ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

THE LIVELIHOOD OF THE FOREST DEPENDENT POPULATIONS: A CASE STUDY OF THE WOMEN FUELWOOD CARRIERS IN WOREDA 1 OF THE GULELE SUBCITY IN NORTHERN ADDIS ABABA

BY

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To

ADVISOR: FEYERA SENBETA (Ph.D.)

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Title

The Livelihood of the Forest Dependent Populations: A Case Study of the Women FuelWood Carriers in Woreda 1 of the Gulele Sub City in Northern Addis Ababa.

By

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DEVELOPMENT STUDIES

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Abstract

The present study is aimed at assessing the living conditions and the socioeconomic situation of Women Fuelwood Carriers and their interaction with the forest resources, and the effect on the forest as well, due to fuelwood harvesting, as a result of the great demand for energy supply. The cumulative effect of the illegal activity carried out by the WFCs on the reserved forest, as the major or sole means of their livelihood, has further repercussions. It contributes to increase depletion of the plantations, destroys the sustainable supply of fuelwood and ultimately puts at stake, not only the very survival of WFCs themselves, but also the household energy needs of end-users at large. Without education or training, or other way of supporting themselves and their families, these women subsist on fuelwood carrying and trading, as their primary source of income, at a considerable cost both to their own health and personal safety, and to the sound management of the forest resources. The general objective of the research is to assess the livelihood conditions of the women fuelwood carriers in northern Addis Ababa as well as their activities within the forest, in order to determine ways and means to make it sustainable and environmentally friendly. To do so, the researcher had to employ both quantitative and qualitative research methods to gather the necessary data for conducting the study. These included descriptive surveys using structured questionnaires, semi-structured interviews and FGDs with informants by employing interview guidelines and/or checklists, observations and documentary analyses to generate pertinent primary and secondary data from primary and secondary sources, with a view to ensuring the quality of data. To this end, a total of 92 sample respondents were selected out of 2000 target population, using systematic sampling techniques. This study found out that the socio-demographic and economic characteristics of the surveyed population depict exactly the state of poverty these WFCs are living in. They are essentially young adults and married migrants from different parts of the country and they are illiterate; having no significant assets to make a positive impact in their lives, although some of them claim to have assets of some sort back home. Their perception about the forests and its importance is, therefore, limited. Living in groups in tiny housing units and filthy environment, without any meaningful alternative income-generating activities, these Orthodox people, by religion, take all risks to gain a loft of bread out of the forests. The existing forests protection enforcement mechanisms and policies are inefficient to keep then at bay and inadequate to ensure good forest conservation practices in the study area. This is very often due to inadequate number of personnel to patrol the forest, lack of smooth communication, lack of clear guidelines and of co-ordination among the Government local authorities responsible for making it happen. Consequently, awareness creation is needed at all levels on the importance of a sound forest conservation system; and provision should be made of an adequate number of forest security guards in the study area with encouraging incentives in order to guaranty an effective forest protection. Local authorities and relevant stakeholders should commit themselves not only to provide WFCs with access to schools to acquire new life skills and alternative generating income, but also with decent housing units to allow them fit in the society in dignifying manner. Given the fact that effective management of forests is of paramount importance, there is a need for all parties concerned to pursue collective participatory forest management initiatives in such a way as to safeguard the interest of all, the environment and, particularly of the poor, who are the most reliant on the continued access to resources for fuelwood supplies.

Acronyms and Abbreviations

ABE	Alternative Basic Education
BBS	Basic Business Skills
Df	Degree of freedom
FGD	Focus Group Discussion
FGUs	Forest Group Users
FGs	Forest Groups
FWFC	Former Women Fuelwood Carriers' Association
HH	Household
HHH	Household Head
ILO	International Labor Organization
MOA	Ministry of Agriculture
MOLSA	Ministry of Labor and Social Affairs
NTFPs	Non-Timber Forest Products
P	Probability of Type 1 Error one is willing to Tolerate
SPSS	Statistical Package for Social Science
$\chi 2$	Chi-square
WFCs	Women Fuelwood Carriers

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

The recent supply disruptions in the international crude oil market followed by the escalating prices of crude oil have prompted policy makers in oil- importing countries to face the challenge of coping with higher oil prices (IEA, 2005). The degree to which oil price influences such economies depends mainly on the energy policies adopted, pricing mechanism implemented, the structure of the energy markets and the degree to which the international price changes are transmitted (ibid). Ethiopia is not an exception. Being a non-energy-fossil oil producing country, Ethiopia is also a victim of the higher oil prices in the international market due to its high dependence on petroleum imports (WFP, 2009; Heimann, 2009; Yared Haile-Meskel, 2008). The increasing demand for petroleum products for electricity generation, transportation, industrial production and domestic needs has made the Ethiopian economy more vulnerable to oil price shocks (Heimann, 2009).

The prospects of harnessing other renewable sources of energy in Ethiopia, as a measure to reduce the rate of consumption of fuelwood are a subject of discussion in different pieces of literature on this matter (Heimann, 2009; New Business Ethiopia, 2010). But, in this context of using forest resources, there is a dilemma. One of the controversies of development is between economic development and environmental conservation. Here, one may pose the following question: should a government give priority to conservation of forest over the livelihoods of the local population?

The rising demand for energy, due to widespread consumption of biomass fuels as sources of energy in Addis Ababa, and in Ethiopia in general, is one of the causes of deforestation (Heimann, 2009). It also perils the health conditions of the populations by the smoke it releases into the surrounding environment, as the local users burn firewood for domestic purposes, polluting the air (Smith *et al.*, 2000; Vinod *et al.*, 2005).

However, the nature of the relationship between population and biomass, particularly fuelwood, is a subject of debate and controversy in the literature. Some scholars (Anderson 1986, 1987; World Bank, 1987) argue that there is a direct relationship between changes in fuelwood consumption and changes in rates of population growth and urbanization. Others (Cline-Cole *et al.* 1990) believe that this direct link is likely to be distorted by changes in the size of consuming units. One argument frequently encountered in the literature is that population concentration in urban areas leads to an increase in the demand for fuelwood, and that urban demand has a great potential for depletion of tree stock (O'Keefe and Raskin, 1985; Anderson, 1987), which triggers environmental concerns. To mitigate these demands, improved stoves and other measures of energy-saving were suggested as necessary to increase the efficiency of biomass fuel uses. Also, since the use of wood for fuel contributes to deforestation, they found that resorting to alternative sources of energy for cooking would be environmentally desirable. They thought that planning for suitable alternative fuels should, therefore, reduce dependence on wood. As biomass fuels were increasingly becoming scarce because of unsustainable wood cut, better management of biomass resources was found to be necessary.

A hundred years ago, around 1895, in order to minimize the massive deforestation around the Addis Ababa city and to reduce the possibility of an energy crisis, Emperor Menelik introduced *Eucalyptus* to Ethiopia. In fact, the main purpose was to redress the situation of severe shortage of fuelwood and construction materials in Addis Ababa and other regions in the country. Many foreign and local studies have already revealed the tremendous socioeconomic benefits that the eucalyptus trees offer to households (Davidson, 1995; Turnbull, 1999; Demel Teketay, 2000; Dechasa Jiru, 2001; Tsegaye Bekele, 2001) to mention but a few.

A segment of the population living by the Entoto Foothills, northern Addis Ababa, is basically dependent on the forest of eucalyptus as their source of energy (Fekerte Haile, 1991) and as source of income as well. The city of Addis Ababa requires large amounts of firewood to satisfy its energy needs. Women and children backloading mostly branch-wood and leaves into town supply a significant part of the requirements, (ibid). Despite of the extremely arduous work in collecting and selling firewood, most of the WFCs have very low income and belong to the most disadvantaged sections of society. For lack of adequate education and skills and alternative livelihoods, as well as the rising demand for biomass energy, the women fuelwood carriers (WFCs) contribute to the depletion of the peri-urban forests of Addis Ababa. This negative interaction with the forest may lead to the WFCs' livelihood insecurity, by disrupting the sustainable supply of fuelwood and ultimately put at stake, not only the very survival of WFCs themselves, but also the household energy needs of end-users at large. Despite harassments, the forest security guards have not been able to discourage them from pursuing the illegal activities in the forest reserve.

The environment is the variable of ultimate concern, as events taking place somewhere; they influence the state of the environment. In the present case study, the environment is made up of woodlands from which the harvesting of wood for the provision of fuelwood in urban areas takes place. Woodlands are renewable resources, resilient to certain levels of harvest/disturbance. The sustainability objective is to at least maintain the ecological functions of the resources. Ecosystems, hydrological and socio-economic functions of woodlands are compromised when harvesting levels go beyond certain thresholds (Chambwera, n.d.).

The difference between the present research and most of the studies done on the livelihood conditions of women firewood carriers in Ethiopia is that the latter are based purely on economic perspective without considering the environmental aspects of development (e.g. Tadesse Tafesse., 2002; World Bank, 2004; Shanko, 2004), while the former focused more on the women's livelihoods in the light of environment sensitive development.

1.2 Statement of the Problem

The women fuelwood carriers, who make a living out of the forest resources, in Woreda 1 of the Gulele Sub City of the northern Addis Ababa, face the problem of livelihood insecurity. Without education or training, these women find it extremely difficult to get a decent job other than tapping into the forest.

The women who make their living by collecting fuelwood from forest plantations to sell in urban market places are strikingly visible as they stream in their hundreds, each day, labouring under their heavy loads. But, as with so much of women's productive work, this activity has been largely invisible to planners and policy makers. In this case, their invisibility is particularly astonishing: The Women Fuelwood Carriers (WFCs), as they have come to be known, daily provide an essential service, without which most urban dwellers could not cook their meals or heat their houses.

In the capital city of Addis Ababa, with a population of 2,738,248 (CSA, 2007) - reported in 2008, the majority of households use fuelwood for cooking, brewing and heating, most of which is supplied by thousands of women (WFCs) each day. The work the women do to earn their living is illegal, and ultimately destructive. They collect fuelwood from plantations own by the government and by gathering leaves and branches from the forest floor and from living trees; they hamper the trees' growth, rob the soil of fertilizer and contribute to soil erosion.

The cumulative effect of the WFCs' work in the forest reserve, as the only means of their livelihood, has further repercussions. It contributes to increase depletion of the plantations, disrupts the sustainable supply of fuelwood and ultimately puts at stake, not only the very survival of WFCs themselves, but also the household energy needs of end-users at large.

Managers have struggled to protect the plantations from illegal forest users, rural and urban ones, particularly as the state enterprise with the monopoly for fuelwood has only been able to provide about a third of urban need, according to local authorities. This huge gap has been filled by farmers who bring in fuelwood on donkeys – and by WFCs loaded on their back (direct observation). Forest protection has been very traditional: it has depended on the vigilance of armed guards (inadequate in number and poorly paid).So far, there was no attempt to encourage the participation of forest users or others stakeholders in the plantations´ protection scheme or management plan.

The WFCs subsist on fuelwood carrying and trading, as their primary source of income, at a considerable cost both to their own health and personal safety, and to the sound management of the forest resources. The income that the WFCs earn from the selling a bundle of fuelwood barely permits survival – when they collect it themselves they end up selling it in the local market to the tune of ETB 15.00 - 20.00. Such a meager income entails, apart from the harassment by and bribes to the forest security guards, the back-breaking work of walking up to 30km round trip; and back-loading an average weight of 30kg on the return journey.

Deforestation related issues are a real national concern in the study area, according to some local authorities. But, equally important is the issue of the livelihood of a large number of people who depend on supply of traditional fuels to make a living. In fact, balancing these two concerns of maintaining the WFCs' sustainable livelihood and protecting the forest are the central theme of this research.

1.3 Objectives of the Study

The general objective of the research is to assess the livelihood conditions of the women fuelwood carriers in northern Addis Ababa as well as their interaction with the forest. The specific objectives are:

- To assess the women fuelwood carriers socioeconomic situation;
- To identify the role of fuelwood sell in their livelihood;
- To study the interaction between WFCs and the forest;
- To recommend measures to assist in promoting the livelihoods of the WFCs and mitigating the negative effects of their activities in the forest.

1.4 Research Questions

The research questions to be dealt with are:

- What is the current livelihood (social, natural, physical and financial) situation of the women fuelwood carriers?
- What is the role of fuelwood sell in their livelihood?
- Is there any kind of interaction between the WFCs and the forest?
- What are the factors likely to improve women fuelwood carrier's livelihood conditions?

