution	30 (43.48%)	0 (0.00%)	30 (43.48%)
University/College	21 (30.43%)	3 (4.35%)	24 (34.78%)
Total	66 (95.65%)	3 (4.35%)	63 (100.00%)

The table above indicates that computers are more readily available at research institutions with a total percentage of 43.48%, followed by University/Colleges (34.78%), IARC (9.0%) and Government Ministries (6.0%). The results give a general indication that information technology, particularly computer hardware and software resources are available in all the representative institutions in the region.

Table 5.10 Computer Accessibility by Specialization

SPECIALIZATION	FREQUENCY OF COMPUTER ACCESSIBILITY		
	Yes	No	Total
General Agriculture	3 (4.35%)	0 (0.00%)	3 (4.35%)
Animal Breeding	1 (1.45%)	0 (0.00%)	1 (1.45%)
Animal Health	4 (5.80%)	0 (0.00%)	4 (5.80%)
Animal Science	7 (10.14%)	2 (2.90%)	9 (13.04%)
Forage Agronomy	6 (8.70%)	1 (1.45%)	7 (10.14%)
Pasture Agronomy	1 (1.45%)	0 (0.00%)	1 (1.45%)
Systems Analysis	1 (1.45%)	0 (0.00%)	1 (1.45%)
Animal Nutrition	41 (59.42%)	2 (2.90%)	69 (100.00%)
Total	64 (92.75%)	5 (7.25%)	69(100.00%)

There are computers and information technology resources readily available to most of the users as indicated in table 5.10. A majority of them (92.75%) are able to operate their systems, while those users relying on technicians only make up 7.25%. This implies that the Information Technology literacy among the users is high, therefore, an automated system can easily be operated by the users after brief training. The users of the system can therefore, be considered at two levels: the novice users (7.25%) and the experienced users (92.75%). Meaning that the design aspects of the proposed system has to accommodate both novice and the experienced users.

5.1.2.7 Software Availability

Software availability has been considered in terms of word processing software, Data Base Management Systems software, and statistical analysis software. The results indicate that most institutions use word processing software - 98.55%, followed by Data Base Management Systems software - 81.16, and use of Statistical analysis packages at 75.36%.

Table 5.11: Software Availability by Institution

INSTITUTION	FREQUENCY OF SOFTWARE AVAILABILITY		
	Word Processing	DBMS	Statistical Analysis
Government Ministry	6 (8.70%)	5 (7.25%)	4 (7.69%)
IARC	9 (13.04%)	8 (11.59%)	10 (19.25%)
Research Institution	29 (42.03%)	23 (33.33%)	20 (38.46%)
University/College	24 (34.78%)	20 (28.99%)	18 (34.61%)
Total	68 (98.55%)	56 (81.16%)	52 (75.36%)

5.1.2.8 Sources of Information used by the Users

The sources of information used are:

- . Feed composition tables;
- . Text books;
- . Own analysis (Semi-automated systems); and
- . FAO Tropfeed Database (automated).

The use of these sources are illustrated in Table 5.12. The results indicate that most of the users (31.71%) use feed composition tables, followed by Text books (26.83%), own analysis results (24.39), and the FAO Tropical Feed Composition Data base (17.07%). As indicated by the results, most of the sources used are either manual or semi automated systems, meaning that although the computers are readily available their power and speed for data manipulation and management are not utilized for the management of feed information.

Table 5.12: Sources of Information

SPECIALIZATION	SOURCES OF INFORMATION OF FREQUENCY			
	FAO Tropfeed data base (automated)	Own Analysis Semi-aut	Compost. Tables (manual)	Text books
Agriculture	0 (0.00%)	0 (0.00%)	1 (2.44%)	0 (0.00%)
Animal Breeding	0(0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Animal Health	1 (2.44%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Animal Nutrition	5 (12.20%)	9 (21.95%)	10 (24.39%)	8 (19.51%)
Animal Science	0 (0.00%)	0 (0.00%)	2 (4.88%)	1 (2.44%)
Forage Agronomy	1 (2.44%)	0 (0.00%)	1 (2.44%)	1 (2.44%)
Pasture Agronomy	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)
Systems Analysis	0 (0.00%)	0 (0.00%)	0 (0.00%)	1 (2.44%)
Total	7 (17.07%)	10 (24.39%)	13 (31.71%)	11 (26.83%)

5.1.2.9 Recommended Inclusion in the Composition Tables

This section considers features the users expect in the new proposed system, as solutions to the limitations of the present system.

In the results, the users identified the limitations of the present feed composition systems, and made recommendations on what should be included in a regional feed composition information retrieval system. The recommended inclusion are:

- . Accessibility and availability of the composition information to the regional users (39%);
- . Additional information elements in relation to the vitamins and amino acids, are often times not included in ruminant composition tables (31.9%);
- . Annual and frequent update of the database and related collaborating centres (20.9%);
- . Region specificity in relation to climate and agro-ecological zones (7.3%); and
- . More sophisticated automated windows version (1.4%).

5.2 DISCUSSIONS

It is evident from the analysis that there are several user groups with varying qualifications, who are involved in animal nutrition and related fields. These users' information needs are dependent on their profession and institutional affiliation, meaning that in the design of a new system, the users' requirements in relation to their profession and institutional affiliation should be considered since these are the determinants of output requirements of the user.

Additionally, Information Technology resources are readily available at the representative institutions in the region. These facilities are not utilized optimally in feed information systems. Since these facilities are readily available to the users, the new system proposes the use of these facilities to improve information generation, processing, output and storage of feed composition information.

From the survey results, it can be concluded that there is need for the design and development of a computerized information retrieval system which would meet the specific needs of the users of feed composition systems in Sub-Saharan African region.

The design for the proposed system includes:

- . **Input formats:** This include input sheets and screen features for data input, retrieval, querying and data validation;

- . **Database facilities;**

- . **Data processing features:** This includes relationships and linking facilities which would facilitate information storage, processing and retrieval;

- . **File organization features;**

Interactive system features: This include the querying formulation and searching of the data base, through menu driven feature; and

Output features: This include report formats and output screen features.

These features would improve the user friendliness, accessibility and use of the feed information system in meeting the user requirements. All these features and the limitations were considered, as indicated in the following chapter, for the design of the proposed system - FAIRS.

CHAPTER SIX

THE SYSTEM DESIGN

6.0 INTRODUCTION

In designing the proposed Feed Analysis Information Retrieval System (FAIRS), the user requirements, the economic viability, and the available information technology facilities in the present system are considered, to facilitate the design and development of a user friendly, flexible and viable system. The design process, therefore, involves the planning, arrangement and sketching of different components/elements in a viable and unified whole (Burch and Grudnitski, 1986).

The proposed prototype system is a computerized Feed Analysis Information Retrieval System, capable of generating electronic and manual outputs. The system is also expected to provide a basic framework for the computerization of feed analysis information systems in the region, to facilitate information exchange, and collaboration between centres involved in animal production and feed resources.

This chapter describes the design of the system, the databases and the user interface aspects. In view of the above objectives, the requirements of FAIRS are given below.

6.1 SYSTEM REQUIREMENTS

From the animal production point of view, the feed analysis information retrieval system is designed to:

- . Maintain and control a permanent record of feedstuffs' composition from Sub-Saharan Africa region; and
- . Facilitate availability of and accessibility to feed composition information to the regional users in the right format.

Specifically, FAIRS is expected to meet the following requirements:

1. Maintain and keep up to date records on feed composition.
2. Provide update reports annually, and on request from the users.
3. Provide facilities for addition, deletion and editing of inputs to the database.
4. Provide backup controls incase the system fails.
5. Provide facilities for searching, browsing, marking, retrieving, saving and printing of outputs.
6. Provide facilities for file organization and database re-indexing.
7. Provide facilities for exiting the system.

The design of FAIRS is described below in relation to the basic design components comprising inputs, functions, databases, outputs, controls, technology and user interface.

6.1.1 System's Inputs

The prime aim of the new system is to establish a feed information retrieval system which is up to date, user friendly and available to the regional user. The implications are that the system must have an efficient input processes with high data quality, which in turn results to high quality outputs. The quality of data which is to be input to FAIRS from LAS system is of very high quality. It is generated from a standardized, uniform and internationally recommended environment. Figure 6.1 indicates the input, process and output (IPO) chart of FAIRS.

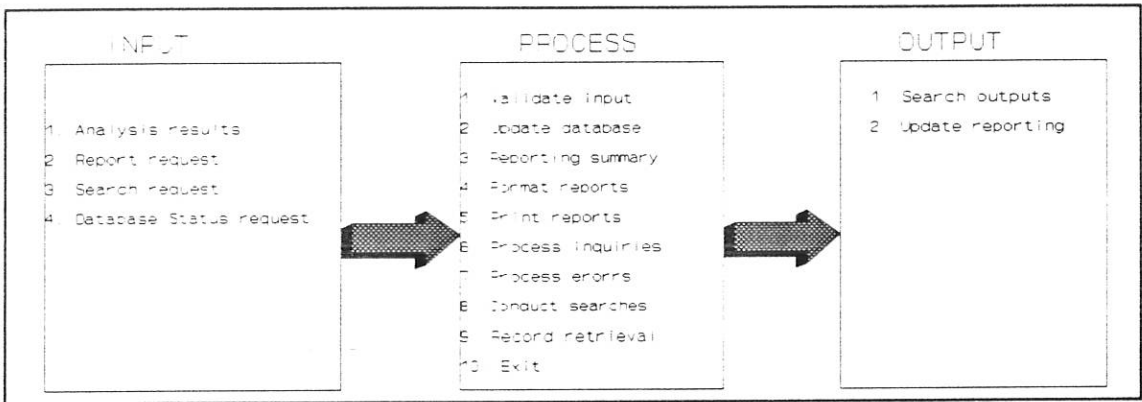


Figure 6.1: FAIRS IPO CHART

The main inputs to the system are from:

- . Analysis results reports;
- . Text books/research reports;
- . Feed Composition Tables outputs; and
- . Report requests;
- . Database status requests; and
- . Search requests.

Information from the first three sources are validated and entered to the input sheets manually. The feed information in the input sheet from different sources are then entered into the FAIRS database files through on-line keyboard device.

At data entry point, there is a proposition to control entry to the database through passwords, and field specific controls to allow updating, editing and deletion only in some fields. Data entry to primary key and coded fields would be dependent on certain conditions and can only be done by authorized personnel.

Additionally, at the data entry point, there would also be input validation. This would be based on the data type and field value, and in case the input is invalid, an error message is to be given.

Input validation and update are done simultaneously. This would facilitate integration of data flow and input to maintain data integrity, system control and resource sharing.

There is a secondary input to the system from the LAS system. It could be performed in an off-line batch mode by downloading of analysis results from LAS on a weekly basis. The information from LAS can only be downloaded if the information is on new feedstuffs or updates on the earlier analysis.

6.1.1.1 Input Structures

The following are the main input data structures used to capture data for the feed analysis information retrieval system. The structure's name, type, source, destination, and data elements are indicated below.

6.1.1.1.1 ILCA Laboratory Analysis Request Form

The ILCA Laboratory Analysis Request form is a form sent by a requester to ILRI laboratory along with feed samples. The form contains information about the requester, his/her research project, date of sample collection, origin of sample, country of sample collection and the analysis to be done.

At the initial stages when there was no feed information unit, these request forms were filed and stored for archival purposes. But when the feed information unit was established, they formed part of the input containing information on earlier analysis and analysis results of requests from the feed information unit.

For ease in filing and identification, these forms have serial numbers and laboratory codes where the requested analysis was done.

The form is on an A4 paper size, type set in small prints and tabulated into units. The data types contained in the form are alphanumeric, with a sections for dates. The results on the forms are mostly hand written. The data elements of this form are described below.

Table 6.1: Data elements for the LAS Request Form

Serial number	Requester Name	Project Number
Surface Texture	Region	Date of Collection
Dry Forage	Type of Sample	Further Information
Plant Part	Altitude	Soil Classification
Grazed/Browsed	Maturity Stage	Animal Species
Analysis Required	Results	Description Codes
Dry Matter (as fed)	Dry Matter (Detn)	Ash
Ether Extract	Nitrogen	Crude Protein
Organic Matter	Neutral Detergent Fibre	Cellulose
Hemicellulose	Acid Detergent Fibre	Lignin
ADFN	Tannin	Silica
Chromium	Calcium	Phosphorus
Iron	Magnesium	Sodium
Potassium	Sulphur	Cobalt
Copper	Manganese	Molybdenum
Selenium	Zinc	DMS

COMMENTS : The data elements are assigned codes for easy of input to the LAS system.

6.1.1.1.2 Analysis Request Form for Plant Samples Only

This is a request form that is sent with the plant samples from the requester to the laboratory, requesting for analysis of plant samples only. It originates from the requester to the laboratory, and is sent back to the requester with the results. It is also type set with small prints and is on an A4 paper size. The only difference between this form and the ILCA’S general analysis request form is that, this form does not include information on elements analysis can be performed on, but asks the requester to fill in the analysis he/she wants to be done. In ILCA’s general request form, the requester only marks the rows corresponding to the analysis they want performed.

Table 6.2: Data Elements for Analysis Request Form for Plant Samples Only

Requester Name	Country	Number of Samples
Type of analysis requested	Project Number	Region
Mean Annual rainfall	Altitude	Programme and its objectives
Quantity of sample	Laboratory number	Project Sample Number
Sample Description	Soil Type	Date of Collection
Species of experimental animal used	Stage of maturity	Part of Plant
Comments	Name	Comments

6.1.1.1.3 Input Sheet

This is a form used to capture data from manual sources. It provides the format within which the collected data is categorized and recorded under the appropriate entity in relation to the system's requirement for the production of the ILRI's Table.