1.5 Significance of the Study

This paper aims at providing the policy makers and planners (development practitioners/environmentalists) with tangible and concrete evidences on how to improve the livelihood situation of the vulnerable and poor women firewood carriers. For this purpose, the study identifies training needs for WFCs development. On the other hand, the research explains the implications of the eucalyptus trees to the local people livelihood and the peril on the environment of the cutting off of those trees. Finally, this study may be considered as a basis for further in-depth empirical investigation/research on areas of forest-environment interaction and it may serve as a material source.

1.6 Limitations to the Study

The most salient limitation is the language barrier. To minimize this issue, several translators were employed not only to ensure the flow of communication, but also to guaranty data accuracy (by using a kind of triangulation system). These helped to administer the questionnaires and moderate focus group discussions as well. Apart from these, there are other factors that may challenge some of the findings of the studies, such as the cultural background of the researcher and that of the WFCs; the sex difference between the researcher and the women; even though other ladies were recruited as enumerators to carry out the job of data collection. Another difficulty faced by the researcher was the WFCs' busy working schedules; all these factors combined encroached upon the respondents understanding, attitudes and perceptions towards their overall conditions, which might have influenced the validity and reliability of some of the data generated from sensitive questions in the study.

1.7 Organization of the Thesis

This Thesis is organized into five chapters. Chapter one deals with the general introduction of the study including research objectives. Chapters two deals with review of literature on research topics. The literature review focuses on livelihood of the forest dependent populations, forest resources and management, and so on. Chapter three contains the methodology applied to accomplish the research objectives and description of the study area. Chapter four deals with presentation and analysis and interpretation of the data collected. Chapter five presents the conclusion drawn from the study and the recommendations.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 Definition of Terms and Concept

Forest

FAO (1998) defines forest as follows:

> *A "land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). The trees should be able to reach a minimum height of 5 meters (m) at maturity in situ. It may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground; or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent".*

Livelihood: "A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living" (DFID, 1999).

Forest fringe community: Refers to the people who live in or near the forest and have access to forest areas and who depend to a large extent on the forest for their livelihoods.

Sustainability in these contexts refers to the ability to maintain or enhance resource productivity on a long-term basis.

Sustainable livelihood: "A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (DFID, 1999).

Food Security: The ability to adequately satisfy these stocks and flows of food and cash for a sustained source of meeting basic needs is what is expressed as security. A livelihood quality will improve when its security and sustainability are improved. Security in this context refers to secure ownership of, or access to resources and income-earning activities, including reserves and assets to offset risk, ease shocks and meet contingencies (WCED, 1987; Chambers and Conway, 1992).

Vulnerability: it refers to the external environment in which people pursue their livelihoods and their exposure to the negative effects of external environments, as well as their resilience in resisting and recovering from external shocks and trends (Chambers, 1989).

2.2 Livelihoods in Forest Dependent Communities

Many forest dependent people employ a diversity of means to help meet basic needs: food and cash crop production, forest and tree product gathering and income-earning enterprises both on and off the farm. Often, the poorer the household, the more diverse the sources of their livelihood, as the needs for the year must be made up from various off-farm as well as on-farm natural resources, and often from migrant labouring as well (Shepherd *et al.*, 1999 in: Tropenbos International, 2005).

The dependence of local populations on forest resources can be derived from a number of sources, two of these are: their close contact with the forest and its products; their vulnerability with Non-Timber Forest Products (NTFPs) providing an important safety net in times of stress in their economic activities (Shackleton and Shackleton, 2004). Poor rural and 'peri-urban' people are very much dependent on land and other natural resources for their livelihood (Chambers and Conway, 1992) as well as for income (Tropenbos International, 2005).

Contribution of Forestry to Livelihoods Improvement

Forests contribute to all aspects of rural and peri-urban lives of fringe communities: providing food, medicines, fuelwood, fodder, canes, building materials, wrapping leaves, pestles, chewing sticks, and materials for all sorts of household items.

However, these contributions vary in terms of income to households. Cavandish (1998) estimated a 35 % contribution of forest income to the total income in rural areas of Zimbabwe. While Levang *et al.,* (2003) estimated 30.4 % contribution to the income of 72 percent of the households in Indonesia; Adhikare (2003) states that forest contributes 14-20% to total income of mountain dwellers in Nepal rural areas. A study carried out by Bawayla (2004) in Zambia indicated that the average income derived from forest product is approximately to the tune of US$900 per household per year among residents of Nyampande and US$450 by Chibwe residents.

Obviously, as several studies indicate, forest income is more important for poor households than non-poor ones. For example, a study in Uganda (Johnson, 1991) reveals that the importance of forest income decreases as the degree of poverty decreases. It concludes that the forest income is more important for poor households because the major part of their income comes from forest. But for non-poor households, the forest income contributes only a little, if at all, in the overall income. Vedeld *et al.,* (2004) also indicated that poor households generate income from forests, which is one of diversifying source of income.

However, forestry to be genuinely successful in sustainable poverty reduction, women as well as minorities needs to be involved and empowered. Rogers. A. (1992; 1997) is conversant and associated with low levels of education and lack of skills. Training and extension program organized through Forest Group Users (FGUs) increase the skill and knowledge of the users and thus helps to select, design and implement the appropriate livelihood strategy for them (LFP, 2003). Improvement in income opportunities and human capital of the poor would naturally reduce their vulnerability to adverse shocks and would promote their livelihoods. Forest policies, forest acts, and FGUs rules, the FGUs organization, social relations and networks, inclusion through the active participation of women and disadvantaged groups and the practice of democratic processes in decision making increases the social capital of FGUs.

The FGUs funds (Financial capital) and the FGUs institution (Social capital) can be used to develop physical capital such as roads, drinking water supply, school and irrigation canal at local level, which improve the well being of the people. These have important impact on poverty reduction and livelihood diversification by improving the markets, speeding the flow of information and resources and integrating the local economy into national economy. It is expected that mobilization of local people in the whole process of planning, implementation and benefit sharing of Forest Groups ensure lower unit costs, better quality of work, and greater transparency in fund utilization, greater local ownership and more long-term sustainability (World Bank, 2003, cited in Kanel *et al.,* 2004).

Household's Dependence on Fuelwood

According to Sokona (n.d.), the literature on the fuelwood question increasingly suggests that there are a host of complex sociological, economic and ecological factors, which actively mould and reshape the nature and magnitude of the energy crisis confronting poor households in Africa. Reference has been made to scarcity of labour force, transport difficulties, competing demands for wood products, land tenure systems and patterns of population settlements and movement. It has been stressed that there is a close link between energy, water and food, and that fuel scarcities, while serious, are only one of the numerous difficulties which threaten survival (ibid). Fuelwood shortages are a symptom of widespread rural and peri-urban poverty and are linked to the more fundamental dimensions of survival, production and land management.

Historically, wood has been the most important source of bioenergy (http://www.greenfacts.org/glossary/abc/bioenergy.htm). Wood has been used for cooking and heating since the discovery of fire. In developing countries, it is also used in commercial applications such as fish drying, tobacco curing and brick baking (ibid). In developed countries, it is predominantly used for energy generation in the forest industry.

In Ethiopia, as in so many other developing countries, fuelwood is still produced, consumed and also sold in the local markets to generate household income (http://www.greenfacts.org/glossary/wxyz/wood-energy.htm). Since fuelwood is mainly used in private households for cooking and heating and it is very often traded informally, it is difficult to collect reliable empirical data at household level. But, one thing is for sure, the fuelwood is a major source of energy for households. Those who engage in the collection and selling of firewood on a regular basis are invariably the poorest of the poor. They are particularly women (WFCs) and children, who depend on fuelwood collection and marketing for their livelihood (Dessalegn Rahmato, 2001). On the other hand, poor women in rural and urban areas may resort to firewood collection and selling as one of their coping mechanisms in times of crisis, as well. As in the case of Arssi, for instance, during famine period, besides livestock and household assets, people also sold trees, firewood and charcoal. Especially the women became involved in carrying the firewood to the nearest cities for sale. They became the backbone of their families (Dodota, Arssi, 2007), which is equivalent to say that fuelwood plays an empowering role in poor households in Ethiopia.

Citing Dessalegn Rahmato, a study undertaken by ILO/MOLSA, for example, revealed that over 80 percent of households in Addis Ababa obtain their domestic energy from biomass fuel (wood, and tree residue) and dung, and the annual inflow of fuelwood into the city is estimated at close to 21,000 metric tons. It goes on to say that between 15 to 20 thousand of women and children in the capital provide about 35% of the city's domestic energy supply, while another third is supplied by peasants from surrounding areas. Fuelwood selling is the main non-farm income source for female-headed households. This is due to its 'openness' for anyone who is capable of collecting and transporting (Degefa Tolossa, 2005).

Biomass and Energy Substitution

About 2.3 billion people worldwide - every two in five rely on biomass fuel, mostly fuelwood, as their main or soul sources of domestic energy requirements (Sands, 2005; FAO, 1995). About 3 billion people of the planet depend on biomass energy for cooking (Dessalegn Rahman, 1998).

The use of biomass has a number of repercussions for poor people. The fuel quality is low, and when burnt it gives off quantities of smoke and particulates that are recognized as having negative effects on health. The several hours a day spent in collecting fuel means that this time cannot be used for other livelihood activities. Although nearly every household in rural areas will use some biomass as an energy carrier, poor households will spend more time searching than those in higher income groups (Reddy, 2000).

Although economic development in many developing countries has been rapidly progressed alternatives to biomass, fuels are still scarce in many rural areas (Koopmans, 1993; Soussan, 1991). In fact, forests are still among the vital sources and are providing majority of the biomass fuel required in most developing countries.

The construction of the traditional cooking stove leads to combustion processes inside stoves to be non-ideal, thus, favoring incomplete combustion. Due to the incomplete and inefficient combustion, such stoves produce significant quantities of 'products of incomplete combustion' (PIC) importantly fine and ultra fine particles, which have more global warming potential (GWP) than CO_2 (Smith *et al.*, 2000). Bhattacharya *et al.*, (2000) report that incomplete combustion of biomass in the traditional cooking stove release carbon monoxide (CO), nitrous oxide (N_2O), methane (CH_4), polycyclic aromatic hydrocarbons (PAHs), particles composed of elemental carbon or black carbon, and other organic compounds.

As local people of forest areas are heavily dependent on forests for their energy needs, improving cooking stove would reduce indoor air pollution and increase energy efficiency.

Wood fuel burning on traditional stoves causes emissions of pollutants such as carbon monoxide, methane, nitrogen oxides, benzene, formaldehyde, benzo (a) pyrene, aro-matics and respirable particulate matter (Shukla, 1996). These emissions have significant implications for climate change due to their considerably high global warming potential compared to CO_2 (IPCC, 1990).

The effects of the biomass burning in the traditional cooking stoves on human health have been reported by many scientists in the world. Among them blindness (Mishra *et al.*, 1999a); asthma (Schei *et al.*, 2004); acute respiratory infections (Smith *et al.*, 2000; Vinod *et al.*, 2005); cancer (Bhargava *et al.*, 2004); chronic obstructive pulmonary disease (Ekici *et al.*, 2005); eye discomfort, headache, back pain (Diaz *et al.*, 2007); reduced birth weight (Mishra *et al.*, 2004); stillbirth (Mishra *et al.*, 2005); and tuberculosis (Mishra *et al.*, 1999b), among others.

Historical background of Forest Management in Ethiopia

Ethiopia has an old age history of management of natural resources. Perhaps, this is due to immense wealth in natural resources of Ethiopia.

Towards the turn of the 19th century, that is during the reign of Menelik II, 1890-19 14, urbanization began in Ethiopia in several areas (Willis, 1966). This was the beginning of a major forest destruction period. According to Fekerte Haile, citing Willis, after Menelik settled at Ankober, the forest resources in the area were completely used up for construction and fuelwood and he was forced to relocate the capital to Inewari. This movement from place to place in search of fuelwood and construction material continued until Menelik settled at Entoto near Addis Ababa. The third major deforestation, however, occurred when the Derg was overthrown and the new regime came to power (Dessalegn Rahmato, 2001).

Peri-urban Forest Resources Management of Addis Ababa

Menelik introduced the range of eucalyptus forest in the periphery of Addis Ababa to meet the increasing demand for wood due to population growth. The seedlings were supposed to be for each residence to plant, tend and utilize, as Rases and Mekuanint were given land in and around Addis Ababa. These landlords intensified the management control of the then privately owned eucalyptus forest. As the landlords employed local tenants to guard and strictly control the resources, the forests were reportedly properly managed (World Bank, 1987). Nevertheless, there are no figures indicating the productivity of the Addis Ababa peri-urban forest during this period (Aklog, 1990).