The form is also tabulated in order to accommodate all the elements required by the system. It is not type set, but is provided on an A4 paper size with fine prints. This form is filled and maintained by the feed composition unit.

Table 6.3: Data Elements for the Input Sheet Form

Date	Year	Laboratory Number
Acid Detergent Fibre - Ash	Ash	Lignin
Neutral Detergent Fibre	In vitro	Dry matter (detn)
Nitrogen	Phosphorus	Calcium
Sodium	Ferrous	Potassium
Magnesium	Zinc	Chromium
Cobalt	Requester	Country
Region	Collection Date	Date In
Plant Part	Species	Maturity
Sample Type	Further information	Energy Extract
Tannin	Others	Remarks

6.1.1.1.4 International Stages of Maturity Terms of Plants

This is an International nomenclature for the description of feed maturity stages formulated by the international feed standards. The main purpose of this document is to facilitate standardized characterization of feedstuffs.

The nomenclature is in form of a document, only distributed to institutions involved in animal research of feed production systems, by INFIC.

Table 6.4 Data Elements for the International Stages of Maturity Terms of Plants Form

Preferred term	Definition
Comparable term	

6.1.1.1.5 Some Anti-nutritional Factors and Means of Reducing the Effects on Ruminant Animals

This is a form that contains information on the inhibiting chemical and physical characteristics of feedstuffs. For feedstuffs that can be utilized as animal feeds after processing, the processing procedures/treatments are given.

Table 6.5 Data Elements for Anti-nutritional factors Form

Material	Factor	Chemical/Physical nature
Effect on Animals	Processing/treatment before feeding	Feed name

6.1.1.1.6 Recommendation on the maximum limits of inclusion (%) of some ingredients of feedstuffs for ruminants

These are the inclusion percentages of feedstuffs to different livestock groups for economical production.

Table 6.6: Data Elements for Feed Recommendation Limits Form

Material	Animal Group
Animal's Stage of development	Feed Name

6.1.1.2 Inputs Design

The input design of the proposed automated system include the design of both the manual and electronic forms, in terms of input sheets and screens.

The input sheet used by the present system is a single sheet which is circulated to three data entry points before a final consideration and data entry into the database. The main constraint of the input sheet is that it takes a long time before it is returned for data entry. The elimination of this constraint would be achieved through the use of multiple copies of the input sheet, to different sections where data is collected for entry into the database files. The input sheet is illustrated in Figure 6.2 below.

The electronic forms of the data entry sheet is identical to the manual input sheet on paper except that these are design on the screen. There are several screens designed to facilitate interactive operation of the system. The input design of the proposed system includes the following screens.

- . Data entry screen;
- . Search request screen;
- . Report request;
- . File reorganization; and
- . Report inquiry screen;

Each input element has a variety of data elements described in detail in the Data Dictionary (Appendix D). Where the data elements appear more than once, only one instance is considered to avoid duplication.

FEED ANALYSIS INFORMATION RETRIEVAL SYSTEM			
INPUT SHEET			
Date: _____			
Feed Name Scientific: _____		Common Name: _____	
Entry number: _____		Centre Name: _____	
IF_Number: _____		Country Code: _____	
Feed Description: Maturity: _____		Altitude: _____	
Origin: _____		Rainfall Amount: _____ mm	
Treatments: _____		Soil Type: _____	
FEED COMPOSITION			
CHEMICAL:	MINERAL:	AMINO ACID:	VITAMI
			N:
NUTRITIVE			
VALUE:			
ANTI-NUTRITIONAL CHARACTERISTICS:			
FEEDING LEVELS (SPECIFY ANIMAL GROUP & AGE)			
COMMENTS:			
NAME: _____			

Figure 6.2: Input Sheet

- The Welcome Screen:** This is the first screen which gives an introduction to the system. It contains the name of the system, the developer and an instruction to press the [CR] key to continue. Figure 6.3 illustrates the welcome Screen

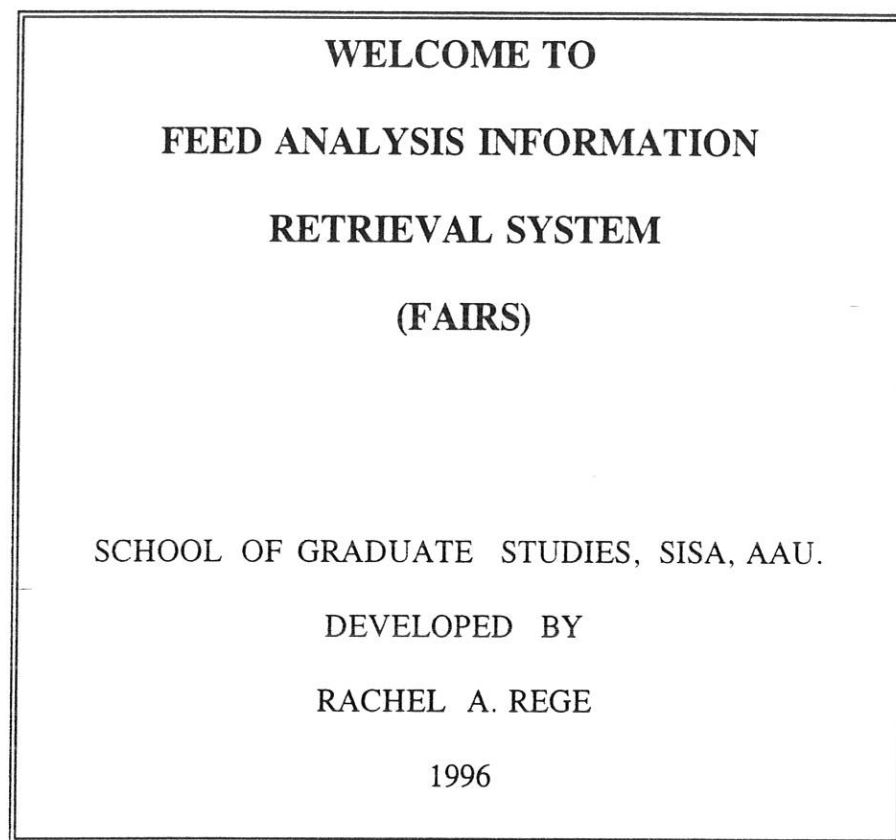


Figure 6.3: FAIRS Welcome Screen

2. **Main Menu:** This is the main screen with the systems' processing options. It comes after the welcome screen. By selection of the desired option, the user is further taken to the desired sub-screens. The main screen format is illustrated in Figure 6.4 below.

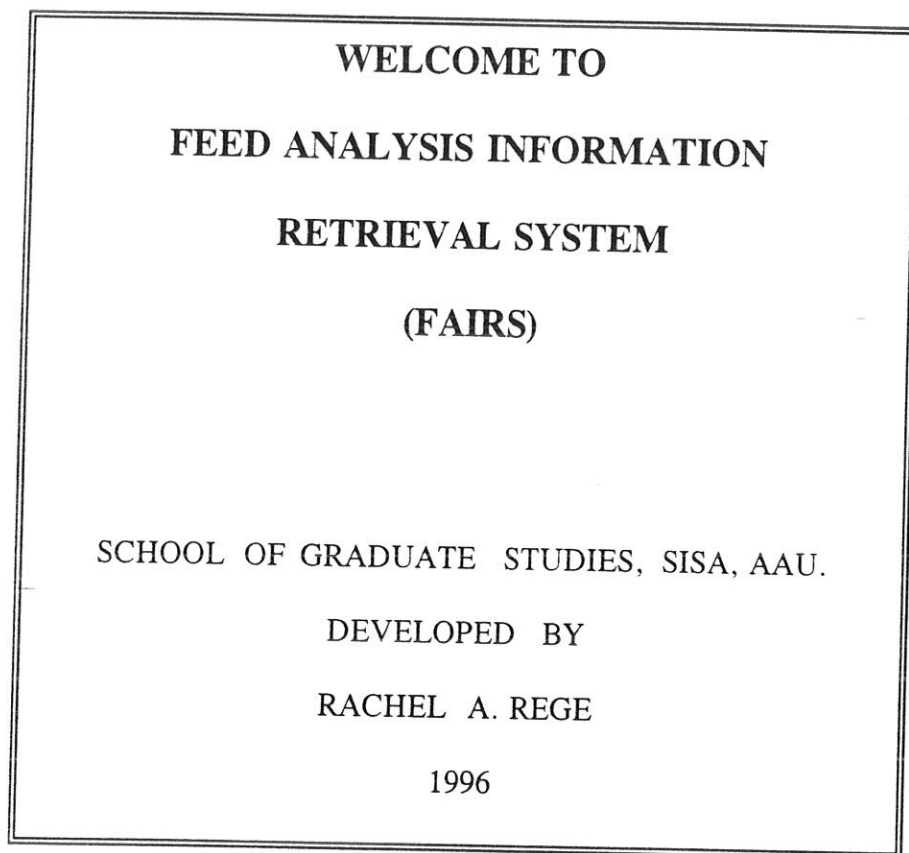


Figure 6.3: FAIRS Welcome Screen

2. **Main Menu:** This is the main screen with the systems' processing options. It comes after the welcome screen. By selection of the desired option, the user is further taken to the desired sub-screens. The main screen format is illustrated in Figure 6.4 below.

MAIN MENU PROCESSING OPTIONS 1. DATA ENTRY 2. SEARCH REQUEST 3. REQUEST REPORTS 4. FILE RE-ORGANIZATION 5. DATABASE STATUS REQUEST 0. EXIT ENTER YOUR SELECTION __
--

Figure 6.4: FAIRS' Main Menu Screen

3. Data entry option: This screen is expected to facilitate data input to a database file, editing, addition, deletion and saving. Since there are different data inputs to the system, the option provides a sub-menu to select the required record type as in Figure 6.5 below.

```
***** DATA ENTRY OPTIONS *****  
  
      DATABASES  
  
      1. IDENTIFICATION DATA  
      2. CHEMICAL COMPOSITION  
      3. NUTRITIVE VALUES  
      4. MINERAL COMPOSITION  
      5. AMINO ACID COMPOSITION  
      6. VITAMIN COMPOSITION  
      7. ANTI-NUTRITIONAL ELEMENTS  
      0. EXIT  
  
ENTER YOUR SELECTION ____
```

Figure 6.5: FAIRS' Data Entry Screen

Each of the data input options has independent files which are linked through indexed fields. The design of the different files were based on the analysis results which indicated that different users require different information from the system. In view of this, it was necessary for each schema to be considered in the light of the user requirement and be designed in the most convenient way. In this case, the most convenient way in terms of the system's entities and attributes identified during the analysis stage, are these files which form complete and independent units.

While in the data entry option menu, if a selection is made, an input form appears on the screen. But, this is different in the search option menu, where if a section is made, the user is expected to give a search term for a search to be effected. If [1] is selected, for instance, in the above screen the following screen will be displayed for data entry.

***** IDENTIFICATION ELEMENTS ENTRY*****

ENTRY NUMBER: XXXXXX

DATE: DD/MM/YY

FEED NAME:

SCIENTIFIC NAME: XXXXXXXXXXXXXXXXX.

COMMON NAME: XXXXXXXXXXXXXXXXXXXXXXXXX.

INTERNATIONAL FEED NUMBER: XXXXXX

FEED DESCRIPTION: XXXXXXXXXXXXXXXXXXXXX

COUNTRY CODE: XXXXXX

CENTRE OF COLLECTION: XXXXXXXXXXXXXXXXX

ALTITUDE: XXXXXXXXXXXXX

RAINFALL: XXXXXX mm.

SOIL TYPE: XXXXXXXXXXXXXXXXX

Figure 6.6: FAIRS' Identification Data Elements form

4. Search request option: This screen allows searching of the database through International Feed number(IF_NO), Feed Name, country code and a combination of these. This screen provides facilities for viewing the search output; organizing; and printing of the search output. The format for the search request screen is given in Figure 6.7 below.

SEARCH REQUEST SCREEN INTERNATIONAL FEED NUMBER: XXXXXX FEED NAME: XXXXXXXXXXXXXXXXXXXX COUNTRY CODE: XXXXXXXXX FILL THE BLANKS AND PRESS [ENTER]
--

Figure 6.7: FAIRS' SEARCH REQUEST SCREEN

5. Database Status request Screen:

This screen provides the facilities for giving information on the status of the database by giving the last entry number and the last date an entry was made. The users of this form are the data input personnel. This form is used for monitoring the growth of the database. The format for the report inquiry screen is illustrated in figure 6.8 below.

```
***** REPORT INQUIRY SCREEN *****  
  
LAST ENTRY NUMBER: XXXXXX  
  
DATE OF LAST ENTRY: DD/MM/YY  
  
1. PRINT  
  
2. VIEW  
  
3. SAVE  
  
0. EXIT  
  
ENTER YOUR SELECTION ____
```

Figure 6.8: Report inquiry screen format

6.1.2 Systems Functions

The FAIRS system's functions are viewed in the light of the processing of the inputs to the system to produce outputs that meet the users needs. FAIRS is expected to receive inputs through the input operations described above followed by the processes described below.

6.1.2.1 Validation of Inputs to the System to Ensure Data Integrity

The system is required to validate inputs to the system and display messages to the user, in order to enter inputs or requests according to user specifications.

6.1.2.2 Data Updates

The database updates need to be done when there are new analysis results on feed entries that are not yet in the system; or on reviewed analysis, so as to take care of the growth of the system's database. The updating procedure includes adding, editing, deleting, saving and exit modules.

6.1.2.3 Process On-line Inquiries

To facilitate searching and information retrieval, the system is expected to have procedures that would allow the user to input queries to the system and receive their responses. FAIRS has incorporated some of these facilities, just as much as time could allow.

6.1.2.4 Perform Searches and Retrieve Information on the Required Output.

The system should have procedures that retrieve records based on search requests. These procedures are to allow a user to retrieve records by International Feed Number (IF_NO), Feed name, Country Code or by using relational operators to search by a combination of the above as required. The following two operations can be called from this option or performed on dependently.

6.1.2.5 Format Reports in Response to Queries to the System

The system should provide menu driven procedures for formatting outputs generated from the system through inquiries. This is to allow the user to specify the output he/she expects.

6.1.2.6 Print Reports from the System or Download Outputs on to Diskettes

The system should have procedures to allow the users to specify the types of outputs required. The output can either be sent to the printer to produce hard copy outputs or saved to diskettes to have soft copy outputs.

6.1.2.7 Process Errors and Provide Guiding Messages to the Users of the System

The system is to provide procedures to handle errors and give guiding message to the users of the system. These facilities will be included in the database, so as to maintain data integrity and for system maintenance. The guiding messages improves the system friendliness to the novice users who might not know what is next, if an error message has been displayed on the screen.

6.1.2.8 Exit from the System

The system should provide procedures for the users to discontinue operations at any level.

FAIRS functions will be supported by available information technology and personnel resources in the present unit. Details on these resources are discussed in chapter four.

6.1.3 System's Output Design

The success or failure of a computerized system is determined by the quality of the output from the system. It is therefore, important that the output forms and screen formats are given considerable significance (Rowley, 1990).

A variety of outputs will be available on-line. The reports generated by the system will depend on the user's requirements.

Additionally, update reports will be produced to provide information on the trends and changes over a period of time. For reporting, the graphics facilities provided by the Data Bases Management System will be used.

The screen formats will be provided with pull down menus facilities to cater for both novice and experienced users, as a convenient and quicker means for system interaction and data manipulation. Most of the screens are illustrated above.

The outputs from the system will be either in soft or hard copies in a tabular form. The data elements contained in the output are illustrated in the output layout form in Figure 6.9 below.

=====OUTPUT FORM LAYOUT=====	
ENTRY NUMBER: _____	DATE: DD/MM/YY
INTERNATIONAL FEED NUMBER: _____	
FEED NAME: _____	
FEED COMPOSITION: DM %	
CHEMICAL: _____	
MINERAL: _____	
NUTRITIVE VALUES: _____	
VITAMINS: _____	
AMINO ACIDS: _____	
ANTI-NUTRITIONAL ELEMENTS: _____	
INCLUSION PERCENTAGE: _____	

Figure 6.9: FAIRS output form layout

From the above entities, the user can specify what is needed, to have the required output.

6.1.4 System Controls

FAIRS will include electronic databases and manual record which need safekeeping and control. To support the control operations of the system, a host of computer controls to ensure the safety, integrity, efficiency, and accuracy of the system will be effected. The control procedures considered are described below.

6.1.4.1 Access Control

Access to some of the processes of the database will be controlled through passwords. For instance, the first level of password control is used to monitor access into the system. The second level of password control is used at updating, deleting, and editing of the database files and indexes. Only authorized scientists and technicians will be assigned passwords to access the second level control. Data input to the system will also be validated by the value assigned to the different fields, a facility provided by the DBMS.

6.1.4.2 Fault Tolerant Controls

Automated information systems are information technology dependent, therefore, computer availability and reliability are of paramount importance for the effective and efficient functioning of the information system. System failure or malfunction should be avoided through use of backup systems and double power supplies.

6.1.4.3 Backup and storage controls

The database files containing system information will be backed up on a weekly basis onto magnetic tapes, and stored away from humidity, sunlight and dust. The storage of the diskettes in a stable environment would ensure that the quality of the diskettes and the data stored therein are maintained.

6.1.5 Data Base Design

There will be one database for the system which will be made up of several files. The files are:

- . The Identification file;
- . Chemical composition file;
- . Mineral composition file;
- . Nutritive value file;
- . Vitamin content file;
- . Amino Acids file;
- . International stages of maturity file;
- . Anti-nutritional elements file; and
- . Recommendation on maximum limits file.

Each of these file will have indexed fields for file linking, searching and information retrieval purposes. Since the volume of information on the regional feedstuffs is quite large (records at ILRI only are over 16,000), the different files will facilitate faster processing.

The system is expected to have a centralized data base system at ILRI, containing all the regional feed information. This system has to have collaborating and supporting databases established at the NARS and regional laboratories to effect region specific analysis of feeds. The national databases are to maintain only national collections, but can get information from ILRI on other feedstuffs they do not hold. The master database at ILRI will be used by the staff at Addis Ababa, while portions of the data base, such as those schema representing updating and data entry will be accessed only by authorized users.

Direct access storage devices including a variety of magnetic disks will comprise the physical data base of the system. Data on these physical storage devices will be organised for direct and indexed searching. Magnetic disks will be used for backup purposes. The schema of the overall database is given below in figure 6.10.

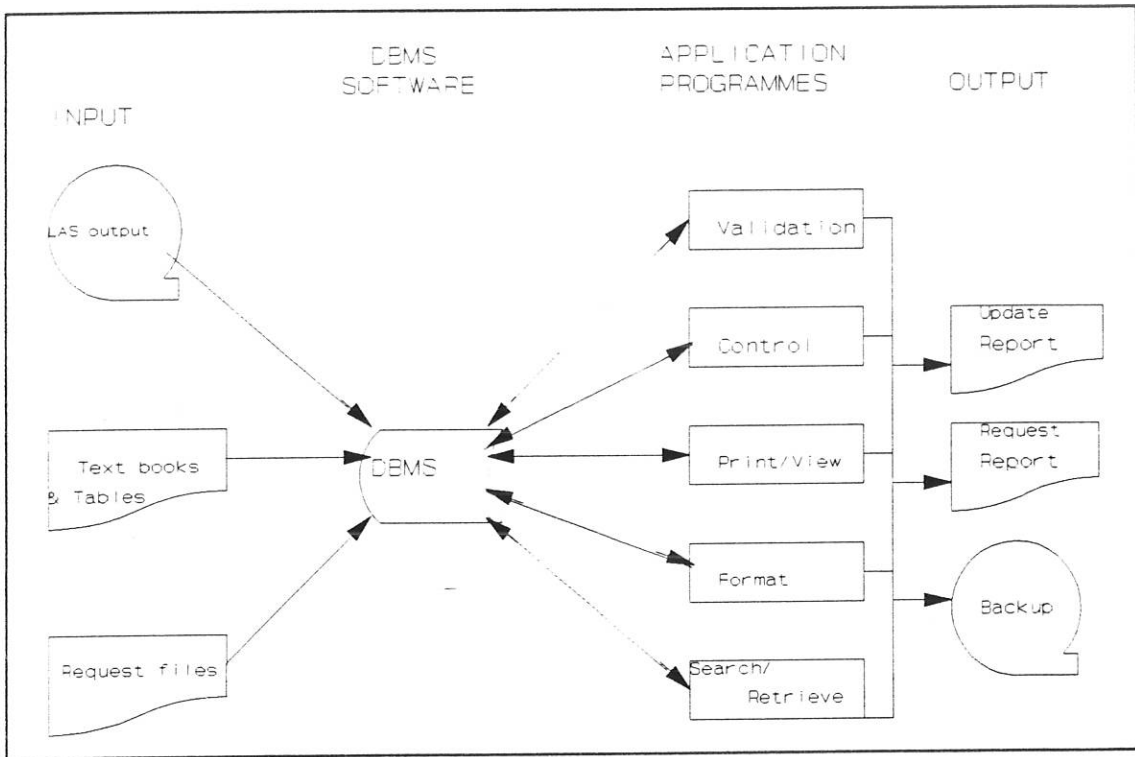


Figure 6.10: Database Schema

6.1.5.1 Details of the Design

In database design, there is need to specify the relationships that exist among entities, attributes and records. In other words, the relationships specification assist the designer to represent the real world situation in the database system.

The main aim of FAIRS database is data integration and minimization of data redundancy. The design of FAIRS database therefore, involves:

- Data dictionary development;

- . Data elements, entities, and attributes identification;
- . Relations and relationship definition; and
- . Presentation of flat files.

6.1.5.2 Data Dictionary Elements

The data dictionary describes data that will be contained in the FAIRS database, while the data elements provides a basis for the database schema and include all the structures that exist in data flows and stores. If a data element appears at several points in the system, only a single entry of that element is considered. In addition to the data element name, description, data type, length, value of field and whether the element is a primary, secondary or composite key for searching and linking purposes are given. The Data Dictionary is given in Appendix D.

6.1.5.3 Data Entities and Attributes

The data entities of FAIRS include the entities of the present system plus the additional entities which were missing in the present system, but were recommended by the users in the survey results. The users indicated that one of the limitations of the present system is that it has limited information on feed composition. For this reason, entities like feed description, vitamins and Amino Acids; and attributes like the International Feed Number are included in FAIRS to meet the user requirements. The main entities and

their attributes are indicated below. The attributes that are underlined within parenthesis are the primary linking key elements to the entities outside the parenthesis. Since some of the entities has too many attributes which makes tabulated presentation quite cumbersome, the following approach has been adopted.

ENTITIES

ATTRIBUTES

1. FEED IDENTIFICATION (IF_NO, FEED_NAME, FEED_DESC, COUNT_CD, COMPOSN, DRY_MATTER)
2. CHEMICAL COMPOSITION (IF_NO, ASH, LIGNIN, NITROGEN, HEMICELL, CELLULOSE, CRUDE_PROT, ORG_MATTER, ETHER_EXTRACT, NEUTRAL_EXTRACT, DIGESTIBLE_ENERGY, TOTAL DIGESTIBLE NUTRIENTS, DIGESTIBLE PROTEIN, CRUDE FIBRE, NITROGEN FREE EXTRACT)
3. MINERAL COMPOSITION (IF_NO, FEED_NAME, PHOSPHORUS, CALCIUM, SODIUM, IRON, POTASSIUM, MAGNESIUM, COPPER, MANGANESE, SELENIUM, ZINC, CHLORINE, SULPHUR, COBALT, FLUORINE, IODINE)

4. NUTRITIVE CONTENT (IF_NO, COUNTRY_CODE, DIGESTIBLE
ORGANIC MATTER IN THE DRY MATTER,
INVITRO DRY MATTER DIGESTIBILITY)
5. VITAMIN CONTENT (IF_NO, COUNTRY_CODE, FEED_NAME,
PROVITAMIN A, VITAMIN D2, VITAMIN D3,
VITAMIN B12, THIAMIN. BIOTIN, CHOLINE,
FOLIC ACID, PANTOTHENIC ACID, NIACIN,
PYRIDOXINE, RIBOFLAVIN)
6. AMINO ACID COMPOSITION (IF_NO, FEED_DESCRIPTION,
FEED_NAME, ARGININE, CYSTINE,
GLYCINE, HISTIDINE, LSOLEUCINE,
L Y S I N E , M E T H I O N I N E ,
PHENYLALANINE, SERINE, THREONINE,
TRYPTOPHAN, VALINE)
7. ANTI-NUTRITIONAL FACTORS (IF_NO, FEED_DESCRIPTION, MATERIAL,
FACTORS, TREATMENT BEFORE FEEDING,
EFFECT ON ANIMALS)
8. INTERNATIONAL STAGES OF
MATURITY (IF_NO, FEED_NAME, PREFERRED TERM,
DEFINITION, COMPARABLE TERM)

9. RECOMMENDED INTAKE LEVELS (IF_NO, ANIMAL CLASS, ANIMAL WEIGHT)

6.1.5.4. Relations and Relationships

Identification of relationships and relations is what led to the isolation of the above entities and attributes. Through removal of redundant attributes, identification of primary relationships, relationship characterization and dependencies, the unique keys underlined within the parenthesis were identified. In situations where there were repeating common key attributes, composite key are identified to facilitate searching in the database.

The Feed identification field has a one to many (1:M) relationship with the other entities through the International Feed Number field (IF_NO). Other identified composites keys indicate N:M (Many to many) relationship. Through these identified relationships different relations are presented to facilitate linking within the database.

6.1.5.5 Presentation of the Flat File

FAIRS flat file contains all of the above enumerated attributes, with a single occurrence of the International Feed Number. The flat file format represents the report output format. Specifications can be made to produce only the required elements. Data elements of the flat file include all the data attributes highlighted above.

6.1.6 User Interface Design

The user interface consists of the screen features of a system which allows a user to interact with a computer. It is the most important feature which represents the system's functions to the user (Everest, 1986).

The following are some of the factors which were considered in designing the FAIRS user interface:

- . User requirements in terms of the inputs and outputs. The consideration of these factors led to the design of the processes which would be necessary to produce the desired output;
- . User's qualification;
- . User's exposure and use of computers and DBMS software;
- . The availability and accessibility of computers at institutional level; and
- . The characteristics of the system's data and size.

The design of the user interface of FAIRS was dependent on the indications that the users of the system are mostly experienced user who use and operate computers frequently, and a minority are novice users who depend on technicians. The designer has made attempts to make FAIRS quite flexible in accommodating both the experienced and novice users. The interface also provides instructions and shorter means for system manipulation.