Rural-urban Migration

The negative effects of environmental deterioration on the productive capacity of the land, threatens food production and the livelihoods of both rural and urban populations. Because the poor in developing countries live primarily in rural areas and are dependent on agriculture, rural poverty and environmental degradation are obviously closely related (Todaro, 1989).

Migration is often a direct response to environmental degradation and rural poverty. In his study of the demographic responses to drought and food crisis in the Sahel in the mid-1980s, Hill (1989) asserts that the main individual, household, and community strategy for coping with drought was out-migration. Migration may be viewed as part of a household survival strategy even during non-drought years, whereby a family allocates part of its labor for nonfarm work (including seasonal out-migration).

A migrant move to wherever the expected net objective and subjective returns to migration are greatest. Microeconomic models lead to several important generalizations about the impact of migration on individuals (Massey *et al.,* 1993). Individual characteristics (education, experience, and occupational skills) increase both the likelihood of migration and the probability of employment in the destination area relative to the area of origin. In short, the microeconomic theory suggests that people make decisions about where to live depending on where they can expect to maximize their future earnings.

Livelihood Strategies

A livelihood comprises the capabilities, assets and activities required for means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, and maintain or enhance its capabilities and assets both row and in the future, while not undermining the natural resource base (Carney, 1999).

Sustainability is important if programs in poverty reduction are to be lasting. Sustainability of livelihoods rests on several dimensions, environmental, economic, social and resilient in the face of external shocks and stresses; are not dependent on external support (Ashby and Carney, 1999).

Conceptual and Theoretical Framework

The focus of the framework is on the livelihoods of the women fuelwood carriers in Woreda 1, Gulele Sub City in the northern Addis Ababa region. Livelihoods of community members are influenced by external and internal forces and factors, such as economic trends, conflicts, resource management, seasonality and health. People's objectives (or livelihood outcomes) are normally shaped by their livelihood assets and strategies. Following the Sustainable Livelihoods Framework by DFID (1999), a livelihood consists of different capitals; physical, human, financial, social and natural. Within this study these capitals are mostly considered in relation to the forest. Natural capital is particularly salient in the studied community because various livelihood strategies such as NTFP gathering, chainsaw operations or basket weaving can help inhabitants in achieving their livelihood outcomes. Desired outcomes can reduce vulnerability, increase income, and improve food security or a more sustainable use of the resource base.

The feedback process shows the link between the livelihood outcomes and assets. For example, proper use of forest resources warrants the sustainability of the natural asset and therefore has a positive effect on the livelihoods of community members.

CONCEPTUAL FRAMEWORK

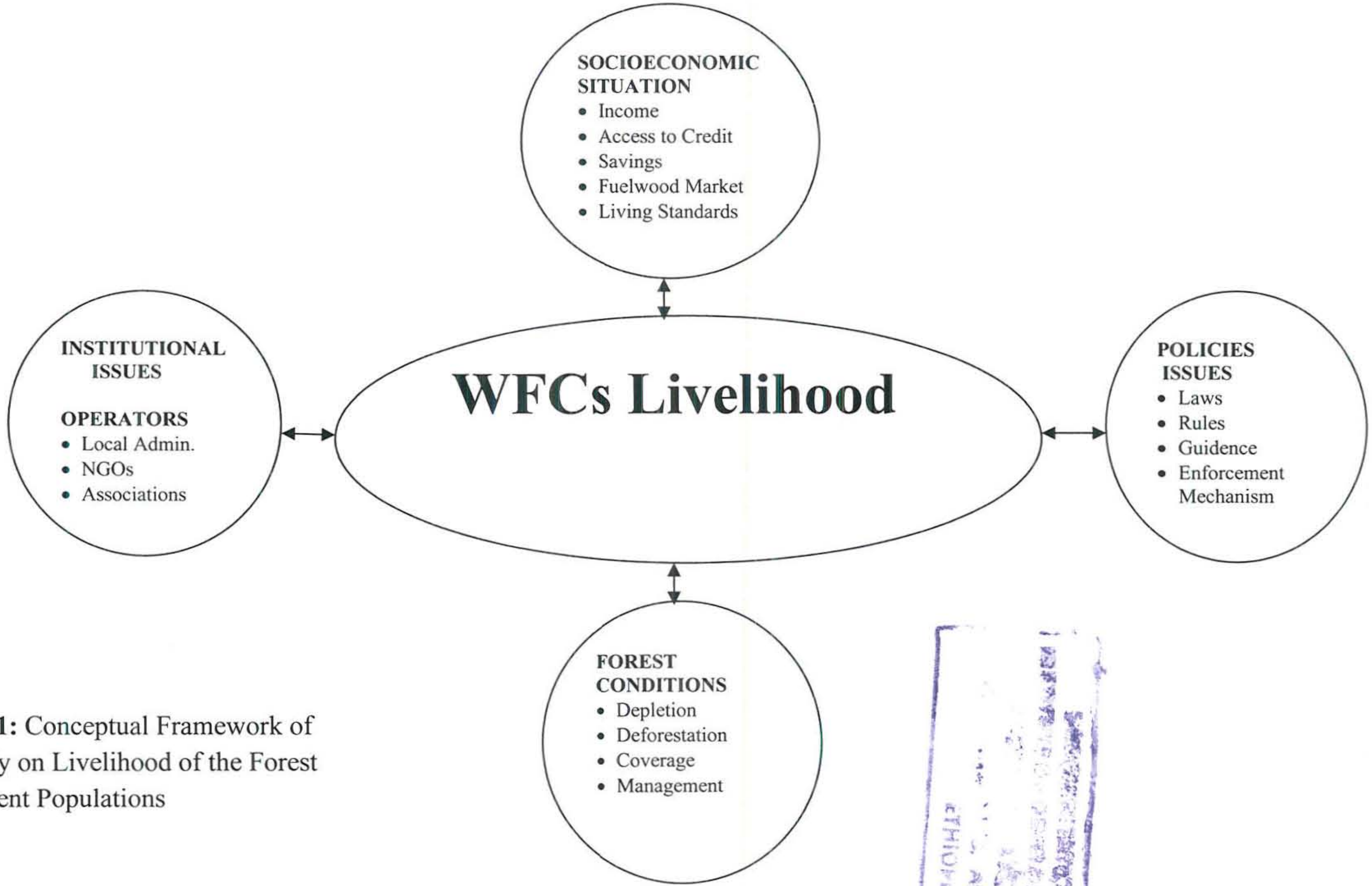


Figure 1: Conceptual Framework of the study on Livelihood of the Forest Dependent Populations

Factors Likely to Improve Livelihoods

There are several factors that influence one's livelihood. These factors defer from one community to the other depending on the location and cultural background. The dependence of local people on forest resources can be derived from a number of sources, two of these are: their close contact with the forest and its products; their vulnerability with NTFPs providing an important safety net in times of stress in their economic activities (Shackleton and Shackleton, 2004). Poor rural and 'peri-urban' people are very much dependent on land and other natural resources for their livelihood (Chambers and Conway, 1992) as well as for income (Tropenbos International, 2005).

Generally speaking, the most important factors are those such as economic status, age and gender, which play a critical part in shaping opportunities to sustain or improve livelihoods. These factors also influence the outcomes of managed processes of social change such as decentralization, and the ways in which different people may be represented in, or excluded from, natural resource management processes.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Description of the Study Area

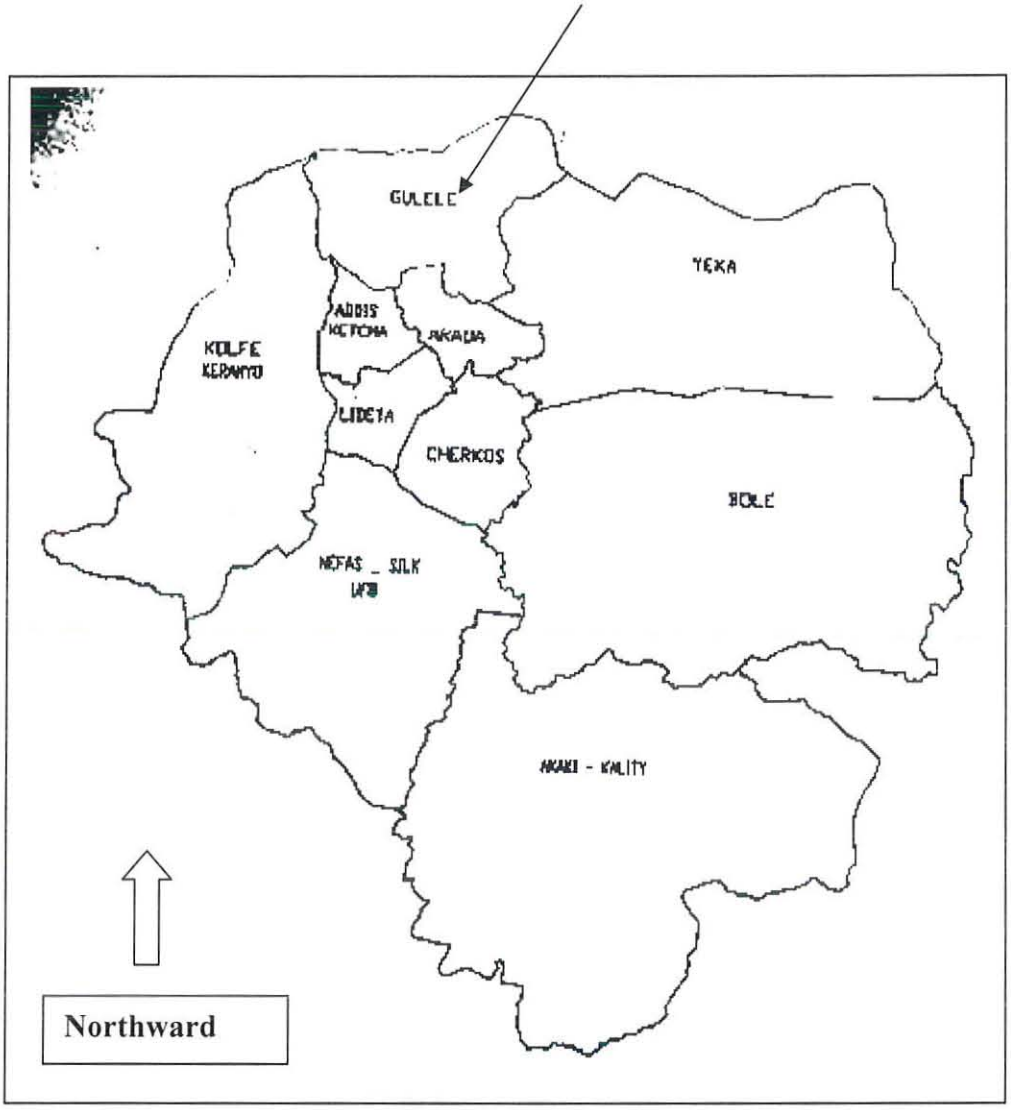
The City of Addis Ababa, officially known as the City Government Administration of Addis Ababa, is one of the city administrations in the country which is located in the central highlands of Ethiopia that stretches from 1800 to 3200 meters above sea level. The City Administration of Addis Ababa, in geographic terms, is located between 9 02 N, 38 42 E (Ethiopian Government, 2011). The total area of Addis Ababa is 526.99 square kilometers. Its topography is constituted by hills, valleys, rivers and streams. The mean month rainfall based on records of weather station at Bole is minimum 16.8 mm and maximum 278 mm, in the months of January and August respectively (N.M.A., 2011). The average rainy days are 20, 27, 26 and 18 in the months of June, July, August and September, respectively. The mean monthly temperature ranges from 20 ^{0}C to 25^{0}C during the day time.

According to the official document of the City Administration of Addis Ababa (2010), the total projected population of the City Administration of Addis Ababa for July 2010 was estimated to be 2, 739, 551 persons; disaggregated by sex, 47.65% males and 52.35% females (CSA, 2010).

The capital city, according to the Annual Book of the City Administration of Addis Ababa, was divided into 10 sub-cities and a total of one hundred sixteen woredas/districts for administrative purpose beginning July 2009 (see Maps 1- 3). Gulele Sub-city Administration is one of the sub-cities.