The users will be involved at three levels:

1. **Use of database to extract information:** At this stage menu derived dialogue boxes are provided. The user can enter the appropriate number or place the cursor on the selection and press [enter].
2. **Data Entry:** At this level the user is also provided with menu driven options, which lead to the data entry forms.
3. **General Interactive operation:** At this level the user will mainly be operating the system to get information on the regional feedstuff. This can be for the purpose of report generation, and personal updates. The user interface has provisions for such operations.

Full scale system automation covers a broad range of facilities in the user interface, all these could not be considered in this study because they are out of the scope of the project. Therefore, the general layout of the screen features already described above under different sub-headings will suffice for the user interface.

6.1.7 Systems Technology

The system is expected to be supported by a range of information technology facilities in order to be efficient in data processing and to produce required information outputs. These facilities include the following:

6.1.7.1 Hardware

As indicated previously, the present unit has hardware facilities available.

1. The Hardware requirements of FAIRS are:

- . At least a Personal Computers with at least 640 kilobytes Random Access Memory;
- . At least 4 Megabytes of free Hard disk storage space;
- . Floppy diskettes for backups and output deliveries to users;
- . Keyboard facilities;
- . Two printers (One Epson and One Laser jet printer). This is to facilitate production of hard copy printouts of requests and updates from the system in both draft and fine copies and
- . Communication facilities: Connection to the existing LAN and the CGNET. This will facilitate reception of requests and output deliveries, to urgent needs.

6.1.7.2 Software Requirements

The software requirements of FAIRS are:

1. An operating system which is capable of:
 - . Better input/output control;
 - . Automatic recovery and backup facilities;
 - . Control of system's time;
 - . Control of data transmission; and
 - . Control of DBMS.
2. A Data Base Management Software for the development, control, maintenance and manipulation of the database. The DBMS chosen for use is dBase IV, this is because the survey results indicated that most of the institution surveyed had computer and DBMS software, specifically dBase IV. The data elements in FAIRS database are mostly numeric, with several text containing fields. The software has to be able to facilitate searching and retrieval of information from the system through indexed files.

The following chapter gives an overview on the prototype development and implementation plan.

CHAPTER SEVEN

PROTOTYPE DEVELOPMENT AND IMPLEMENTATION PLAN

7.0 INTRODUCTION

This chapter covers FAIRS prototype development and the implementation plan. Most of the activities are, therefore, highlighted in relation to the prototype features, testing, evaluation, and cost benefit analysis before full implementation. These activities depend on the design and analysis aspects already discussed in the preceding chapters.

7.1 PROTOTYPE DEVELOPMENT

Given that this study was conducted within a specified time and within the scope of designing a prototype system, FAIRS provides the basic features of an information system which facilitate information storage and retrieval.

The main objectives of the Feed Analysis Information Retrieval System is to maintain and control permanent records on indigenous animal feedstuffs, and to facilitate availability and accessibility of this information to the regional user in both electronic and manual formats. The practicality of this objective has been demonstrated through the use

of sample data from the manual data sources described in Chapter Six. FAIRS prototype database is made up of the following nine files:

- . Identification file;
- . Chemical file;
- . Mineral composition file;
- . Nutritive Value file;
- . International stages of maturity file;
- . Amino Acids file;
- . Vitamin content file;
- . Anti-nutritional elements file; and
- . Recommendation on maximum limits file.

These files contain specific information on the elements falling under each major composition category, which is the file name. These files are linked to specific screens and forms, which facilitate the system's functions to store and retrieve data to specific reports. The report formats are basically dependent on the user's specifications linked to the search output.

The main processing options of the prototype are:

- . Data input/output;
- . Query processing;
- . Report generation; and
- . File re-organization.

These functions are illustrated below in relation to the views, forms, and reports produced. FAIRS prototype is designed with features that support database creation, data input/output, data processing, and user interfaces. These features are illustrated below in Figure 7.1.

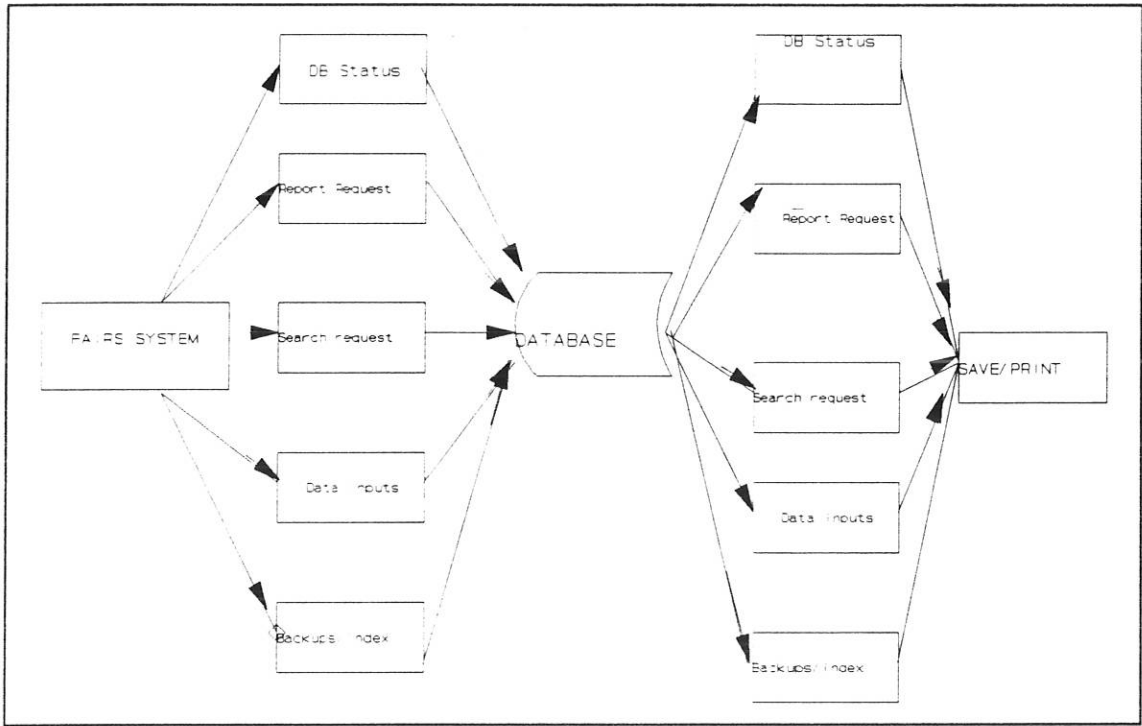


Figure 7.1: FAIRS schema

7.1.1 User Interface

FAIRS has been designed with simple and attractive screen features which are meant to capture the users' interest and maintain interactive system and user relation. The first screen is a Welcome Screen, illustrated in Figure 7.2.

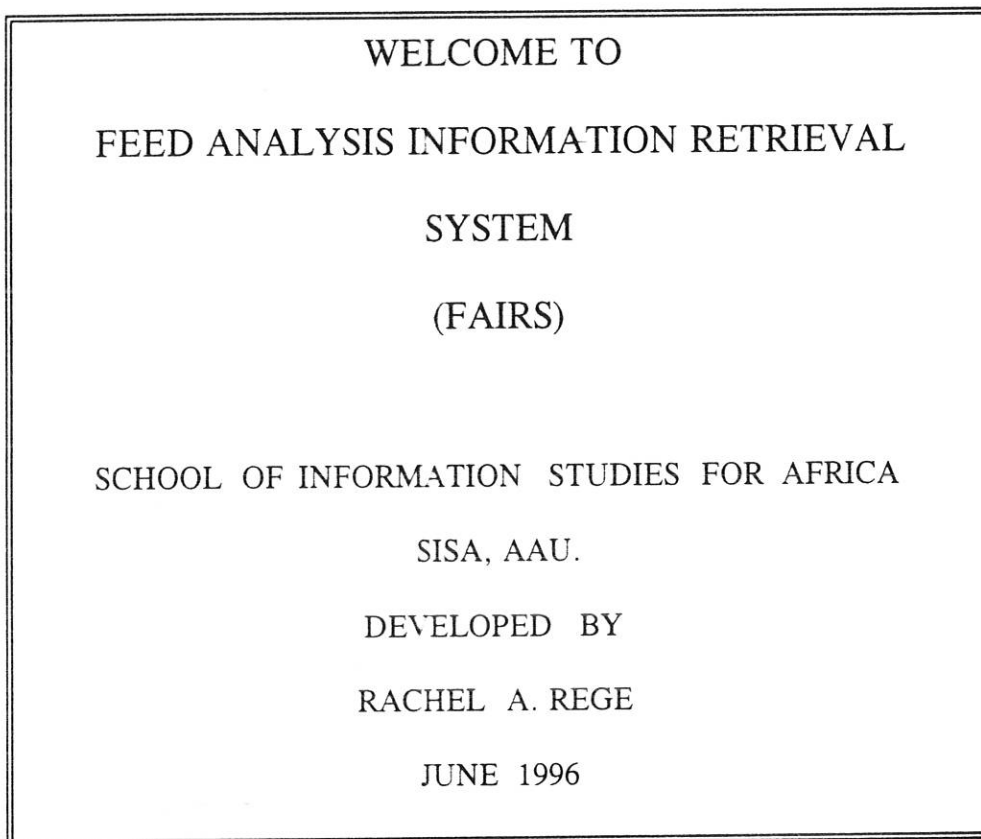


Figure 7.2: Welcome Screen

The Welcome Screen is followed by the MAIN MENU SCREEN illustrated in Figure 7.3 below.

The functions of the MAIN MENU screen are mainly involved in the system's processing options. It allows the user to perform any of the options through selecting the option and by highlighting the choice, or entering the number corresponding to the option.

FEED ANALYSIS INFORMATION RETRIEVAL SYSTEM dBASE IV FEEDS SYSTEM
--

=====MAIN MENU===== 1. DATA ENTRY 2. SEARCH REQUEST 3. REPORTS GENERATION 4. FILE RE-ORGANIZATION 5. DATABASE STATUS REQUEST 0. EXIT ENTER YOUR SELECTION ____
--

Figure 7.3: Main Menu

1. Data Entry Option: The function of this option is to allow the user to add, edit or delete data from the data base. The next screen presented to the user is illustrated in Figure 7.4 below.

```
===== DATA ENTRY OPTIONS =====  
  
          DATABASES  
  
1. IDENTIFICATION DATA  
2. CHEMICAL COMPOSITION  
3. NUTRITIVE VALUES  
4. MINERAL COMPOSITION  
5. AMINO ACID COMPOSITION  
6. VITAMIN COMPOSITION  
7. ANTI-NUTRITIONAL FACTORS  
8. RECOMMENDATION ON MAXIMUM LIMITS  
0. EXIT  
  
ENTER YOUR SELECTION ____
```

Figure 7.4: Data Entry Options' Screen

In the data entry option if a user selects [1] then he/she is presented with the screen illustrated below in Figure 7.5.

```
===== IDENTIFICATION DATA ENTRY =====  
  
1. ADD NEW DATA  
  
2. EDIT DATA  
  
3. DELETE DATA  
  
ENTER YOUR SELECTION ____
```

Figure 7.5: Identification Data Entry Options

If a user wants to select edit or delete data, then he/she is prompted to enter the records ENTRY NUMBER, IF_NO, FEED NAME, or COUNTRY CODE. Following which the identification elements edit screen appears.

```
=====IDENTIFICATION ELEMENTS EDIT=====
ENTRY NUMBER: _____
DATE: DD/MM/YY _____
FEED NAME:
    SCIENTIFIC NAME: _____
    COMMON NAME: _____
INTERNATIONAL FEED NUMBER: _____
COUNTRY CODE: _____
CENTRE OF FEED COLLECTION: _____
ALTITUDE: _____
RAINFALL: _____mm
SOIL TYPE: _____
PRESS <CR> TO SAVE OR <ESC> TO ABANDON CHANGES
```

Figure 7.6: Identification Elements Edit Form

2. Search Request: The function of this option is to allow the user to search the database by FEED_NAME, INTERNATIONAL FEED NUMBER, COUNTRY CODE or by a combination of these. If a user selects this option, he/she is prompted to enter the search terms or fill in the screen shown in Figure 7.7.

```

=====SEARCH REQUEST SCREEN=====

INTERNATIONAL FEED NUMBER: XXXXXXXXXX

FEED NAME: XXXXXXXXXXXXXXXXXXXXXXXXXXXX

COUNTRY CODE: XXXXXXXXXXXXXXXXXXXXXXXX

                FILL THE BLANKS AND PRESS <CR>

```

Figure 7.7: Search Request Screen

The user is then prompted to choose the database file he/she wants the search to be conducted in, as illustrated in figure 7.8.

```

=== SEARCH REQUEST ===
      DATABASES
1. CHEMICAL
2. NUTRITIVE
3. MINERAL
4. AMINO ACID
5. ANTI-NUTRITIONAL
6. FEEDING LEVELS
7. VITAMINS
8. IDENTIFICATION
9. MATURITY
ENTER YOUR SELECTION ____

```

Figure 7.8: Database Search Request

The search results are then presented in a different screen which prompts the user to either save, print, browse or exit as illustrated in Figure 7.9 below. The search output illustrated was conducted in the Nutritive Value database file.

=====SEARCH OUTPUT=====

ENTRY NUMBER: XXXXXXXXX

FEED NAME: XXXXXXXXXXXXXXXXXXXX

INTERNATIONAL FEED NUMBER: XXXXXXXXXXXXXXXXXXXX

COUNTRIES: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

FEED COMPOSITION:

NUTRITIVE: DM - % IVDM - % DOMD - % ME - %

1. SAVE

2. PRINT

0. EXIT

ENTER YOUR SELECTION ____

Figure 7.9: Search Output Form

3. File Re-organization: The functions of this option is to allow the Database Administrator to either re-index or back up for a particular file.

=====FILE RE-ORGANIZATION=====

1. INDEX

2. BACK-UP

ENTER YOUR SELECTION ____

Figure 7.10: File Re-organization Processing Options

If the Administrator selects either options, the following screen appears which requires a selection of the database to effect the option.

=====FILE RE-ORGANIZATION
DATABASES=====

1. IDENTIFICATION

2. CHEMICAL

3. NUTRITIVE VALUES

4. MINERAL

5. AMINO ACID

6. VITAMINS

7. ANTI-NUTRITIONAL ELEMENTS

0. EXIT

ENTER YOUR SELECTION ____

Figure 7.11 File Re-organization Database Options

For instance, if the user selects [2. CHEMICAL] database, the following screen illustrated in Figure 7.12 appears.

=====CHEMICAL DATABASE INDEX=====

FIELD(S) TO INDEX: _____

PRESS <CR> TO CONTINUE

OR <ESC> TO CANCEL

Figure 7.12: Chemical database index form

If the indexing is effected, then the following screen illustrated in figure 7.13 appears.

```
=====CHEMICAL DATABASE INDEXING =====  
INDEXED ON FEED NAME, IF_NO AND COUNTRY  
  
10 RECORDS INDEXED  
  
1. DISPLAY RECORDS  
2. PRINT RECORDS  
3. SAVE RECORDS  
0. EXIT  
  
ENTER YOUR SELECTION _____
```

Figure 7.13: Chemical Indexing Output Form

For the display option, the records are displayed on the screen and can be browsed and marked for printing. For the print option, the output is sent to the printer. While for the save option, the user has to specify the path to save to and the file name.

7.2 IMPLEMENTATION PLAN

7.2.1 Testing

It is mandatory to test a prototype system before full implementation. This is done to evaluate the performance of the prototype in the real system's environment. In the case of FAIRS, the prototype will be tested at ILRI, Addis Ababa, to facilitate necessary amendments and modifications before implementation. The system testing will use the system's present electronic files which are in dBase III.

7.2.2 Training

Other than the demonstrations, both personnel and users require training at different levels to be able to operate and successfully interact with the system. It is intended that FAIRS personnel at ILRI, Addis Ababa, will be trained first followed by the ILRI users and finally the NARS users. The training will be conducted through ILRI'S Research Networks and seminars. The designer will conduct demonstrations at these meetings and provide documentation on the installation, data base establishment and system maintenance. For interested Institutions, this documentation may be distributed to them along with soft copies of the database.

7.2.3 Cost Benefit Evaluation

This aspect is not necessary for ILRI's situation since most of the required technology and personnel are already available. However, for the NARS and other users who might not be having the necessary technology it is required. Therefore, recommendations will be provided on the basis of the minimum systems requirements specified in Chapter Six.

7.2.4 Equipment Installation

Minimum equipment specifications required for FAIRS implementation are given in Chapter Six. The equipment requirement is often influenced by what the information technology local market offers, and in certain circumstances the users do not have a choice if the facilities are offered as aid to their institutions.

7.2.5 Conversion

There are several system conversion procedures. In the case of FAIRS, most of the conversion will involve data from the data files of the present system into the FAIRS. The most appropriate method applicable to FAIRS is the phased conversion and implementation. Initially this will need a lot of human hours, but after the establishment of the system, there will only be updating of the database and its maintenance.

The analysis and design of the proposed system has been discussed in detail in the previous chapter.

7.2.6 Standards and Codes

In the design stage use of standard codes have been suggested. The standard codes relevant for FAIRS are only the International Standard (ISO) for the country codes and the International Feed codes which is used for Feed Description, Provision of the International Feed Numbers (IF_NO), and Feed Class.

These standards provide a basic systems' format within which data can be exchanged, and systems collaboration facilitated. These elements provide unique entities for indexing and search purposes.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.0 INTRODUCTION

This chapter gives a summary of the assessment of the study, its limitations and constraints are in the conclusion. The recommendation section highlights the necessary action to alleviate the constraints on the exiting system with respect to the role of INFIC, the regional and national Agricultural research systems in the establishment of Feed Analysis Information Retrieval Systems.

8.1 CONCLUSION

One of the main obstacles to livestock production in sub-Saharan Africa, apart from disease, is that of inadequate and unbalanced feeding. The implications are that the animals in the region live on low nutritional planes, which definitely results to low production. This problem is mostly due to the fact that the available information on the feedstuffs are not readily available, and if available, are not in appropriate formats for the users.

Considerably, less is known about the chemical constituents of the foods and feeding stuffs in the region than in developed world. This is more particularly so because most of the information available in the form of research reports or handbooks, are only available to a few users. Information obtained from similar sources abroad can only serve as a guide to foods and feeding, since the interaction of climate, soil, nutrition, species, strains and other factors cannot bring appreciable differences between the chemical make up of the locally grown feeds and those grown in temperate climates.

The analysis of the study results have indicated that the feed information systems in the region are faced with the following constraints:

1. The systems are inefficient in terms of:

- . Accessibility and availability of information to the regional users identified in the previous chapters: Most of the records are mainly within the confines of research institutions and are not readily available to the general users, or users in institutions lacking laboratory capabilities;
- . Standardization of the system through use of international feed codes and standards recognized internationally;
- . The information content: The records that exist on the regional feeds mostly seem to be biased towards the needs of the researcher(s), or guarded by the mandate of the institutions within which the research work is conducted;
- . Inadequate description of feedstuffs;

- . Inefficient consideration and documentation of variations in quality of feed ingredients in relation to climate, soil type, stage of harvesting and type of processing;
- . Inefficient documentation of analytical methods used.

2. User requirements:

- . Most of the information available to the users are in documents, meaning that any updates has to wait for the next publications;
- . Due to isolation of the analysis and record keeping done at different institutions, there is duplication of efforts and limited resources.

In Sub-Saharan Africa feed analysis results have been put to various uses, in order to utilize this information more effectively, and efficiently, the following aspects merit consideration:

1. Recognition and full operation of a feed information retrieval system to meet the user needs.
2. Use of feed standards, to facilitate information exchange.
3. Increasing the use of software and hardware to increase the efficiency and effectiveness of the system.

It is evident from these discussions that there is an urgent need for a Feed Information Retrieval System, within which these problems could be addressed. Therefore, the

proposed Feed Analysis Information Retrieval System (FAIRS) prototype proposes the use of information technology facilities available at the regional and national institutions involved in animal research to perform the following functions:

- . To establish national and regional databases to handle feedstuffs composition information;
- . To utilize the micro-processing power and speed of computers to process and generate reports according to the users' needs;
- . To facilitate data input, updates and manipulation when there is need; and
- . To facilitate easy electronic information exchange with other feed information systems, under INFIC and at the regional level through the available information Networks.

To meet these objective, FAIRS has been designed to:

- . Include the missing information elements not considered in the ILRI's manual table, so as to wholly meet the needs of the users;
- . Use data models to facilitate data manipulation, searching and retrieval;
- . Design output formats; and
- . Design user interfaces.

There are still interim measures to be taken before full implementation of FAIRS as pointed out in the previous chapter.

8.2 RECOMMENDATIONS

The need for information on the indigenous animal feeds in the region is obvious, but the establishment of FAIRS can only solve the problems of a few individuals if the full support and collaboration is not received from the National Agricultural Centres in the region. It is therefore, important that the regional users are made aware of FAIRS and their assistance sought once the testing has been completed.

1. From the view point of inputs to FAIRS, it is recommended that local forages and feeds should be properly identified, with description of international feed codes/numbers, as per specifications in the International standards. Specifically, the documentation and characterization of the African feedstuffs should be done in relation to the recommendations of INFIC. This also presents a challenge to INFIC to play an active role as the unifying body advocating Feed Information Exchange and utilization to improve the global animal production levels. In addition, the following measures are to be taken for proper input of data to the system:

- . Use of codes;
- . Detailed characterization in terms of the INFIC standards on feed description;
- . Setting of Standards for analytical procedures to determine output standardization, data quality, and facilitate exchange.

2. In order to make optimum use of feed information, regional feed networks are to be formed.
3. The possibilities of developing an interface for FAIRS that can be used on both the local area network (LAN) or on the CGNET are to be explored.
4. The possibility of availing feed information as a read only database on the Internet should be considered, since a number of African countries are already connected.
5. The possibility of the development of a CD-ROM database of materials from the whole region may be considered.

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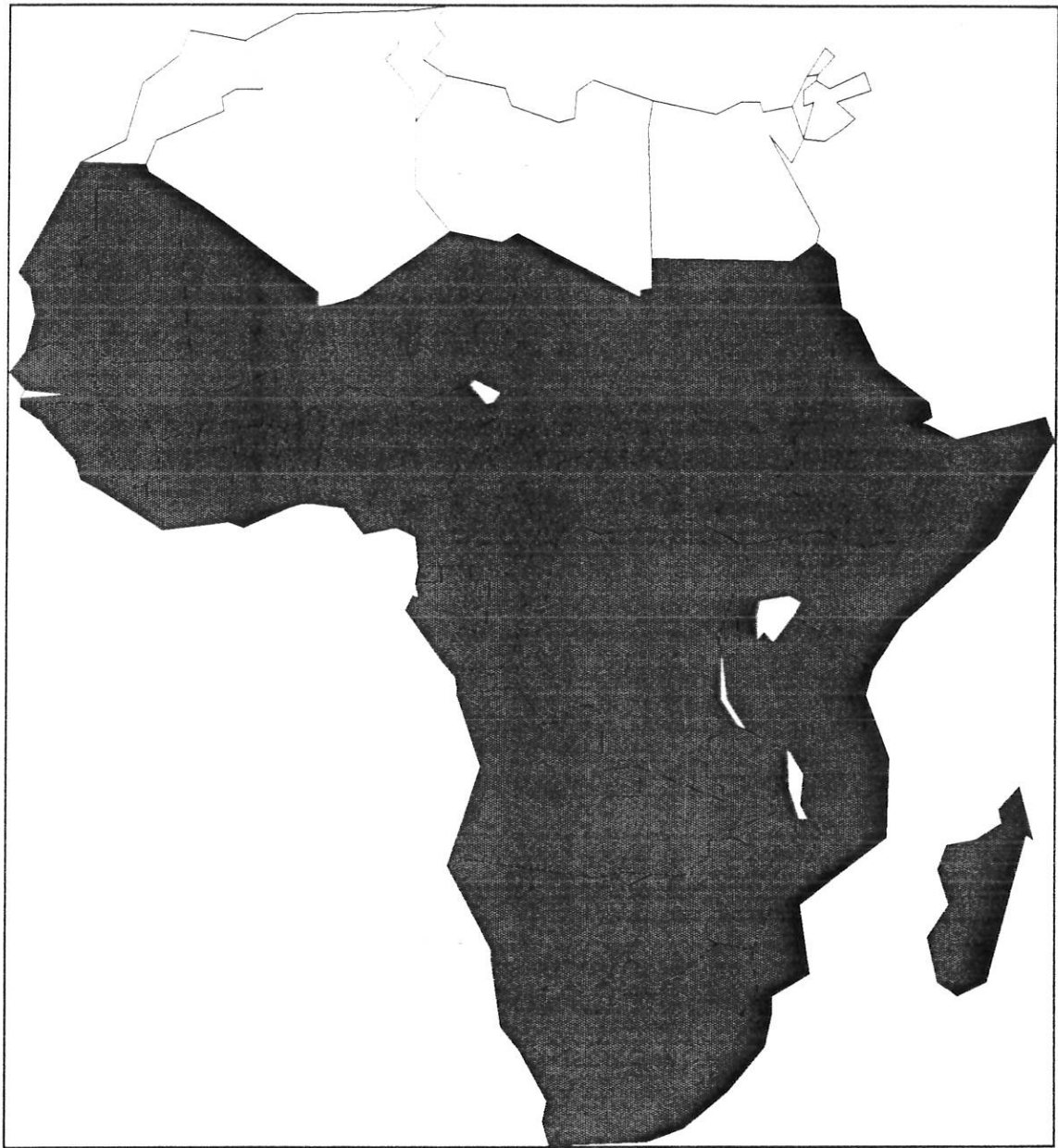
APPENDICES

APPENDIX A: SUB-SAHARAN AFRICAN COUNTRIES SURVEYED

Angola	Benin
Botswana	Burkina Faso
Burundi	Cameroun
Cape Verde	Central African Republic
Chad	Comoros
Congo	Cote d'Ivoire
Djibouti	Equatorial Guinea
Eritrea	Ethiopia
Gabon	Gambia
Ghana	Guinea
Guinea Bissau	Kenya
Lesotho	Liberia
Madagascar	Malawi
Mali	Mauritania
Mauritius	Mozambique
Namibia	Niger
Nigeria	Rwanda
Senegal	Seychelles

Siera Leone	Somalia
South Africa	Sudan
Swaziland	Tanzania
Togo	Uganda
Zaire	Zambia
Zimbabwe	

APPENDIX B: MAP OF SUB-SAHARAN AFRICA



APPENDIX C: QUESTIONNAIRE SAMPLE

QUESTIONNAIRE FOR THE SURVEY OF THE INFORMATION NEEDS OF NUTRITIONAL RESEARCHERS OF RUMINANT LIVESTOCK IN SUB-SAHARAN AFRICA.

The animal nutrition section of the International Livestock Research Institute - ILRI has compiled a lot of information from the laboratory analyses of Sub-saharan African ruminant feedstuffs over several years. This is a commendable effort. To improve the accessibility and availability of this information to the researchers and interested users, there is need to computerize the storage and retrieval of Information.