The total area of the Gulele Sub-city is 30.18 square kilometers, which makes it the fourth Sub-city in terms of its geographic dimension. In the Sub-city, a total of 267,624 persons were living in 2007. The population density of the Gulele Sub-city was 9438.9 persons per a square kilometer, which ranked it the fourth densely populated section of the City. In 49,661 households, 23,315 individuals, and 31,320 households had access to either radio, telephone and/or TV set, respectively.

In Gulele Sub-city there are currently a total of 10 woredas/districts. District/Woreda 1 Administration (previously known as Kebeles 19/20/21 Administration) is one of the districts under the auspices of the Gulele Sub-city Administration. This District is the study area. District/Woreda 1 Administration had a total population of 29,235 persons in July 2007. Disaggregated by sex, there were 48.04% males and 51.96% females. In addition, the total number of households in the study area was 7,833 householders who had been resided in 6,843 housing units of different types in terms of the materials used for their construction such as walls, floors, ceilings, and other parts made of mud, bamboo/reed, wood planks, parquet/polished wood, cement screed, plastic tiles, cement tiles, brick tiles, ceramic/marble tiles and/or others.



Source: City Administration of Addis Ababa, September 18, 2010

Figure 1: Map of the City Government of Addis Ababa – The Study Area (Gulele Sub City)

3.1 Methods

Criteria for Selecting the Study Area

In order to draw representative sample from the target population, the study followed multistage sampling procedures. The study purposefully selected Woreda 1 of the Gulele Sub City, in which the target population is located. Then, it employed systematic sampling techniques because the list of the women fuelwood carriers (the target population), which is the sampling frame, was available, part of it in Woreda's Office and another part in the Former Women Fuelwood Carriers' Association, and totally it was 2000 WFCs.

This is followed by the sampling interval exercise, which was determined based on the formula $K=N/n$, where N is the size of the target population, n the size of the sample and K is the sample interval, e.g. 2000/92=22 (Sample Size Calculator by Raosoft, Inc., 2004).

To arrive at the sample size of 92, the researcher resorted to the website-based formula called Raosoft Sample size calculator, admitted a margin error of 10%, which is common to tolerate the above-stated sample size. The researcher also used 95% as the confidence level, which is the amount of uncertainty possible to tolerate, given the sample size. After entering the number 2000 as the size of target population, the response distribution was fixed at 50% (since the researcher did not initially know the skewness of the distribution of the target population, and the sample size recommended was 92.

To draw the stated representative sample size 92, the study used Random starting by choosing a number (7) between 1and K (22), after that the consecutive sampler of respondents was drawn following sampling interval calculated above, e.g. 7, 29, 51, 73,...92.

3.2 Methods of Data Collection

Household Survey

Quantitatively, the study employed the descriptive survey method to collect quantitative data and describe the general and specific characteristics of the target population –Women Fuelwood Carriers (WFCs). Further, structured questionnaires were used to generate general socio-demographic profile of the respondents.

The quantitative data were triangulated by qualitative data. Qualitatively, the study used semi-structured interviews with a total of ten (10) persons (7 female and 3 male) to collect data on their attitude towards the forest in light of environmental protection and development in a sustainable manner.

3.3 Focus Group Discussion

This was undertaken along with community leaders and *Woreda's* Officials. Two different focus group discussions were conducted separately for collecting different information regarding Women Fuelwood Carries. Each focus group discussion was comprised of 6 individuals. To guide the discussion, (Fuelwood Carries & Non Fuelwood Carries) semi-structured checklists were developed on a number of issues such as the interaction between the WFCs and the forest, the environmental protection, livelihood sustainability, the factors likely to improve WFCs livelihood situation; the WFCs' attitude about the resources (perceptions towards the forest in the future, the livelihood impacts, concern about sustainable use of natural resources; community attributes (community-based organization, type and functions, institutions on resource use, decision making processes). This method of data collection was very important as it helped to cover a wide range of issues that would require a lot of time and huge amount of financial resources, if carried out through household surveys.

3.4 Key Informant Interview

Selected people from the Woreda study area and zonal concerned government offices, private investors, NGOs Staffs and other stakeholders were interviewed using a guide.

3.5 Direct Observation

Direct observation was conducted in the selected areas of the study, where there is a severe effect of deforestation on the livelihoods of the WFCs. In this regard, the WFCs were followed to and from the forest to know how they actually do the harvest the bundles of firewood, and other forest resources. The physical settings of the area, condition of the forest, and management practices were subjected to physical observation as well. Direct observation was also made on the respondents' households, housing conditions their access to different facilities such as water, toilets, and so on. All of these were undertaken with the help of checklists to complete the reliability of data collected through the above-mentioned techniques.

3.6 Secondary Data

Having due regard for the validity and quality of information, secondary data were collected through reviewing the available studies, books, plans and reports at different relevant institutions, including the local authorities.

3.7 Data Analysis

Immediately after the successful completion of data collection, the quantitative data were edited, coded and entered into the latest version of Statistical Package for Social Sciences software (SPSS version 19.0) to be cleaned and made ready for analysis. The data generated were of quantitative and qualitative nature. Therefore, for data collected through focus group discussion, and key informant interview, qualitative assessment were employed and used in triangulation of evidences. Besides, qualitative information (response of the FGD & the interview) was analyzed, verified and applied to draw inference and conclusions. Each qualitative analysis was integrated with quantitative analysis for purpose of inference.

Meanwhile, quantitative data were analyzed using descriptive statistics with the help of the above-stated statistical software (SPSS). Based on surveyed data, socioeconomic characteristics of sampled households were described with respect to livelihood diversification status by employing descriptive statistics. In addition, some open-ended questions, which were incorporated in the structured questionnaires, were also analyzed quantitatively in the same way.

In order to quantify qualitative data with the study, the researcher first coded the open-ended questions. In so doing, the researcher classified major responses which were not given frequently. The classification of responses was primarily based on similarities or differences among the responses, after the researcher had looked for major characteristics of the responses and put them accordingly.

CHAPTER FOUR

4. DATA PRESENTATION, ANALYSIS AND INTERPRETATION

Sampled Household

The respondents who were sampled to participate in the present study were ninety-two (92), selected from the following areas: kebele 19 (57. 60%); kebele 20 (35.90%); and kebele 21 (6 %).

The women fuelwood carriers (WFCs), who were the respondents in this study, were from different villages. Although they were more or less evenly distributed, its concentration was more skewed towards Kuskuam where 16.30% of the respondents came from; followed by Bilatie Gibi with 15.20 % and then Dejazmach Metaferiya with an equal percentage of the WFCs; next, Adarashe with 14.10%, and other ones in less significant numbers.

Sex

Concerning the sex of respondents, all of them were female. This is not a coincidence. It happened that way because the sample respondents were all women fuelwood carriers and therefore there is no single man involved in the survey. According to local people, traditionally speaking, the above-mentioned activity is a women's business.

Age

The age of fuelwood carriers ranged from 18 to 68. A significant proportion of the respondents' age (34.80 %) were found to be within the range of 18-27; about 33 percent of them were within the range of 28-37; while 22.80% fell within the age category of 38-47. The age average is about 33.4 years and there were no younger girls registered undertaking these activities as shown in previous similar studies (Fekerte Haile, 1991). The fact is that the sampling frame got from the Former Women Fuelwood Carriers' Association (FWFCs) did not register ladies younger than 18 years old. However, the data gathered showed that there are younger girls fuelwood carriers, who were even younger than the minimum above-stated age, including younger boys. Relatively speaking, these younger boys and girls who were children of the FWCs follow the footsteps of their mothers in collecting firewood on weekends. Generally, the WFCs' age distribution shows that they fall not only within the economically active age category (15-60), but they are also elderly and economically inactive ones.

Educational level

In this context, it was discovered that 51.1 percent the of respondents were illiterate; 15.20 percent of the studied respondents were those who completed primary education (grade 1-4) and other 15.20 percent achieved primary education (grade 5-8). Only 1.10 percent of the respondents have alternative basic education and another 1.10 percent completed the secondary education (grade 11-12). By all means, this is a very low level of educational achievement by the households. This suggests that any kind of program designed to improve their livelihood would require further training and outreach activities by stakeholders.

The study also found out that the relationship between the educational level of the respondents and their age was statistically significant at the calculated value of $\chi 2 = 31.162$, df = 35 and critical or table value of $\chi 2 = 49.8018$ and $p = .05$. The results further indicate that age is an important indicator of educational achievement. The older you are the lesser probability you have to achieve higher educational level. Thus, younger WFCs have achieved higher educational level.

Marital Status and Religion

Most of the sampled respondents (78.3%) were married. Little more than 16 percent were single or never married and 4. 3% were divorced. 1.10 percent of the firewood carriers were widowed and none of them were separated. One positive aspect in this context might be the possibility of supporting each other – husband and wife – in terms of generating household income. The other aspect, perhaps less favorable, is that the women, being married and as a fuelwood carrier, may not have time to support other household members back home and, at the same time, carry out other household chores in a traditional way.

As far as religious affiliation or devotion is concerned, out of ninety-two sampled respondents, 75 percent are Orthodox Christian. About 23 percent Protestants and Catholics were just two percent.

Family Size

About 35 percent of the sampled respondents had a family size of two, followed by 25 percent single family sized households. The minimum percentage (1.10%) of WFCs reported a family size of 6. Generally, on average, the household in the study area have about 5 household members, which is a bit higher than that of the Gulele Sub city (4.2 % per household) and that of Addis Ababa (4.1 % persons per household), in accordance with the Central Statistical Agency (2008). Apart from this fact, data generated through observation of some selected households showed that the family size of the WFCs was found to be much bigger than that statistically reported. This happens because the respondents simply reported members of the respective households composed by the core dependents (i.e. wife, husband and children). But, in reality and what is interesting is that there are two different sets of family living in the same house, supporting each other. The implication is that their livelihoods are expressions of styles of survival strategies, cohabitation, tolerance, and transparency.

There is association between yearly household income and the total number of household members. The results of bivariate analysis show that family size of WFCs is dependent upon their yearly amount of income at $\chi2_{\text{calculated}} = 20.782$, df = 24 and p = .652, which is bigger than .05 (i.e., 95% confidence level). This means that there is a significant difference between those WFCs who earn higher amount of income yearly and those of lower earners in terms of total family size. Thus, one can conclude that WFCs who earn higher annual household income seem to have bigger family size than those women who have low yearly income.

4.1 Social-economic Situation

Job Opportunities

All of the sampled respondents (100 percent) were firewood collectors. They predominantly depend on firewood for their livelihood. Forest provides the basis for their livelihood: money, child education, learning trade and starting a petty trade, if they can. By implication, it is not difficult for one to presume that the forest resources, being the major source of income, are very much endangered of depletion and consequently of deforestation in the long run, due to the pressure this section of the populations exert on it for their survival.

Occupation diversity in the household should be one of the coping strategies used by WFCs. Nevertheless, about 100 percent of the respondents reported that they are not engaged in petty trading. 2.20 % alone seek to do this kind of business, which include *enjera* baking, selling vegetables, brewing *tela* (local beer), spinning cotton and carpeting. From the total number (92) of the respondent only 1.10% were engaged in petty trading for a period of seven months. The implication is that the majority of the respondents had no other significant source of income but from fire wood collection and selling.

Only 37 percent of the respondents out of the total of 92 were self-employed. About 4.3% of the respondents engaged in backstreet market, washing clothes on house to house basis, spinning cotton and the like for the period of 10 years. The rest of them (i.e., from 1.10 to 3.3%) were engage in some sort of activities for a period between 1 to 37 years. These women could not do more in term of self-employment for lack of finances.

The majority of the respondents (71 percent) in Woreda 1, Administration of Gulele Sub City have been engaged in the firewood collection. The minimum percent of the respondents who have been involved in the activity of collecting firewood was 1.10%, which reflects different years of services like from 1 to 33 years. These statistics reveal the great importance the forest resources have in the livelihood of the concerned WFCs. In other words, this is due to the lack of alternative generating income and the need to continue to support the household income. In the same framework, chi-square analysis supports that these WFCs are found to be dependent on firewood harvesting and selling to be able to generate adequate income for the respective households at $\chi2_{\text{calculated}} = 6.584$, $df = 5$, $\chi2_{\text{critical/table value}} = 11.0705$ and $p = .253$. With this analysis in mind, one may conclude that the WFCs are really dependent on the forest.