PURPOSE: The response to this questionnaire will be used to assess the information needs of the users (in research and related fields) in sub-saharan Africa, and to determine features which should be considered in the design of the database and information system which is important to users.

Your immediate response will be highly appreciated as the project is to be completed within a short period of time. Please take a few minutes of your time now and answer the following simple questions.

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PART I. USER REQUIREMENTS/NEEDS

1. Name: _____

2. Designation: _____

3. Area of specialization: _____

4. Qualification: _____

5. The following regional feed composition tables / standards are available to users. They provide information on feed names, location of collection, plant part (where applicable), chemical composition, mineral content, nutritive values e.t.c.

[1]. Document on the Chemical composition and nutritive values of feedstuffs for ruminant livestock in Sub-saharan Africa, compiled by ILCA in 1994 - not yet released: The subject of this questionnaire.

[2]. Arab and Middle East tables of feed composition.

[3]. The Canadian feed composition tables / standards.

[4]. The American feed composition tables / standards.

[5]. The Latin American feed composition tables / standards.

[6]. The Korean feed composition tables / standards.

[7]. The European feed composition tables / standards.

[8]. Feeding standards for Australian livestock ruminants.

a. Which of these feed composition tables are you aware of ?

☐ 1 ☐ 2 ☐ 3

☐ 4 ☐ 5 ☐ 6
☐ 7 ☐ 8

b. How frequently do you use these composition tables ?

1. At least once a month.
2. At least once every two to six months.
3. Once a year if at all.
4. Not At all.

c. Please fill in the table below. Rows correspond to the composition tables and columns refer to frequency of use.

Frequency

Standards/ Tables.	1. Atleast once a month.	2. At least once every two to six months.	3. Once a year if at all.	4. Not at all.
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

d. How do you rate the precision adequacy of information in the tables ?

1. 80 - 100%

2. 60 - 80%

4. 40 - 60%

6. 20 - 40%

7. Below 20%

e. Fill the following table only for rows corresponding to composition tables you have used.

Precision %

Standard /tables	1. 80-100	2. 60-80	3. 40-60	4. 20-40	5. Below 20
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

(ii) Which of these pieces of information would you consider useful in a feed composition database ?

[] 1. Information on the basic chemical composition: DM, ASH, ADF, NDF, CP, EE, e.t.c.

[] 2. Information on digestibility: IVDMD, DOMD, ME e.t.c.

d. How do you rate the precision adequacy of information in the tables ?

1. 80 - 100%

2. 60 - 80%

4. 40 - 60%

6. 20 - 40%

7. Below 20%

e. Fill the following table only for rows corresponding to composition tables you have used.

Precision %

Standard /tables	1. 80-100	2. 60-80	3. 40-60	4. 20-40	5. Below 20
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

(ii) Which of these pieces of information would you consider useful in a feed composition database ?

[] 1. Information on the basic chemical composition: DM, ASH, ADF, NDF, CP, EE, e.t.c.

[] 2. Information on digestibility: IVDMD, DOMD, ME e.t.c.

- ☐ 3. Mineral content: Na, Fe, K, Mg, Cu, e.t.c. expressed either as % or ppm.
- ☐ 4. Common names of feed e.g. Plant name.
- ☐ 5. Botanical name of the plant
- ☐ 6. Both botanical and common names.
- ☐ 7. Location from which a particular feedstuff was collected.
☐ Country ☐ Ecological zone ☐ Both
- ☐ 8. Characteristics of the feedstuffs e.g. Toxic chemicals and other anti nutritional factors which might limit the extent to which a particular feedstuff may be included in feeds for specific classes of livestock.
- ☐ 9. Feed description, which refers to the feed part analyzed and how the plant/feed was processed.
- ☐ 10. Others (specify) _____

7. Do you use information from the tables to generate reports?

Yes ☐ No ☐

If yes,

a. What type of reports?

☐ Research reports

☐ Management annual reports

☐ Manufacturer's feed assessment reports

☐ others (specify) _____

b. How frequent (approximately) do you produce such reports?

☐ Monthly

☐ Quarterly

☐ Annually

[] Others (specify) _____

8. Do you encounter any of the following constraints with regard to feed composition tables / standards?

[] The tables are not readily available.

[] If available, are in hard copies and are difficult to update.

[] Generation of reports from the tables is not easy.

[] They do not contain pertinent / relevant information for your purpose.

a. If a database management system is to be developed, give suggestions on how these problems can be overcome or what you would particularly like to see improved / added / included.

(1) _____

(2) _____

(3) _____

PART II:INSTITUTION/ORGANIZATION/AFFILIATION:

9. Name of institution: _____

10. Full mailing address: _____

Province / Region / District: _____

Country: _____

Telephone: _____ Fax: _____

Telex: _____ E-mail: _____

Cable: _____

11. Type of institution:

☐ Research Institution

☐ University or College

☐ Government ministry

☐ others (specify) _____

12. Nature of work:

☐ Agricultural research

☐ Academic/teaching

☐ Consultancy

☐ Extension services

☐ Commercial

☐ Others (specify) _____

13. Does your institution have computers? Yes ☐ No ☐

14. Do you personally have access to a computer (Including institutional computers if any)?

Yes ☐ No ☐

a. If the answer to question 13 is YES and NO to question 14, Who operates the computers?

☐ Research assistant

☐ Technician

☐ others (Specify) _____

b. If there are computers in your institution, for what purposes are they used?

☐ Word processing:

☐ Database management:

☐ Others (specify): _____

15. Are feed tables of any kind loaded on any of these computers?

Yes ☐ No ☐

a.If Yes, which ones (see question 5 for numeric codes)?

☐ 1 ☐ 2 ☐ 3 ☐ 4

☐ 5 ☐ 6 ☐ 7 ☐ 8

PART III. OTHER SOURCES OF INFORMATION

16. Do you use any other sources of feed composition / standards ?

Yes [] No []

a. If yes, specify by giving information about the sources - including full titles and institutions where additional information on them can be obtained.

- 1. _____
- 2. _____
- 3. _____
- 4. _____

17. Any other suggestions or Remarks?

Date: _____

APPENDIX D: DATA ELEMENTS DICTIONARY

The data elements dictionary provides the basis for the database schema. It contains all the data elements in the systems' forms and structures, except for the elements which have multiple occurrences which are only considered once. The data elements Name, Description, type and length are given. The dictionary describes all the data elements of FAIRS.

DATA ELEMENT NAME: Serial Number
DESCRIPTION: Unique number given in a sequential manner to the ILCA laboratory analysis request forms
TYPE: Numerics (Serial_No.[char*7])
LENGTH: - Seven characters
RANGE: 0001 - 9999
KEY: Primary key
COMMENTS: This field is used for the registration of the samples at the laboratory on reception

DATA ELEMENT NAME: Project / sample number
DESCRIPTION: Code for the project used for record keeping and costing
TYPE: Alpha-numeric (Samp_No[char*6])
LENGTH: Six characters
KEY: Primary key
COMMENTS: LAS database classifies the results output by project / sample number

DATA ELEMENT NAME: International Feed number
DESCRIPTION: This is the legal feed definition, for positive identification.
TYPE: Numeric
LENGTH: Six digits
KEY: Primary Key
COMMENTS: This code is often hyphenated (1-01-395 for trifolium pratense)

DATA ELEMENT NAME: Region
DESCRIPTION: Locality from which a sample is collected
TYPE: Alphabetic
LENGTH: Fifty characters
KEY: Primary key
COMMENTS: The LAS system uses this field for data categorization and storage

DATA ELEMENT NAME: Date of collection
DESCRIPTION: Refer to the date the sample is collected
TYPE: Date
LENGTH: Eight characters
RANGE: DD-MM-YY
COMMENTS: For samples whose quality depreciates with storage, this can be used as an indicator to variation in results e.t.c.

DATA ELEMENT NAME: Requester's Name
DESCRIPTION: Name of the individual or the research unit requesting for the analysis
TYPE: Alphabetic
LENGTH: Fifty characters
VALUE: Given
RANGE: A - Z
KEY: Secondary key
COMMENTS: This field can also be used for grouping analysis done for a particular researcher

DATA ELEMENT NAME: Country
DESCRIPTION: The national boundaries within which the sample is collected
TYPE: Alphabetic
LENGTH: Thirty characters
KEY: Primary key
COMMENTS: This is used by LAS system to systematize and document the analysis requests and results

DATA ELEMENT NAME: Altitude
DESCRIPTION: Height above sea level of the region from which the sample is collected
TYPE: Alpha-numeric
LENGTH: Six characters
RANGE: Alpha-numeric
KEY: Secondary key
COMMENTS: Can be used to group plant origin feedstuffs from particular altitude range

DATA ELEMENT NAME: Soil / Field Classification
DESCRIPTION: Type of soil from which the feedstuff was grown or collected/grown
TYPE: Alphabetic
LENGTH: Twenty characters
COMMENTS: This can be used to evaluate the feedstuffs difference in relation to soil type, and a particular species

DATA ELEMENT NAME: Surface texture
DESCRIPTION: The texture of the sample
TYPE: Alphabetic
LENGTH: Ten characters
COMMENTS: This is the texture of the sample when sent for analysis. It is defined as sand, loam or clay

DATA ELEMENT NAME: Dry Forage
DESCRIPTION: Refers to the nature of the forage sent in for analysis
TYPE: Alphabetic
LENGTH: Ten characters
COMMENTS: Used for the description of forage form when sent for analysis

DATA ELEMENT NAME: Genus / Species variety
DESCRIPTION: This is the scientific class of the feed sent in for analysis
TYPE: Alphabetic
LENGTH: Fifty characters
KEY: Secondary key
COMMENTS: This determines the objective of the analysis

DATA ELEMENT NAME: Grazed/Browsed
DESCRIPTION: Refers to the use of the sample sent for analysis
TYPE: Alphabetic
LENGTH: Fifty characters
COMMENT: This is used to specify how the feedstuff is used, and the climatic area of collection

DATA ELEMENT NAME: Plant part
DESCRIPTION: Refers to plant part of the sample, it is an important factor in feed description
TYPE: Alphabetic
LENGTH: Twenty characters
KEY: Secondary key
COMMENT: This can be used as an indicator to variation in analysis results

DATA ELEMENT NAME: Maturity stage
DESCRIPTION: Refers to the stage of growth of the feedstuff. It is an important factor influencing the nutritive value of forages, silage and some animals
TYPE: Alphabetic
LENGTH: Twenty characters
COMMENTS: This is useful for the determination of when a feedstuff is most nutritive

DATA ELEMENT NAME: Type of sample
DESCRIPTION: Refers to the class of the sample, for instance legume, animal and grass
TYPE: Alphabetic
LENGTH: Thirty characters
COMMENTS: This is useful for the laboratory since some samples should be analyzed within a particular period after collection

DATA ELEMENT NAME: Animal species
DESCRIPTION: Refers to the scientific class of the animal
TYPE: Alphabetic
LENGTH: Ten characters
KEY: Primary key
COMMENTS: This is the object for the analysis

DATA ELEMENT NAME: Further information
DESCRIPTION: Additional information required or about the sample
TYPE: Alpha-numeric
LENGTH: One hundred characters
COMMENTS: May contain opinions or further information on the sample or analysis

DATA ELEMENT NAME: Dry Matter as Fed (DMF) %
DESCRIPTION: The amount of dry matter as is given to the animals
TYPE: Numeric
LENGTH: Six characters
RANGE: 0001 - 9999

COMMENTS: This is the dry state of a feedstuff

DATA ELEMENT NAME: Dry Matter (DETN.) %
DESCRIPTION: This is the feedstuff chemical composition with respect to Dry Matter percentage
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Ash %
DESCRIPTION: This is the feedstuff chemical composition in ash percentage
TYPE: Numeric
LENGTH: Four characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Ether Extract (EE) %
DESCRIPTION: This is the crude fat percentage (%)
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Nitrogen (N)
DESCRIPTION: This is the total nitrogenous elements of a feedstuff
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Crude Protein (CP) %
DESCRIPTION: The value of this field depends on the nitrogen content of a feedstuff
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived (Nitrogen x 6.25)
RANGE: 0001 - 9999

DATA ELEMENT NAME: Organic Matter %
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Neutral Detergent Fibre %
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Cellulose %
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999
COMMENTS: This is the chemical composition percentage of elements forming the plant cell wall

DATA ELEMENT NAME: Hemicellulose %

DESCRIPTION: This is the chemical composition percentage of elements forming the plant cell wall, but of a less complex composition, in that it is readily broken down into simple sugars

TYPE: Numeric

LENGTH: Six characters

VALUE: Derived

RANGE: 0001 - 9999

DATA ELEMENT NAME: Acid Detergent Fibre (ADF) %

TYPE: Numeric

LENGTH: Six characters

VALUE: Derived

RANGE: 0001 - 9999

DATA ELEMENT NAME: Lignin %

DESCRIPTION: This is the woody percentage of the feedstuff, at times, it is an indicator of indigestible portion of the feed