Table 1: Number of years of the Respondents' Firewood Collection in the Study Area

Duration of FW Collection in Years	Frequency	Percent
1-5	32	34.80
6-10	33	35.90
11-15	9	9.80
16-20	11	12.00
21-25	4	4.40
26-30	2	2.20
33+	1	1.10
Total	**92**	**100.00**

Source own survey 2010-11

4.2 Daily Amount of the Respondents' Income in ETB

The majority of the WFCs are living in a poverty condition (75 percent), in which they earn less than one Dollar a day, as stated by the World Bank (2002) regarding the poverty line (1 USD threshold for poverty line). On the other hand, an insignificant percentage of the respondents were found to earn more than a Dollar daily (1.10% to 2.20%). The finding of the present study implies that these women live in poor conditions. In contrast, qualitative findings indicate that there are some people in the Household helping generating income from the business activities in backstreet market, and other informal sectors.

As far as yearly household income is concern, there is a great variability among WFCs in the study. Twelve percent of the sampled respondents were found to earn ETB 2,501.00-3,500.00 per year, whereas only between 2.20% to 3.30% earned an amount about ETB 7,501.00-8,501.00. An individual requires a total amount of ETB 5976.00 to live and work in health condition annually. The study found out that about 30 percent of the respondents earned less than the above-mentioned amount annually. The remaining proportion was found to be in relatively good living condition as they were found to earn an amount which ranges from ETB 7,501.00-8,501.00. The minimum amount of annual household (HH) income was found to be about ETB 500.00 whereas the maximum amount was ETB 8,501.00. This happened like that, because some HHs had been engaged in other income generating activities such as spinning, weaving, daily laborer, petty trading, washing clothes on house to house basis, baking *ingera,* and brewing, and when it was summed up on annual basis it appeared to be like the above estimations.

Table 2: Yearly Amount of the Respondents' Income in ETB

Birr	Frequency	Percent
<500	2	2.20
501-1500	20	21.80
1501-2500	17	17.7
2501-3500	11	12.00
3501-4500	20	21.9
4501-5500	9	9.7
5501-6500	2	2.2
6501-7500	6	6.5
7501-8500	2	2.2
8501+	3	3.3
Total	**92**	**100.0**

Source own survey 2010-11

Household Income

The sources of household income in the study were found to be composed of husband, wife, and parents of either household head, children and brothers-in-law. The males' household heads normally contribute to the household with income they would get from weaving staffs, while their wives would be away for firewood harvesting. These are highlanders from Gamo communities and skillful weavers who migrate to Addis Ababa looking for better markets and better pay for their products (Olmstead, 1974), cited in Getaneh Mehari (2006).

In answering the question whether a large number of dependents in the family would constitute a problem, 54.30 % out of a total of 92 sampled respondents said that no matter the size of their aggregate it would not make any difference, while 46 percent said yes it would.

4.3 Firewood Collection and Markets

A significant part of the women firewood collectors (43.50 %) woke up at 05: 00 am; while others (11 percent) at 04: 00 am to go to forest to collect firewood and other resources and in the process they (30.40 % and 26%) would spend in there, on average, 5 hours a day. There were still others (10 percent and 6.50 percent) who would spend even more like 6 and 8 hrs, respectively. These statistics really show how dependent these people were on the forest and the danger it represents to forest degradation and soil erosion, as well as to the environment as a whole.

The researcher's direct communication with the respondents and observation revealed that all of WFCs were collecting firewood from the reserve forest. The main purpose for harvesting fuelwood was basically to generate income to purchase other goods needed in the household. Those goods were food, soap, clothing and footwear, utensils, utilities, etc. The other purpose for harvesting firewood from the reserve forest was for consumption in order to provide household with the necessary cheaper energy for cooking and heating.

Concerning the marketing, the findings of the study document indicate that the prices of different sized bundles of firewood, including dried leaves and brunches, come up with mix varieties of figures that range from ETB 1.00 to 40.00. Simple survey revealed that there are over 13 market places in and around the study areas of the Woreda, where the WFCs were selling bundles of firewood.

The findings of these market places showed that four (4) scooped dried leaves with two hands was ETB 1.00; very small bundle of dried brunches with dried leaves was four (4) ETB. The minimum price of a bundle of firewood sold by a WFC in the market place was between ETB 18. 00 and ETB 20. 00. The price of the same size of the bundle of firewood could vary from one trader to another in the same market. If another trading woman, other than the firewood collectors, was to sell the same size of bundle of firewood the price would increase by ETB 5.00 (minimum) and ETB 8.00 (maximum). So, considering the above-mentioned circumstances, the average prices (minimum price) in the market ultimately range from ETB 25.00 to 28. 00. The maximum price ranges from ETB 30. 00 to ETB 35.00, contrary to what the traders had previously said to be ETB 40. 00 the selling price for the bundle of firewood. After a number of observations of the market prices at different market places, it was found that the latter was the accurate price.

Observation showed that there were a number of well-organized full time women fuelwood traders who had been supplying different sized bundles of firewood into the local market places in those above-mentioned areas of the Sub City, in Addis Ababa. These women were found to have already established socioeconomic relations with the WFCs in the study area and its surroundings, and even with firewood traders from both sexes that brought the bundles by loading them on ISUZU trucks to the City Government Administration of Addis Ababa.

Despite these happenings, these women, whose perception by the society is belittled everyday because of what they do for a living, who walking long distances, often barefoot, back-loading bundles of firewood under the intense sun, faced the unfair prices of the local markets, most of the time practiced by wholesalers and retailers. The WFCs would return home silent and almost empty handed, experiencing physical, social and psychological impact. These women, who many times buy a bundle of firewood from the forest at ETB 15.00 to ETB 20.00, ended up selling it with a marginal profit of ETB 5.00. That is the fate these women have to face sometimes (personal communication).

The women found it to be very risky to collect firewood during the rainy season, because in that period of time there were many wild animals in the forest. Another inconvenient fact expressed by the respondents was that the wet leaves and small wood they harvested from the forest could not be sold immediately. It would require a special place to keep them until such a time they would be dried and ready for sale. Although in the end the products would cost more in the market and therefore it meant more money for the WFCs, they expressed fear of being attacked by animals like hyenas and monkeys. Another serious risk stated was the heavy rain. When they were caught in by a sudden rainfall, the probability of becoming sick was very high; sicknesses like upper respiratory infections, cold, asthma and the like.

4.4 Place of Firewood Collection

The findings of the study show that WFCs did collect firewood from reserve forest/plantation. In accordance with the quantitative data reported, 100 percent of the WFCs harvested firewood from the above-stated area.

The respondents, when asked about the number of times they collect firewood from the forest, 30.4 % said they did it every day, 13 percent of them collected firewood five days a week and 12 percent went to the forest every two days and finally 3.3 % said six days a week.

The WFCs' main purpose for going to the forest was not only the collection of firewood. Sometimes, about 4 and 2 percent of them engage in wild fruit collection and other wood products.

4.5 Some Aspects of Forest Law and Enforcement

This study generated both quantitative and qualitative data on whether the efforts to reduce illegal firewood collection on and off reserved forest in Entoto Mountain were effective or not. Quantitatively, the study figured out that about seventy-one percent of the women respondents had stated that the efforts in Woreda 1 Administration were ineffective to prevent 'illegal' firewood collectors from entering into the reserve forest. Findings from qualitative research of this study also revealed that the existing forest laws that have been enacted and rectified by the national authorities were not being implemented properly, at least at local level. While conducting semi-structure interviews with three different government officials at Gulele Sub city Environmental Protection Sector Office, as they confirmed, 'the forest laws of Ethiopia are there, but how do you expect us to implement it? There are many compatriots out there who are poor and in need of forest resources to eke out their living, including women firewood collectors, peasants in and around the forest. It is impossible to implement and realize our existing forest laws on the ground as long as there are their bellies to be filled in!' In fact, this holds true in many African countries. These arguments also reflect the findings of Yonas Yemshaw (2001) who, referring to the Proclamation 94/1994, which provisions stipulate that forests are to be utilized according to the management plans and that the local people may utilize natural forests in respect of these management plans and by paying the appropriate fees according to their extractions, said both provisions were never implemented as only a few of the forests had management plans and owing to extreme poverty, it was not possible to charge the local people for wood extraction. In fact, to the best of the researcher's knowledge, some legislators had prescribed laws in some developing countries that did not work (and they had to shelve them). And this is because they did not consult the local people before hand to find out whether those laws were appropriate against the reality on the ground. So, formulation of laws and policies is sometimes made without taking into account the actual circumstances the targeted populations live under, rendering the laws and policies inoperative. This situation is common in many African countries. In Ghana, for instance, concerning forest policies, institutions and policies, the study revealed that community members often resort to measures that tend to resist the enforcement of these policies, drawing on members' social power or capital to alter and or transform such enforcement (Abane, 2009).

The study further tried to find out the reasons why the Process Owner's Office was ineffective to reduce illegal firewood collection on and off forest reserve. The respondents responses to this question was reflected in a mixed way, as they (31.5 %) said 'while the forest laws restricted me from getting access to the forest, my capacity to pay the required amount of money (as bribe) paved the way for me to enter the forest'. 26.1 % said, 'our social contact and relationship developed with the guards positive attitude towards WFCs and they helped us to collect firewood'. Fifteen percent of them answered as follows: 'WFCs access to the forest mostly depended on the willingness of the forest security guards'. One percent reported that 'we have already got informal permission to enter the forest; while 26.1 % said that 'I have no idea about the forest laws and no problem regarding entry into the forest'.

A semi-structured interview with a guard was conducted in order to determine his job description as well as those of his colleagues and their socioeconomic status. At the end of the interview, it was found that the total number of guards assigned to the area which extend from Entoto Saint Mary Church to French Saint George Church, which is approximately 55 ha, are sixty five (65) (permanent and temporary employees). Their age ranged from 35 to 55 and they belong to different ethnic groups such as Gamo, Oromo, Gurage, Amhara and Tigrian. Each of these guards earned a monthly salary of ETB 400.00 out of which they pay house rent of about ETB 70.00, taxes and pension. These guards had an official mission of watching over and patrolling all the above-stated geographical extension of forest under the responsibility of Ethiopia Cultural Heritage, which had been given the mandate to protect and conserve the forest in that area. Only five (5) guards patrol all the area every day.

After the interview, the researcher was able to draw the conclusion that this guard and his colleagues were working under severe pressure. The number of patrolling agents was very small in comparison with the geographical extension of the area they were told to control. They were living very humble social lives with their families. In times like these, in which everything is found to be expensive, it is hard to realize that these guards, who are 45 years old and above, earning a salary of ETB 450.00, still have energy and strength to stand the cold very early in the morning and late evening. These guards need a huge supplement of staff to help them in patrolling and positive incentives, if they were to succeed in effectively protecting the forest. Otherwise, they will continue to accept bribes, to use violence against WFCs and be loose in their activities to protect the forest.

4.6 Standards of Living and Housing Conditions

Observation by the researcher revealed that the housing units and conditions in the study area where WFCs were living in were deplorable. The houses were made of wood, mud, stone, cement, plastered hollow blocks, bricks, and corrugated iron sheet; their ceiling construction materials were fabrics, bamboo/reed, chip wood/hardwood, and grass; but the environment was extremely filthy and would normally be considered unfit for human habitation. Fifty percent of them have no latrine, sharing common pit-latrines. The statistical data gathered shows that the remaining 50 percent of the respondents whose houses have latrines, 28.3 % of those latrines are located outside the compound and are old requiring cleaning and maintenance. Only 7 percent declared to have them inside the house. These unsanitary conditions, coupled with high population densities, make the environment highly hazardous, particularly to children.

Little over 75 percent of the sample respondents share a single multi-purpose room with other household members and/or other families. The common room is used for cooking, dining, storing, sleeping and as a living room. Some even do not have such a room; they live with others as dependents or use a corner of a kitchen as a sleeping place against payment of a small amount of money every month. Only 6.50% had a house with two rooms. About three-quarters had wooden and metal beds.

Table 3: Number of Rooms per Respondents' Households

No. of rooms	Frequency	Percent
One room	70	76.10
Two rooms	16	17.40
Three rooms	6	6.50
Total	**92**	**100.00**

Source own survey 2010-11

Nowadays, due to land scarcity, it is extremely difficult, in Addis Ababa, particularly within the confines of the population surveyed, for individual households to build their own houses. Normally, in the urban centers people rent houses according to their ability to pay. So, among the respondents, 80.40 % rented the houses they are living in. Only 11 % of them have their own houses. Based on the results of cross-tabulation analysis, the study indicated that ownership of a house was not dependent upon the average of yearly household income at $\chi 2_{\text{calculated}} = 190.053$, df = 159 and p = .047. Therefore, those WFCs who had earned relatively higher average yearly income might not have owned the house they are currently living in.

Table 4: Ownership of the House in which the Respondents Live

Ownership Status	Frequency	Percent
One's own	10	10.90
Rental	74	80.40
One's parent(s)	7	7.60
Lives with one relative	1	1.10
Total	**92**	**100.00**

Source own survey 2010-11

Typical of big urban centers, house rent is a nightmare when it comes to its costs. Addis Ababa is not an exception. But, obviously, it all depends on one's pocket. In the study area, the monthly house rent for people of low income earnings like the sampled WFCs was found to be from ETB 3. 00 (from kebele owned houses) up to ETB 350.00 (privately owned houses). So, the average monthly payment (for rental houses) was ETB 89.00. But, of course, as it was stated earlier on, these are houses with no human conditions of habitability. And 76.10 % of the respondents said that they are the ones who pay their house rent, and they live in the area for a period between 1 to 54 years, which implies that they have spent a lot of money when compared to their meager savings. On the other hand, it also revealed that while some have settled there for a long time, others are recent migrants.

Although the vast majority of respondents do have access to electricity, nonetheless they use it only for lighting. For cooking, brewing and heating, 67 % of them use Kerosene dried leaves and/or firewood in order to save money for other purposes. But, the implication of this situation is the huge amount of pollution the city has in the atmosphere.

Water is scarce. Access to water is still very basic in certain areas. Despite the fact that water, when it runs at home it does intermittently, 71 percent of the respondents still managed to get it through the pipe system, while others get water either from wells (38%) located outside the compound (shared) or freely from springs (11%), which is about 2 km away from their residences.

Women fuelwood carriers being studied here have a very narrow view of capital assets. They consider assets as being the capital observable immediately in their surrounding such as those described in the Table 19. Unlike others in similar situations in different countries, like Ghana, who consider their immediate natural environment as presenting natural assets. They perceive lands, forest areas (including forest reserves) as a major source of natural assets (Harrison, 2006: 27). Natural assets are perceived by them as something valuable and given by nature. In this regard, some of them claimed to own land resources and/or fruits and vegetables back home. Cross-tabulation result shows that there is an association between the period in which the WFC had been engaged in harvesting firewood and the ownership of natural assets at $\chi2_{\text{calculated}}$ = 27.884, df = 19, $\chi2$ critical/table value = 30.1435 and p = .086, with 95% confidence level. According to their perception and understanding, 22.40 % realized that the assets they got here in Addis Ababa are just physical capital such as cooking gas stove/Buta gas in Addis Ababa. Further, significant part of them (22, 20 %) declared to have only a dining table. The study also found that there is a relationship between duration of firewood collection and ownership of physical assets at $\chi2_{\text{calculated}}$ = 31.774, df = 19, $\chi2_{\text{critical/table value}}$ = 30.1435 and p-value = .033. This is to say that, the longer the WFCs collect firewood, the more physical assets they are likely to get.

Table 5: Distribution of Physical Capital being owned by the Respondents

Assets Owned by the Respondents [a]	Responses N	Responses Percent
House of one's own	5	1.20
Telephone	5	1.20
Television	2	0.60
Dining set	91	22.20
Radio	73	17.80
Tape recorder	57	13.90
Bed room set	42	10.20
Cooking gas stove/ Buta gas	92	22.40
Others - household utensils, and related items	43	10.50
Total	**410**	**100.00**

Source own survey 2010-11

4.7 Savings

About 28 percent of the respondents used iddir banking system to save their money. Some 6.50 % used both Iqub and Iddir, while 4.30% used iqub, and 1.10 % said both iqud and bank. For instance, the amount of savings 11 respondents (3.30%), of the total 92 WFCs, had managed to deposit in the Iqub system was ETB 8.00 monthly. Another (3.30%) also deposited ETB 40.00, while 2 of them (2.20%) had saved ETB 5.00. So, it is reasonable to conclude that about a quarter of the WFCs in the study had shown the intention of building up some kind of financial capital through savings. The results of a cross-tabulation analysis indicate that there is a relationship between the period of firewood collection and ownership of financial asset at $\chi2_{\text{calculated}} = 15.963$, df = 19 and $\chi2_{\text{critical/table value}} = 30.1435$, p = .660, with 95% confidence level. Therefore, those WFCs who have been engaged in the business of firewood collection for longer period of time managed to build up their financial assets.

4.8 Medical Services

As far as medical services are concerned, the WFCs were asked whether they were able to pay for it if one of their household members fell ill. About 67 percent of the respondents said no, they did not have the capacity to pay. Only 32.60 % said yes. Among those who did not have the ability to pay a medical treatment, only 11 (12 percent) of the respondents had medical insurance and in some cases (6) it did not cover drugs and laboratory expenses. This situation explains clearly the extent to which these women are poor and behind the curtains. Therefore, the only way they had to survive was to tap into the forest resources. The bivariate analysis reveals that there is association between duration of firewood collection and the WFCs' capacity to pay for medical expenses at $\chi 2_{\text{calculated}} = 24.\ 549$, df = 19, $\chi 2_{\text{critical/table value}} = 30.135$ and $p = .176$. thus, one can deduce that the WFCs who have been harvesting and selling firewood for longer period of time are capable of covering their medical expenses.

4.9 Awareness about Forests and Related Issues

The respondents' levels of awareness about forests and related issues are indicated in the table that follows. Eighteen percent of the sampled respondents said they were aware of the fact that the Entoto Mt. belongs to the Government. About 16 % of them reported that they know about the existence of Government's regulation concerning the forest. About 15 percent of the WFCs know that the fuelwood collection in the forest controlled by the Government is illegal. But, they forget this fact when the belly starts ringing, warning about the lack of food. About 14 percent of the respondents said that they had heard about deforestation. But, 'we have no choice', said one of them. 'How then were we supposed to make a living, and the forest is the only resource we got?'

Table 6: Awareness about Forests and Related Issues

Awareness Levels	Responses N	Responses Percent	Percent of Cases
Whether or not the respondent is aware of the forest on Entoto Mt. belongs to the Government;	64	18.30	82.10
Whether or not the respondent is aware of the existence of any Government's regulation concerning the forest;	55	15.80	70.50
Whether or not the respondent is aware of the reasons for established regulations by the Government (if any);	35	10.00	44.90
Whether or not the respondent is aware of the implication of indiscriminate cutting of trees to the environment;	47	13.50	60.30
Whether or not the respondent has heard about deforestation;	50	14.30	64.10
Whether or not the respondent understands the relationship between deforestation and soil erosion;	47	13.50	60.30
Whether or not the respondent knows that the fuel wood collection is an illegal activity.	51	14.60	65.40
Total	**349**	**100.00**	**447.40**

a. Dichotomy group tabulated at value 1.

Source own survey 2010-11

Although these women fuelwood carriers were basically illiterate, some of them were nonetheless found to be a little bit aware of the value of the forest. They recognized that forest is not only important for the extraction of food, fuelwood and timber, but that it also must be taken care of and protected against soil erosion, in order to ensure both its sustainability and their sustainable livelihood. They perceive the forest as something good for the environment as a whole.

The study assumed that the perception of the WFCs towards the forest, in terms of the environment as a whole, is dependent on educational level. Similarly, the cross-tabulation analysis revealed that the women's perception regarding the forest was associated with their level of education at $\chi 2_{\text{calculated}} = 7.556$, df = 7 and $\chi 2$ critical/table value = 14.0671 at p = .375 with 95% confidence level. Thus, those women who have achieved higher educational level have a better level of understanding of the importance of the forest in terms of the environment as a whole.

4.10 Perception of Forest Cover and Deforestation

Respondents across the survey area reported an overall decline in forest cover as far as they remember. Eighty-eight percent of the respondents were of the opinion that the peri-urban forest in the study area is decreasing compared with the forest coverage that was there 10 to 15 years back. However, a minority (4.30%) reported that the period of decline was now over and in recent years the forests is becoming better, while another 4.30 % said that the forest did no change.

Table 7: Current status of Peri-urban forests

Forest Status	Frequency	Percent
1. Decreasing in high rate	81	88.00
2. Becoming better	4	4.30
3. Increasing	3	3.30
4. Unchanged	4	4.30
Total	**92**	**100.00**

Source own survey 2010-11

On the reasons why it is increasing, decreasing or becoming better, 65.20% of the respondents said that it is decreasing because the City Government Administration of Addis Ababa sells the

Eucalyptus trees. 28.30% were of the opinion that the reason why the peri-urban forest is decreasing is because the forest sector of the Woreda 1 or that of the Gulele Sub city cut and sell the trees in order to generate revenue, without bothering much about replanting of the seedling. Only 2.20 % of the respondents expressed optimism by stating that the concerned body is planting seeds and that there are new off-shots from the already cut logs.

4.11 Rural-Urban Migration

The study indicated that seventy eight percent of the respondents were found to be migrants from different parts of the country, whereas only 22% were born and brought up in the study area. The findings of the study were in agreement with others studies on the same subject, like that of Fekerte Haile (1991). There might be a number of contributing factors, among which perhaps population density may have a lion share. For example, some of the groups of migrants in the study area were from Gamo Gofa, whose population density is 145 persons per sq. Km (CSA, 2008). According to Getaneh Mehari (2006), citing Freeman (1999), Gamo people are highlanders with an economy predominantly based on agriculture. Freeman and Pankhurst (2001: 181), also cited in the same literature, considered the above community as a population with high density and quite small land holdings. They went on to say their land is less fertile and as a result the productivity is low. Getaneh Mehari, citing Olmstread (1974), said the life of Gamo people particularly that of Dorze, is highly associated with rural-urban migration which has to do with weaving economy. Weaving is associated with 'national market', because weaving products are most profitably sold in urban centers. That is why most of the weavers migrate to Addis Ababa (Olmstead, 1974). The research also found out that Gamo men (husbands), being the most skillful within the community of weavers, come first to Addis Ababa, followed by women (the wives) in order to contribute to the household income by collecting firewood (personal communication). This is followed by Tigray, whose regional state recorded 91.2 persons per sq. km. The Amhara come next in terms of numbers of migrants into Addis Ababa, particularly in the study area, whose regional state registered a population density of 108. 15 persons per sq. km. Oromya, with a population density of 76.93 persons per sq. km. Southern Nations, Nationalities, and Peoples Region (SNNP) with 142 person per sq. km. Finally, Gurage region, whose population density was 217.13 persons per sq. km. These are the Regions where the women fuelwood carriers (WFCs) come from due particularly to population pressure in those areas.

However, migration is not a recent phenomenon and it continues to be one of the biggest sources of the fuelwood carriers. Fekerte Haile, in a study on FWCs (1991), found out that a high influx of women to Addis Ababa was reported during the Italian invasion (around 1940) (21). More recently, a report in 1973 indicated 11 per cent more female migrants into urban Ethiopia. The main objectives of the then women migrating to urban areas were to seek for better educational and employment opportunities and to escape from famine (22). Today, the migrants' purposes of coming to Addis Ababa remain the same, including population pressure in the face of shortage of land, both for farming and building, which was already referred to above, looking for ways and means to maximize their potentials and the value of their lives.

4.12 Alternative Livelihoods

The matrix produced by the SPSS data analysis clearly indicates that the majority of the forest-dependent populations have shown positive attitude to change the different activities they had been doing in the forest reserve surveyed. A total of 87 (94.60%) of the respondents stated that they would like to change their activity of firewood collection, while only 5 (5.40%) of them had refused to do so. The same study documented that 61 percent of those women who had already shown positive deviance to change their livelihoods in relation to the forest reserve were further asked about whether or not they had the necessary skills to make the necessary change. In response, they said that they had different types of skills for engaging in alternative livelihoods' activities. The skills found to be at the disposal of the respondents show that most of them had been equipped with relatively unsophisticated or unspecialized types of skills, which could be categorized as household chores and income-generating activities (IGAs) in the study area. The kinds of skills found to be available among the respondents who had already shown interest in changing their present business in the forest reserve (i.e. firewood collection) were the following in their decreasing magnitude: skills for starting and running businesses at back-street markets effectively (9.80%), baking *injera* (meaning the Ethiopian bread) on electric stove (7.60%), washing and ironing clothes (7.60%), spinning a bundle of thread for making Ethiopian traditional or cultural clothes (7.60%), preparing local brewery (4.30%), baking bread or cake (4.30%), spinning cotton (4.30%), food processing (2.20%), making soaps (2.20%), hair dressing

(2.20%), embroidery (2.20%), only 1.10% of them had the skills for running eco-tourism recreational centers. Among those respondents who claimed that they had no skills of any sort, all of them, that is, 34 respondents or about 39 percent of them, out of the total sample in the study, were unanimously found to be interested in attending training on development of skills for household income- generation. Those respondents also showed keen interest in getting trained in food processing (29.41%), followed by basic business skills (BBS) for starting and running any type of income- generating activity (20.70%). However, the women's interest in attending training on bakery, weaving clothes using modern weaving technologies, and making and producing candles as well as waxy candles, accounted for about 12 percent. In general, the majority of those WFCs (about 87 percent) confirmed that they would like to participate in the skills training program and be engaged in non-forest based economic activities such as bakery of *injera,* using electric stove (38.23%) any type of income-generating activities (23.53%), and food processing using alternative household energy sources (about 24 percent).