TYPE: Numeric

LENGTH: Six characters

VALUE: Derived

RANGE: 0001 - 9999

DATA ELEMENT NAME: ADFN %

TYPE: Numeric

LENGTH: Six characters

VALUE: Derived

RANGE: 0001 - 9999

DATA ELEMENT NAME: Tannin %

DESCRIPTION: This is one of the inhibiting factors in feedstuffs

TYPE: Numeric

LENGTH: Six characters

VALUE: Derived

RANGE: 0001 - 9999

DATA ELEMENT NAME: Silica %
DESCRIPTION: This is one of the inhibiting factors in feedstuffs
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Cr2 O3 (Chromium)%
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Calcium (Ca)%
DESCRIPTION: This is one of the major mineral requirements in livestock feedstuffs
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Phosphorus (P)%
DESCRIPTION: This is one of the major mineral requirements in livestock feedstuffs
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Iron (Fe)ppm
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Magnesium (Mg) %
DESCRIPTION: This is an important element for lactating animals
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Sodium (Na)ppm
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Potassium (K) %
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Sulphur (S) %
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Cobalt (Co) %
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Copper (Cu) ppm
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Manganese (Mn) ppm
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Molybdenum (Mo) ppm
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Selenium (Se) ppm
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Zinc (Zn) ppm
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: DMS %
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Others
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Laboratory number
DESCRIPTION: This is a registration number given when the sample is received, it for the laboratory where the sample is to be analyzed
TYPE: Numeric
LENGTH: Six characters
VALUE: Given
RANGE: 0001 - 9999

DATA ELEMENT NAME: Species of experimental animal used
DESCRIPTION: This field is important for *in vivo materials/ experiments*
TYPE: Alphabetic
LENGTH: Twenty characters

DATA ELEMENT NAME: Mean annual rainfall
DESCRIPTION: This is one of the climatic indicators which affect feedstuffs of plant origin
TYPE: Alpha-numeric
LENGTH: Twenty characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Date sample is received
TYPE: Date
LENGTH: Eight characters
VALUE: Given
RANGE: DD-MM-YY

DATA ELEMENT NAME: Entry number
DESCRIPTION: This is assigned in an alphabetical order of the feedstuff names
TYPE: Numeric
LENGTH: Eight characters
RANGE: 0001 - 9999

DATA ELEMENT NAME: Laboratory number
DESCRIPTION: This is a registration number given when the sample is received, it for the laboratory where the sample is to be analyzed
TYPE: Numeric
LENGTH: Six characters
VALUE: Given
RANGE: 0001 - 9999

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DESCRIPTION: This is one of the climatic indicators which affect feedstuffs of plant origin
TYPE: Alpha-numeric
LENGTH: Twenty characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Date sample is received
TYPE: Date
LENGTH: Eight characters
VALUE: Given
RANGE: DD-MM-YY

DATA ELEMENT NAME: Entry number
DESCRIPTION: This is assigned in an alphabetical order of the feedstuff names
TYPE: Numeric
LENGTH: Eight characters
RANGE: 0001 - 9999

DATA ELEMENT NAME: International Feed Description

DESCRIPTION: International feed description is coined using descriptors from one or more of the six facets (Feed origin, part, processes and treatments, Stage of maturity, cutting, and grade)

TYPE: Alphabetic

LENGTH: One hundred characters

VALUE: Derived

DATA ELEMENT NAME: Feed number

DESCRIPTION: This is the number of times analysis has been carried out on a particular feedstuff

TYPE: Numeric

LENGTH: Four characters

VALUE: Given

RANGE: 0001 - 9999

DATA ELEMENT NAME: Metabolizable Energy (ME)

DESCRIPTION: This is the food intake gross energy, minus faecal energy, minus energy in the gaseous products of digestion, minus urinary energy

TYPE: Numeric

LENGTH: Six characters

VALUE: Derived

RANGE: 0001 - 999999

DATA ELEMENT NAME: Digestible organic matter in the dry matter (DOMD)

DESCRIPTION: Calculated value ($\text{DOMD}\% = 0.17\text{DMD}\% - 2.00$). This value is used to calculate the metabolizable energy, DMD, and OMD. The digestibility value of feeds is the most important index of nutritive value available.

TYPE: Numeric

LENGTH: Six characters

VALUE: Derived

RANGE: 0001 - 9999

DATA ELEMENT NAME: In vitro dry matter digestibility (IVDMD)
TYPE: Numeric
LENGTH: Six characters
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Preferred term
DESCRIPTION: This is used to describe the international stages of maturity terms for plants
TYPE: Alphabetic
LENGTH: One hundred characters

DATA ELEMENT NAME: Definition
DESCRIPTION: This is the definition of the preferred term
TYPE: Alphabetic
LENGTH: One hundred characters
VALUE: Derived

DATA ELEMENT NAME: Comparable term
DESCRIPTION: This is a synonym of the preferred term
TYPE: Alphabetic
LENGTH: One hundred characters
VALUE: Given

DATA ELEMENT NAME: Material
DESCRIPTION: This is the description of the feedstuff analyzed, in terms of the common name and the scientific name
TYPE: Alphabetic
LENGTH: One hundred characters
VALUE: Derived

DATA ELEMENT NAME: Factor
DESCRIPTION: This is the anti-nutritional element in a feedstuff
TYPE: Alphabetic
LENGTH: Fifty characters
VALUE: Derived
RANGE: A - Z

DATA ELEMENT NAME: Chemical and physical nature
DESCRIPTION: This is the nature of the limiting factor of the feedstuff
TYPE: Alpha-numeric
LENGTH: One hundred characters
VALUE: Derived
RANGE: Alpha-numeric

DATA ELEMENT NAME: Effect on animals
DESCRIPTION: This is the effect of the anti-nutritional element on animals when fed
TYPE: Alphabetic
LENGTH: One hundred
VALUE: Real
RANGE: A - Z

DATA ELEMENT NAME: Processing and treatment before feeding
DESCRIPTION: This is the treatment on the feedstuff material so that it can be utilized in animal feeding
TYPE: Alphabetic
LENGTH: One hundred characters
VALUE: Real

DATA ELEMENT NAME: Ruminant's feed inclusion levels
DESCRIPTION: This is the inclusion amount of particular feedstuffs to different ruminant groups
TYPE: Numeric
LENGTH: Six character
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Feed classes used
DESCRIPTION: This is the feed classes used, they belong to the following groups (Cereals and cereal by-products, roots and tubers, leguminous seeds, vegetable oil and extraction residues, animal by-products, miscellaneous materials, and additives and supplements
TYPE: Alphabetic
LENGTH: One hundred characters
VALUE: Derived

DATA ELEMENT NAME: Net Energy (NE Mcal/kg or kcal/kg)
DESCRIPTION: This is a calculated value, and have NE_g and NE_m as synonyms. This element is dependent on Total Digestible Nutrients
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
DOMAIN: 0001 - 9999

DATA ELEMENT NAME: Digestible Energy (DE Kcal/kg or Mcal/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Total Digestible Nutrients (TDN) %
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Digestible Protein (DP) %
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Chlorine (ppm)
DESCRIPTION: This one of the minor minerals
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Fluorine (ppm)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Iodine (ppm)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Provitamin A (Mg/kg)^a
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Vitamin D₂(ICU/kg)^a
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Vitamin D₃ (ICU/kg)^a
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Vitamin B₁₂ (mg/kg)^a
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Biotin(Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Choline (Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Folic Acid(Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Pantothenic(Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Niacin (Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Pyridoxine(Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Riboflavin(Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Thiamin(Mg/kg)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Arginine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Cystine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Glycine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Histidine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Lsoleucine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
DOMAIN: 0001 - 9999

DATA ELEMENT NAME: Leucine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Lysine(%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Methionine(%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Phenylalanine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Serine(%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Threonine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Tryptophan (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Valine (%)
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

APPENDIX E: PROGRAMME SOURCE CODE

```

-----
* Program.....: C:FAIRS.
* Author.....: RACHEL ATIENO REGE.
* Date.....: 5-13-96
* dBASE Ver.....: APPLICATION
* Description...: MASTER 2 is a programme for the FAIRS FEED SYSTEM.
* Notes.....:
-----

SET SAFETY OFF
CLEAR
DBNAME=SPACE(10)
FNAME=SPACE(10)
RNAME=SPACE(10)
DO WELCOME
DO TITLE
DO MAIN_DEF
ACTIVATE POPUP MAIN_MNU

PROCEDURE Welcome
CLEAR
SET SCOREBOARD OFF
SET STATUS OFF
SET TALK OFF
@3.5 TO 16.70 DOUBLE COLOR G/BG
@5.10 SAY "WELCOME TO FEED ANALYSIS INFORMATION RETRIEVAL SYSTEM" COLOR R/B+
@6.30 SAY "FAIRS" COLOR RB/B+
@10.15 SAY "SCHOOL OF INFORMATION STUDIES FOR AFRICA"
@11.15 SAY " SISA. ADDIS ABABA UNIVERSITY "
@13.15 SAY " DEVELOPED BY "
@14.15 SAY " RACHEL ATIENO REGE"
@15.15 SAY " JUNE 1996"
?
?
WAIT
RETURN

PROCEDURE Title
CLEAR
SET TALK OFF
@3.18 TO 7.62 DOUBLE
@4.19 SAY "FEED ANALYSIS INFORMATION RETRIEVAL SYSTEM"
@5.32 SAY "dBASE IV FEEDS SYSTEM"
?
?

PROCEDURE Main_def
*Defines the main popup MENU. main_mnu
mesg = "Press first letter of Menu choice, or highlight and Press <Enter>"
DEFINE POPUP main_mnu FROM 9.20 TO 18.60 MESSAGE mesg
    DEFINE BAR 1 OF main_mnu PROMPT " =====MAIN MENU =====SKIP"
    DEFINE BAR 2 OF main_mnu PROMPT " DATA ENTRY" MESSAGE "Add, Edit, or Delete Data from a Database File"
    DEFINE BAR 3 OF main_mnu PROMPT " SEARCH REQUEST" MESSAGE "Search a selected Database"
    DEFINE BAR 4 OF main_mnu PROMPT " REPORTS GENERATION" MESSAGE "Generate report from selected database"
    DEFINE BAR 5 OF main_mnu PROMPT " FILE RE-ORGANIZATION" MESSAGE "Re-organization of Database"
    DEFINE BAR 6 OF main_mnu PROMPT " DATABASE STATUS REQUEST" MESSAGE "Report on Database Status"
    DEFINE BAR 7 OF main_mnu PROMPT " EXIT to dot PROMPT" MESSAGE "Exit program to dBase"
    * Defines the popup database option for selection of Database
    DEFINE POPUP dbop_mnu FROM 3.18 TO 23.63 MESSAGE mesg
    DEFINE BAR 1 OF dbop_mnu PROMPT " =====DATABASE OPTIONS =====SKIP"
    DEFINE BAR 2 OF dbop_mnu PROMPT " DATABASES" SKIP
    DEFINE BAR 3 OF dbop_mnu PROMPT " IDENTIFICATION DATA" MESSAGE "Identification Database File"
    DEFINE BAR 4 OF dbop_mnu PROMPT " CHEMICAL COMPOSITION" MESSAGE "Chemical composition Database File"
    DEFINE BAR 5 OF dbop_mnu PROMPT " NUTRITIVE VALUES " MESSAGE "Nutritive Values Database File"
    DEFINE BAR 6 OF dbop_mnu PROMPT " MINERAL COMPOSITION " MESSAGE "Mineral Composition Database File"
    DEFINE BAR 7 OF dbop_mnu PROMPT " AMINO ACID COMPOSITION" MESSAGE "Amino Acid composition Database File"
    DEFINE BAR 8 OF dbop_mnu PROMPT " VITAMIN COMPOSITION " MESSAGE "Vitamin Composition Database File"
    DEFINE BAR 9 OF dbop_mnu PROMPT " ANTI-NUTRITIONAL FACTORS " MESSAGE "Anti-nutritional Factors Database File"
    DEFINE BAR 10 OF dbop_mnu PROMPT " RECOMMENDATION ON MAXIMUM LIMITS" MESSAGE "Recommendations on Maximum feeding Limits of
        a feedstuff"
    DEFINE BAR 11 OF dbop_mnu PROMPT " MATURITY " MESSAGE "Maturity stages of feedstuffs"