The contribution of the non-forest economic activities in the livelihood of the WFCs, which had been carried out to some extent by the respondents studied, documented positive results. About 9 percent of the respondents argued that the contribution of those livelihood activities to their household income has been very helpful, and 23 percent claimed that they are supporting their household income. Despite the fact that another 9 percent of the respondents had argued that those non-forest economic activities they had been engaged in for years did not help much, due to the soaring living expenses they have to cope with in the City of Addis Ababa.

Surprisingly, almost all of the respondents (94 percent) had never participated in any alternative livelihood training programs to augment the already available income in the households. Only 6.50% of those women firewood carriers had participated in some sort of alternative livelihood training programs, but with different types of IGAs (4.30%), like artifacts made of different materials (2.20%). Therefore, based on the findings of the study, one can deduce that the WFCs do show affirmative attitude towards changing their present livelihoods, which is firewood harvesting. The survey also reveals that the few skills they possess are unspecialized ones and they do not help them much to generate enough income to contribute to a better life of the members of their households. Unfortunately, the WFCs do not have experience of participating in and generating incomes from different components of alternative livelihood programs like hairdressing, artifacts and so on.

In this study, different types of alternative livelihood programs both at the level of the WFCs and the level of household were considered. The respondents gave more than one response. The study revealed that 100 percent of the women would be interested in participating in backstreet market business, and 98.9 % of them were keen in, first, getting organized into an association and then they would engage in trading business. Meanwhile, about 48 percent of the women expressed their desire of modernizing their traditional weaving work, as they stated they would, together with their husbands, engage in weaving traditional clothes, using modern technologies. About 14 percent of the women showed interest in establishing a modern dairy farm business, while 8 percent would like to sell fruits and vegetables. These results indicate that the WFCs are more interested in individual marketing businesses of small-scale than group-based marketing businesses of medium-scale.

In the same perspective, each household of the WFCs was asked about the choice of participating in an alternative livelihood program. The findings of the study showed that all of the respondents would like to be involved in spinning cotton to make thread (i.e. a business they have already been practicing for years). They also expressed the desire to become later on members of the already established Association of WFCs in the study area. But, given the current circumstances, the women firewood carriers are relatively comfortable with the existing living process and context, because they are already tired of asking for support for various types of alternative livelihood programs, but to no avail.

Based on the results of Pearson chi-square analysis, the duration of the WFCs' engagement in firewood collection is associated with their willingness to change the current business in the forest into alternative livelihood options at $\chi2_{\text{calculated}} = 3.6747$, df = 5, $\chi2_{\text{critical/table value}} = 11.0705$

and p-value = .601. This shows that the longer the WFCs remain in the current business the more they develop a positive attitude to change. This is because they want to realize a better living condition.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The importance of this study is to address the dichotomy of poverty, on the one hand, and deforestation and degradation, on the other, thereby striking a balance between sustainable livelihoods for women fuelwood carriers and a sound and sustainable forest. To do so, the researcher embarked on a survey on the ways the women fuelwood carriers live, their socioeconomic situation and attitudes and perceptions about the forest, in order to be able to determine the extent to which their interactions with the forest can bring about deforestation and degradation, and more poverty. By so doing, this study has shown that a socio-economic perspective must take into account an ecological perspective in considering future approaches to forest management. The livelihoods of the population in the study area generally depend on forest resources. The data presented here suggest that the production and sale of fuelwood and other NTFPs provide important sources of cash income for the surveyed WFCs. The study also found that the WFCs live almost in absolute poverty and have no other alternative source of income, and, worse still, most of them are illiterate. Despite of this fact, they can reasonably understand the importance of the forest resources. They are aware of the fact that if they continue to overexploit the forest resources in the form of fuelwood harvesting and timber felling, in the long run, the end result will be deforestation and degradation, and thereby probably the extinction of the only means of survival. But, unfortunately, these are not the only factors causing deforestation. There are other concurrent elements that must be taken into account such as population growth, the rising demand for land for farming, grazing and human settlement. All these problems sooner or later will affect very much their livelihoods.

To minimize and ultimately avoid these inconveniences, the environmental authorities should, in their reforestation program of the Entoto Mountain, consider the integration of eucalyptus. In doing this, they should also create a buffer zone for firewood consumption.

Reserved or "Protected" Forest is known to threaten the livelihoods of forest dependent populations. It proves a challenge for management authorities to reconcile the need for the protection with the recognition of the livelihood dependencies of local communities.

There are legislations to regulate the use of forest resources, such as the Proclamation 94/1994 which, among other things, introduces the principle of benefit sharing with local people in forest management and public participation. But this principle has no effect, because emphasis was put on sectoral coordination with the Ministry of Agriculture and other related sectors.

The same law regulates the utilization of forest resources by the local people, which requires them to obey pre-determined management plans and to pay appropriate fees in accordance with the volume of their extractions. However, the enforcement of these provisions lives much to be desired, due to lack of adequate management plans and owing to the extreme poverty in which the local people live, rendering it impossible to anyone to charge them.

Community-based forest management (CBFM) or community forest (CF) is now becoming a global phenomenon. Engagement of the people dependent on forest in some sort of negotiation of institutional arrangements, outlining of roles and responsibilities, and once a legal framework is in place, the preparation of management plans for simple and easy implementation by them, provision for forest product harvesting, sharing of these and other benefits, and so on, could be a step in the right direction.

National governments all over the world have either revised, or are revising, their national forest policy and legislation with a provision for involving local communities in the management of their country's forest resources. Many bilateral and multilateral development agencies and private organizations have supported, and some are still supporting, field implementation of new policies.

5.2 Recommendations

Given the importance that the forest has for so many people in economic and ecological terms, particularly for WFCs and the rest of the local population dependent on its resources, as well as the need for the local authorities to address the enormous socio-demographic and economic challenges the WFCs are facing, the following recommendations might perhaps help decision-makers and planners to solve the above-mentioned problems:

1. The local authorities, local population and other relevant stakeholders at the different levels should consider ways and means to improve the WFC socio-demographic and economic situations in an integrated and comprehensive approach. This approach should be based on interventions tailored to women, such as the provision of Alternative Basic Education, life skills, reproductive health, modern technology-based weaving and spinning, artifacts, hairdressing, basic business skills, and other vocational trainings, designed to equip WFCs with fast income-generating jobs and to gradually reduce their interaction with the reserved forest, while mitigating the levels of poverty. This approach should also help the WFCs to maximize these opportunities to create assets.

2. An effective management of forests is of paramount importance. Therefore, there is a need for all parties concerned to pursue collective participatory forest management initiatives in such a way as to safeguard the interest of all, the environment and, particularly the poor, who are the most reliant on the continued access to resources for fuelwood supplies.

3. With this in mind, there should also be plans for awareness creation on the importance of forests and for massive tree plantation, both at local and national level, because it is evident that the forest cover is reducing at an alarming rate, in order to replenish it and make it sustainable.

4. Taking into account the fact that biomass is still by far the most affordable source of energy and therefore it is largely used not only in the study area but across the population living in Addis Ababa as well, any policies designed at tightening control of the use of the forest resources should also consider a provision in the forest resources context for the remaining WFCs to collect and sell firewood in appropriate market places.

5. Given the enormous amount of people utilizing fuelwood not only in the study area but all over Addis Ababa, governmental authorities should consider and devise effective ways and means to discourage the use of biomass as energy for consumption, by promoting the use of alternative energy sources such as fuel-efficient stoves, and others like *gonzie*, biogas stove, subsidizing either the price of botanic gas and kerosene or the price of stoves. These measures would aim at reducing the air pollution in the study area considerably.

6. In most urban areas, a market for fuelwood has emerged over time, with the commodity being traded on an almost competitive basis. The market is the linkage between consumers and the sources of fuelwood. Understanding the linkages between household economic activities on one hand, and the supply of fuelwood on the other, facilitates the development of policies and strategies aimed at minimizing the impact of biomass energy consumption on the environment on the one hand, and enabling consumers to improve their welfare on the other. Such a win-win situation can be achieved by considering and stimulating the motivations of all agents involved, and understanding how these are transformed into physical entities like fuelwood demand.

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Appendices

Appendix 1: Questionnaires

Appendix 1.1: Questionnaire for Household (HH) Survey

PART I Demographic Profile and Socio-economic Characteristics

1. Region_______________ Zone_______________ Kebele_______________
Village_______________

2. Sex:

(1) Male (2) Female

3. Age: ____

4. Residential status: (1) Migrant (2) Native

5. Educational level:

5.1 Illiterate

5. 2 Read and write

5.3 Alternative Basic Education

5. 4 Primary Education (1st cycle, grades 1-4)

5. 5 Primary Education (2nd cycle, grades 5-8)

5. 6 Secondary Education (1st cycle, grades 9-10)

5. 7 Secondary Education (2nd cycle, grades 11-12)

5. 8 Above 12 grade

6. Marital status:

(1) Single (2) Married (3) Divorced (4) Widowed (5) Separated

7. Religion background:

(1) Orthodox Christian (2) Protestant
(3) Muslim (4) Catholic (5) Others specify________________

8. Household Head's Gender.

(1) Female (2) Male

9. How many persons belong to the household (family size)?

(1) Male______________________________
(2) Female____________________________
(3) Total______________________________

10. Are there any absent household members?

(1) Yes (2) No

(Determine whether or not to consider them part of the HH, using question 10. 11 and 12)

11. Why are they absent (seasonal labor migration, education, staying with family elsewhere, start own household)? (Pease choose one)

____

12. Are they absent for a period longer than 6 months?

(1) Yes (2) No

13. **If the answer to the Q. N. 11 is 'yes'**, are they part of a household in the place where they stay?

(1) Yes (2) No

14. **If the answer to the Q. N. 12 is 'yes'**: (Do not consider as HH member)

15. Do some present HH members stay in the house for less than 6 months a year?

(1) Yes (2) No

(Determine whether or not to consider them part of the household, using Question 15 and 16)

16. Are there any absent household members?

(1) Yes (2) No

(Determine whether or not to consider them part of the HH, using question 16, 17 and 18)

17. Why are they absent (seasonal labor migration, education, staying with family elsewhere, start own household)? (Pease choose one)

____

18. Are they absent for a period longer than 6 months?

(1) Yes (2) No

19. **If the answer to the Q. N. 18 is 'yes',** are they part of a household in the place where they stay?

(1) Yes (2) No

20. **If the answer to the Q. N. 18 is 'yes'**: (Do not consider as HH member)

21. Occupation: (more than one answer is possible)

(1) Civil Servant (2) Farmer (3) Firewood collector (4) Petty trader

(5) Self-employed (6) Others, specify________________________________

____

22. Number of years in occupation: (more than one answer is possible)

(1) Primary________________________________

(2) Secondary ________________________________

(3) More than, specify________________________________

23. What is your income?

23.1 Daily________

23.2 Weekly______

23.3 Monthly_____

23.4 Yearly_______

24. What is/are the source(s) of income for the household? : (more than one answer is possible)

(1) Household head
(2) Husband
(3) Parents of the household head
(4) Mather-in-law/Father-in-law
(5) Child/children (son/daughter)
(6) Others (specify)

____

25. The contribution of each income source from the total income

Total Income

Source of income	Birr/Day	Week	Month	Year
1. household head				
2.				
3.				
4.				
5.				
6.				