```

```

DEFINE BAR 12 OF dbop_mnu PROMPT *   EXIT TO MAIN MENU * MESSAGE "Exit to Main Menu"
* Defines the popup database search menu for search selection
DEFINE POPUP dbSR_mnu FROM 3,18 TO 23,63 MESSAGE msg
DEFINE BAR 1 OF dbSR_mnu PROMPT *==== SEARCHING ON ....====*SKIP
DEFINE BAR 2 OF dbSR_mnu PROMPT *   DATABASES* SKIP
DEFINE BAR 3 OF dbSR_mnu PROMPT *   IDENTIFICATION DATA* MESSAGE "Identification Database File"
DEFINE BAR 4 OF dbSR_mnu PROMPT *   CHEMICAL COMPOSITION* MESSAGE "Chemical composition Database File"
DEFINE BAR 5 OF dbSR_mnu PROMPT *   NUTRITIVE VALUES * MESSAGE "Nutritive Values Database File"
DEFINE BAR 6 OF dbSR_mnu PROMPT *   MINERAL COMPOSITION* MESSAGE "Mineral Composition Database File"
DEFINE BAR 7 OF dbSR_mnu PROMPT *   AMINO ACID COMPOSITION* MESSAGE "Amino Acid composition Database File"
DEFINE BAR 8 OF dbSR_mnu PROMPT *   VITAMIN COMPOSITION * MESSAGE "Vitamin Composition Database File"
DEFINE BAR 9 OF dbSR_mnu PROMPT *   ANTI-NUTRITIONAL FACTORS * MESSAGE "Anti-nutritional Factors Database File"
DEFINE BAR 10 OF dbSR_mnu PROMPT *   RECOMMENDATION ON MAXIMUM LIMITS* MESSAGE "Recommendations on Maximum feeding Limits of
a feedstuff"
DEFINE BAR 11 OF dbSR_mnu PROMPT *   MATURITY * MESSAGE "Maturity stages of feedstuffs"
DEFINE BAR 12 OF dbSR_mnu PROMPT *   EXIT TO MAIN MENU * MESSAGE "Exit Database Menu"
* defines the popup data entry menu
DEFINE POPUP dent_mnu FROM 2,48 TO 22,78 MESSAGE msg
DEFINE BAR 1 OF dent_mnu PROMPT *====DATA ENTRY====*SKIP
DEFINE BAR 2 OF dent_mnu PROMPT *   ADD NEW DATA * MESSAGE "Add records to database"
DEFINE BAR 3 OF dent_mnu PROMPT *   EDIT DATA* MESSAGE "Edit records in Database"
DEFINE BAR 4 OF dent_mnu PROMPT *   DELETE DATA* MESSAGE "Delete record from Database"
DEFINE BAR 5 OF dent_mnu PROMPT *   EXIT TO DATABASE OPTION MENU* MESSAGE "Exit to Database Menu"
* Defines the popup search menu option
DEFINE POPUP srch_mnu FROM 5,22 TO 18,62 MESSAGE msg
DEFINE BAR 1 OF srch_mnu PROMPT *=====SEARCH REQUEST=====*SKIP
DEFINE BAR 2 OF srch_mnu PROMPT *SELECT YOUR SEARCH KEY* SKIP
DEFINE BAR 3 OF srch_mnu PROMPT *INTERNATIONAL FEED NUMBER (IF_NO)* MESSAGE "Enter IF_NO as search key"
DEFINE BAR 4 OF srch_mnu PROMPT *FEED NAME* MESSAGE "Enter Feed Name as search key"
DEFINE BAR 5 OF srch_mnu PROMPT *COUNTRY NAME* MESSAGE "Enter Country Name as a search key"
DEFINE BAR 6 OF srch_mnu PROMPT *EXIT TO MAIN MENU* MESSAGE "Exit to Main Menu"
* Defines the popup report menu for output report
DEFINE POPUP rpt_mnu FROM 5,5 TO 17,42 MESSAGE msg
DEFINE BAR 1 OF rpt_mnu PROMPT *=====REPORTS=====*SKIP
DEFINE BAR 2 OF rpt_mnu PROMPT *Database Report: * MESSAGE "Select Database to report on"
DEFINE BAR 3 OF rpt_mnu PROMPT *Status Report: * MESSAGE "Reports on status from any Database"
DEFINE BAR 4 OF rpt_mnu PROMPT *Exit to MAIN MENU* MESSAGE "EXIT reports menu"
* Defines the popup destination menu for output destination
DEFINE POPUP dtn_mnu FROM 10,14 TO 20,58 MESSAGE msg
DEFINE BAR 1 OF dtn_mnu PROMPT *=====OUTPUT DESTINATION=====*SKIP
DEFINE BAR 2 OF dtn_mnu PROMPT *Printer * MESSAGE "Select to print output"
DEFINE BAR 3 OF dtn_mnu PROMPT *File * MESSAGE "Select to save output to Disk"
DEFINE BAR 4 OF dtn_mnu PROMPT *Screen * MESSAGE "Select to view output on screen"
DEFINE BAR 5 OF dtn_mnu PROMPT *Exit * MESSAGE "Exit output option to MAIN MENU"
* Defines which procedures are executed by the defined popups
ON SELECTION POPUP main_mnu DO ACTION
ON SELECTION POPUP dbop_mnu DO ENTRY
ON SELECTION POPUP dent_mnu DO DENT
ON SELECTION POPUP DBSR_MNU DO SEARCH
ON SELECTION POPUP srch_mnu DO srch
ON SELECTION POPUP rpt_mnu DO RPT
ON SELECTION POPUP dtn_mnu DO dtn
RETURN

PROCEDURE ENTRY
DO DBSELECT
ACTIVATE POPUP DENT_MNU
RETURN

PROCEDURE Action
CLEAR
DO CASE
CASE BAR () = 1          && Title
CASE BAR () = 2          && Data Entry
ACTIVATE POPUP DBOP_MNU
CASE BAR () = 3          && Search Request
ACTIVATE POPUP DBSR_MNU
CMN_NAME = SPACE(20)
IF_NO = SPACE(8)
SCT_NAME = SPACE(50)
COUNTRY = SPACE(30)
COUNTRY_CD = SPACE(4)
IF CMN_NAME = "Common Name"
IF_NO = "International Feed No."
SCT_NAME = "Scientific Name"
COUNTRY = "Country"
COUNTRY_CD = "COUNTRY CODE"

```

```

DO CASE
CASE SRCH .AND. EOF()
SET FILTER TO
SRCH = .F.
LIST
READ
ENDCASE
ENDIF
CASE BAR () = 4          && Reports Generation
DO DBSELECT
ACTIVATE POPUP RPT_mnu
CASE BAR () = 5          && File Re-organization
DO DBSELECT
ACTIVATE POPUP dbop_mnu
CASE BAR () = 6          && Database status
DO DBSELECT
ACTIVATE POPUP rpt_mnu
CASE BAR () = 7          && EXIT MAIN MENU
DEACTIVATE POPUP
CLOSE ALL
RETURN
ENDCASE
RETURN

PROCEDURE dent
DO CASE
CASE BAR () = 1          && Title
CASE BAR () = 2          && Add New Data to the Database
CLOSE ALL
USE &DBNAME
SET FORMAT TO &FNAME
APPEND BLANK
EDIT NEXT 1
SET FORMAT TO
CASE BAR () = 3          && Edit Data in a database
USE &DBNAME
SET FORMAT TO &FNAME
EDIT +1
SET FORMAT TO
CASE BAR () = 4          && Delete Data in a record
USE &DBNAME
SET FORMAT TO &FNAME
IF ANSWER = ""
DELETE
SKIP
ERASE =&DBNAME
ENDIF
RETURN
SET FORMAT TO
CASE BAR () = 5          && Exit to main menu
DEACTIVATE POPUP
RELEASE ALL
CLOSE ALL
RETURN
ENDCASE
RETURN

PROCEDURE SEARCH
DO DBSELECT
ACTIVATE POPUP SRCH_mnu
RETURN

PROCEDURE srch
CLEAR
MCMN_NAME = SPACE(20)
MIF_NO = SPACE(8)
MSCT_NAME = SPACE(50)
MCOUNTRY = SPACE(30)
MCOUNTRY_CD = SPACE(4)
STERM=SPACE(20)
FTAG=SPACE(10)
CLEAR
@ 5.8 TO 20.68
DO CASE
CASE BAR () = 3
@ 10.10 SAY "International Feed No ?" GET MIF_NO
READ

```

```

DO CASE
CASE SRCH .AND. EOF()
SET FILTER TO
SRCH = .F.
LIST
READ
ENDCASE
ENDIF
CASE BAR () = 4          && Reports Generation
DO DBSELECT
ACTIVATE POPUP RPT_mnu
CASE BAR () = 5          && File Re-organization
DO DBSELECT
ACTIVATE POPUP dbop_mnu
CASE BAR () = 6          && Database status
DO DBSELECT
ACTIVATE POPUP rpt_mnu
CASE BAR () = 7          && EXIT MAIN MENU
DEACTIVATE POPUP
CLOSE ALL
RETURN
ENDCASE
RETURN

PROCEDURE dent
DO CASE
CASE BAR () = 1          && Title
CASE BAR () = 2          && Add New Data to the Database
CLOSE ALL
USE &DBNAME
SET FORMAT TO &FNAME
APPEND BLANK
EDIT NEXT 1
SET FORMAT TO
CASE BAR () = 3          && Edit Data in a database
USE &DBNAME
SET FORMAT TO &FNAME
EDIT +1
SET FORMAT TO
CASE BAR () = 4          && Delete Data in a record
USE &DBNAME
SET FORMAT TO &FNAME
IF ANSWER = ""
DELETE
SKIP
ERASE =&DBNAME
ENDIF
RETURN
SET FORMAT TO
CASE BAR () = 5          && Exit to main menu
DEACTIVATE POPUP
RELEASE ALL
CLOSE ALL
RETURN
ENDCASE
RETURN

PROCEDURE SEARCH
DO DBSELECT
ACTIVATE POPUP SRCH_mnu
RETURN

PROCEDURE srch
CLEAR
MCMN_NAME = SPACE(20)
MIF_NO = SPACE(8)
MSCT_NAME = SPACE(50)
MCOUNTRY = SPACE(30)
MCOUNTRY_CD = SPACE(4)
STERM=SPACE(20)
FTAG=SPACE(10)
CLEAR
@ 5,8 TO 20,68
DO CASE
CASE BAR () = 3
@ 10,10 SAY "International Feed No ?" GET MIF_NO
READ

```

```

        STERM=TRIM(MIF_NO)
        FTAG='IF_NO'
CASE BAR () = 4
    @ 12.10 SAY "Feed Name ?" GET Mcmn_name function "!"
    READ
    STERM=TRIM(MCMN_NAME)
    FTAG='CMN_NAME'
CASE BAR () = 5
    @ 14.10 SAY "Country Name ?" GET Mcountry function "!"
    READ
    STERM=TRIM(MCOUNTRY)
    FTAG='COUNTRY'
CASE BAR () = 6
    RELEASE ALL
    DEACTIVATE POPUP
    RETURN
ENDCASE

if ** < > sterm
SELECT 1
USE FEED1 ORDER &FTAG
GO TOP
SEEK(STERM) &&CMN_NAME
IF .NOT. FOUND() &&.AND. EOF()
    CLEAR
    @8.8 TO 13.68 COLOR G/R
    @ 10.9 SAY "CAN'T FIND THAT. CHECK SPELLING OR SEQUENCE OF CHARACTERS."
    @11.15 SAY "PRESS ANY KEY TO GO TO SEARCH MENU"
    READ
    CLOSE DATABASE
    DEACTIVATE POPUP
    RETURN
ENDIF
IF FOUND() .AND. DBNAME < > "FEED1"
    SELECT 2
    USE &DBNAME &&ORDER &FTAG
    SET RELATION TO FTAG INTO A
    ACTIVATE POPUP DTN_MNU
ENDIF
IF DBNAME="FEED1"
    ACTIVATE POPUP DTN_MNU
ENDIF
RELEASE ALL
endif

CLOSE ALL
RETURN

PROCEDURE DBSELECT
DO CASE
CASE BAR () = 3
    DBNAME = "FEED1"
    FNAME = "FEED1"
    RNAME = "FEED1"
CASE BAR () = 4
    DBNAME = "CHEMCOMP"
    FNAME = "CHEMICAL"
    RNAME = "CHEMICAL"
CASE BAR () = 5
    DBNAME = "NUTCOMP"
    FNAME = "NUTRITN"
    RNAME = "NUTRITN"
CASE BAR () = 6
    DBNAME = "MINCOMP"
    FNAME = "MINERAL"
    RNAME = "MINERAL"
CASE BAR () = 7
    DBNAME = "AMINOCOM"
    FNAME = "AMINO"
    RNAME = "AMINO"
CASE BAR () = 8
    DBNAME = "VITCOMP"
    FNAME = "VITAMIN"
    RNAME = "VITAMIN"
CASE BAR () = 9
    DBNAME = "ANTINUTC"
    FNAME = "ANTI_NUT"

```

```

RNAME = "ANTINUTN"
CASE BAR () = 10
  DBNAME = "FED_LIMT"
  FNAME = "FED_LIMT"
  RNAME = "FEDLIMIT"
CASE BAR () = 11
  DBNAME = "MATURITY"
  FNAME = "MATURITY"
  RNAME = "MATURITY"
CASE BAR () = 12
  DEACTIVATE POPUP
  RELEASE ALL
  RETURN
ENDCASE
RETURN

PROCEDURE rpt
Recordno = RECNO ()
CLEAR
DO CASE
CASE BAR () = 1          && Title
CASE BAR () = 2          && Database Report
  USE &DBNAME
  REPORT FORM &RNAME
  DEACTIVATE POPUP
  ACTIVATE POPUP dtn_mnu
CASE BAR () = 3          && Status Report
  USE &DBNAME
  @ 10,10 SAY "Record #" + STR(RECNO(),5,0)
  REPORT FORM &RNAME
  DEACTIVATE POPUP
  ACTIVATE POPUP dtn_mnu
CASE BAR () = 4          && Exit Menu
  DEACTIVATE POPUP
  RETURN
ENDCASE
RETURN
PROCEDURE dtn
CLEAR
DO CASE
CASE BAR () = 1          && Title
CASE BAR () = 2          && Print
  SET DEVICE TO PRINTER
  REPORT FORM &RNAME
  WAIT
CASE BAR () = 3          && File
  OUTF=SPACE(8)
  @18.5 SAY "ENTER FILE NAME: " GET OUTF
  READ
  REPORT FORM &RNAME TO &OUTF
  WAIT
CASE BAR () = 4          && Screen
  REPORT FORM &RNAME
  WAIT
CASE BAR () = 5          && Exit Menu
  DEACTIVATE POPUP
  RELEASE ALL
  CLOSE ALL
  RETURN
ENDCASE
CLEAR
RETURN

```

DECLARATION

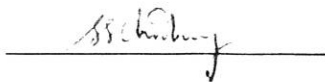
The thesis is my original work and has not been presented for a degree in any other university.



Rachel Atieno Rege

June 7, 1996.

The thesis has been submitted for examination with our approval as university advisors.



Dr. G.G. Chowdhury

June 7, 1996.



Ato. Nega Alemayehu

June 7, 1996