26. Is a Household with a large number of dependants a problem?

(1) Yes (2) No

26.1 **If your answer to the question above is yes,** explain why

____

26. 2 **If your answer to the Q. N. 26 above is No,** explain why

____

PART II Livelihoods Conditions

27. Do you undertake any activity in the forest reserve?

(1) Yes (2) No

27.1 **If yes to Q. No. 27**, what activity do you undertake?

(1) Farming (2) Civil servant (3) Logging (4) Firewood collection (5) Others, specify;

____

27.2. **If yes to Q. No. 27, h**ow often do you undertake that activity in the forest?

(1) Daily (2) Weekly (3) Fortnight (4) Monthly

27.3 **If yes to Q. No. 15, i**n case your activity in the forest is firewood collection, how often do you carry firewood?

1) Daily (2) Every two days (3) Weekly (4) Fortnight (5) Monthly

28. Do you undertake any activity in the off-reserves?

(1) Yes (2) No

28.1 **If yes**, what kind of activity do you undertake?

(1) Farming (2) Hunting (3) Logging (4) Firewood collection (5) Others, specify:

____

29. Do you depend on the forest for food (grass cutter, mushrooms, other)?

(1) Never (2) Seldom (3) Sometimes (4) Often (5) Always

30. Do you obtain materials for house construction from the forest?

(1) Yes (2) No

30.1 **If your answer to Q. No. 30 is yes,** how much do you sell it/them for?

___

31. Do you obtain materials for making furniture from the forest?

(1) Yes (2) No

32. **If your answer to Q. No. 31 is yes,** how much do you sell the furniture for? __

___

33. Do you collect herbs from the forest for medicine?

(1) Yes (2) No

34. **If your answer to Q. No. 33 is yes,** how much do you sell them for?

___

35. Do you use forest materials for customary purposes?

(1) Never (2) Seldom (3) Sometimes (4) Often (5) Always

36. The forest is important to me for fuel wood collection.

(1) Fully disagree (2) Partly disagree (3) Neutral (4) Partly agree (5) Fully agree

37. In case you **(5) fully agree**, how often do you collect firewood from the forest?

(1) Daily (2) Every two days (3) Weekly (4) Fortnight (5) Monthly

38. What do you do with the firewood you collect from both reserve and off-reserve forest?

(1) For home consumption (2) For sale

39. **If your answer to Q. No. 38 is (2) for sale**, how much do you sale a load/bundle of firewood?

(1) Minimum price_________Birr (2) Maximum Price_________Birr (3) Average___________Birr

40. Do you have any other source of income?

(1) Yes (2) No

41. **If yes**, specify all income generating activities and amount of time spent on work.

Activity	Income	Time spent on activity per day
1.		
2.		
3.		
4.		
5.		

42. How long have you been collecting firewood?

43. How many women is there collecting firewood?

____

44. How many men is there collecting firewood?

____

45. If there are no men undertaking this kind of activity, what do you think the reason is? Explain.

____

46. Have you got any idea of how many eucalyptus trees were there where you collect firewood 10 to 15 years ago?

47. How many eucalyptus trees do you think there are now?

48. How much time do you spend? In:

48.1 Firewood collection hours/day____________________

48.2 For transport from place of collection to place of sale_______________ hours/day

48.3 To sale______________________

49. How far do you travel to collect firewood, hours/day?

(1) Dry season______________ (2) Rain season__________________

50. When is it difficult to collect firewood?

(1) Dry season______________ (2) Rain season__________________

51. Why?

____

______

52. What kind of activities do you normally do?

52.1 In the morning, wake up time______________

52.2 In the evening, before going to bed__________________

52.3 State other kind of activities you are engaged in, if any:

(1) _____________

(2) _____________

(3) _____________

53. How many meals do you usually have in a day?

(1) One meal (2) Two meals (3) Three meals

54. How long have been living in your present house?

(1) Months_______________ (2) Years________________

55. The house you are living in

(1) Own
(2) Rent
(3) Parents
(4) Others, specify____

56. **If your answer for Q. N. 55 is rent,** then who pays for the house you are living in?

57. How much do you pay for the rent?

Birr/month____

58. How many rooms does the house you are living in have?

(1) One
(2) Two
(3) Three
(4) More than, specify______________________________

59. Is there a latrine?

(1) Yes (2) No

60. Do you normally use latrine?

(1) Yes (2) No

61. **If your answer to the Q. N. 60 is yes,** where is the latrine located?

(1) Inside the compound (private)
(2) Inside the compound (shared)
(3) Outside the compound (shared)
(4) Others, specify__________________________________

62. Where do you normally get water supply from?

(1) From well
(2) From river
(3) From a pipe system
(4) From others, specify________________________________

63. **If from a pipe system**, where is your water point?

(1) Inside the compound (private)
(2) Inside the compound (shared)
(3) Outside the compound (shared)
(4) Others, specify___________________________________

64. What source of energy do you normally use in your house?

(1) Electric
(2) Kerosene
(3) Others, specify____

65. Which of the following physical capital do you have?

(1) House of your own
(2) Telephone
(3) Television
(4) Refrigerator
(5) Dining set
(6) Sofa set
(7) Radio
(8) Tape recorder
(9) Electric *metad*
(10) Bedroom set
(11) Cooking gas stove

66. Do you have any of the following natural capital?

(1) Land resources
(2) Others, specify ____

67. Do you have any financial capital?

(1) Yes (2) No

68. **If yes**, would it be a kind saving account?

(1) Yes (2) No

69. **If yes**, which of the way of saving do you exactly use?

(1) Iqub
(2) Idir
(3) Bank
(4) Others
(5) None the above

70. How much do you save per month?

(1) Iqub
(2) Idir
(3) Bank
(4) Others
(5) None of the above

71. Do you get credit service?

(1) Yes (2) No

72. **If your answer to the Q. N. 71 is yes,** which of the following gives you credit service?

(1) Bank
(2) Micro saving enterprises
(3) Individuals
(4) Relatives
(5) Others, specify____
(6) No credit service

73. Would you be able to pay for medical treatment in case you or one of your dependents become ill?

(2) Yes (2) No

74. **If your answer for Q. N. 73 is no**, do you have any kind of Medical Insurance?

(1) Yes (2) No

75. **If your answer f or Q. N. 74 is no,** have you ever applied for free medical treatment when someone in your household was sick?

(1) Yes
(2) No
(3) No one in my household ever needed medical attention or treatment.

76. **If your answer for Q. N. 75 is yes,** did you get free medical treatment?

(1) Yes (2) No

77. **If your answer for Q. N. 76 is no,**
why?____

78. How many members of your household

78.1 Went to a day school?

(1) Female (2) Male (3) Total

78.2 Went to an evening school

(1) Female (2) Male (3) Total

78.3 Did not go to a school at all, why?

(1) Female (2) Male (3) Total

79. If any did go to a school at all, why not?

(1) Too young / too old
(2) Could not afford it
(3) Not a priority / did not wish to
(4) Others, specify____

80. Do you have cloths other than the one you are wearing now?

(1) Yes (2) No

81. **If your answer f or Q. N. 80 is yes,** how many pieces do you have?

(1) One
(2) Two
(3) Three
(4) More than, specify____

82. Do you normally wear shoes?

(1) Yes (2) No

83. **If your answer f or Q. N. 82 is yes**, how many pairs of shoes do you have?

(1) One
(2) Two
(3) Three
(4) More than, specify______________________________

PART III. Attitude towards Eucalyptus Forest Resources

84. How do you perceive the forest resources?

(1) In terms of human use
(2) In terms of the need for protection from erosion
(3) In terms of the need for protection of biodiversity
(4) In terms of environment as a whole
(5) In terms of need to take care of
(6) In terms of attraction for its greenness
(7) Others, specify and explain

____

85. How do you see the importance of forest resources? (Multiple choices are possible)

(1) It is a source of income

(2) It is a source of domestic energy (fuelwood)

(3) It is a source of food

(4) It is important for pollution absorption

(5) It is an habitat for biodiversity

85.1Explain your choice of answer

____

(2) Yes (2) No

86. Peri-urban forests are

(1) Decreasing in high rate
(2) Becoming better
(3) Increasing

(4) Unchanged

87. **If your answer to the Q. N. 86 is any of the above, except N. (4),** what do you think the reason for the change is?

87.1Explain your choice of answer

____

____

____

88. **If your answer to the Q. N. 87 is N. (4),** is it

(1) Good?
(2) Bad?

89. **If your answer to the Q. N. 88 is 'Bad' in relation to Q. 86. (4),** what do you think it should be done?

89.1 Explain:

____

90. Do you know how many hectares of eucalyptus trees were there where you collect fuelwood between 10 to 15 years ago?

(1) Yes (2) No

PART IV Problems associated with firewood collection, transportation and selling.

91. Where do you collect fuelwood from?

(1) At the foothill of Entoto Mountain
(2) At the side part of Entoto Mountain
(3) At the top of the Mountain

92. Are you aware that the forests in the Entoto Mountain and the surroundings belong to the Government?

(2) Yes (2) No

93. Are you aware of the existence of any government regulation concerning the forest?

(1) Yes (2) No

94. Do you know the reason why the government established regulations, if any, for those areas where you collect fuelwood?

(1) Yes (2) Not

95. Do you know the implication of indiscriminate cutting off trees to the environment?

96. Have you ever heard about deforestation?

(1) Yes (2) Not

96.1 **If yes**, explain

____

97. Do you understand the relationship between deforestation and soil erosion?

(1) Yes (2) No

98. Do you know that collecting fuelwood in those areas is an illegal activity?

(1) Yes (2) No

99. **If your answer to the Q. N. 98 is yes,** why do you collect fuelwood there?

99.1Explain:______________________________

100. Have you ever had an encounter with the guards keeping forest resources?

(1) Yes (2) No

101. **If your answer to the Q. N. 100 is yes,** what happened when you were caught?

(1) Arrest
(2) Bribe
(3) Beating
(4) Other, specify______________________________

102. Have you ever been rapped while collecting and/or transporting fuelwood?

(1) Yes (2) No

103. **If your answer to the Q. N. 102 is yes,** are you aware of health related consequences of this act?

103.1 **If yes**, please explain____

103.2 **If No**, please explain____

104. What are other risks your work entails?

104.1Explain:____

105. How far is the market from firewood collecting point?

(1) 5 km
(2) 10 km
(3) 15km
(4) Other, specify____

106. How do you manage to get to the market?

(1) On foot
(2) By taxi
(3) By donkey
(4) Other, specify____

107. **If your answer to the Q. N. 106 is by taxi**, how much do you pay a taxi to carry your bundle of firewood to the market?

(1) 1Birr
(2) 2 Birr
(3) 5 Birr
(4) Other, specify____

108. How often do you carry a bundle of firewood to the market?

(1) Once a day
(2) Twice a day
(3) Other, specify____

109. **If your answer to the Q. N. 106 is by donkey,** do you own one?

(1) Yes (2) No

110. **If your answer to the Q. N. 109 is no,** then how much do you pay for a donkey to carry the bundle of firewood to the market?

(1) 0.50Birr
(2) 1 Birr
(3) 5 Birr
(4) Other, specify____

111. How often do you carry a bundle of firewood to the market?

(1) Once a day
(2) Twice a day
(3) Other, specify____

PART V. Community Perceptions of Law Enforcement on their Livelihoods

112. I am readily informed about forest policy and forest law changes that affect me

(1) Never (2) Seldom (3) Sometimes (4) Often (5) Always

112.1 By whom?

____

113. Forest laws are favorable for my livelihood activities

(1) Fully disagree (2) Partly disagree (3) Neutral (4) Partly agree
(5) Fully agree

113.1Explain your choice of answer

____

114. Forest law restricts my access to the forest

(1) Fully disagree (2) Partly disagree (3) Neutral (4) Partly agree (5) Fully agree

114.2 Explain your choice of answer

---

115. What activities of the Forest Service's Authority (FSA) affect you in your daily life?

---

116. The activities of the FSA are beneficial for my livelihood

(1) Fully disagree (2) Partly disagree (3) Neutral (4) Partly agree (5) Fully agree

117. Do you need a permit to collect NTFPs?

(1) Yes (2) No

118. How difficult is it to get permits to collect NTFPs?

(1) Very difficult (2) Fairly difficult (3) Neutral (4) Fairly easy (5) Very easy

112.1Explain your answer

---

119. Do you think that efforts to reduce illegal firewood collection are effective?

(1) Yes (2) No

119.1Why?

---

120. How can these law enforcement structures be more effective?

---

121. I understand the responsibilities of the Forest Service Authority

(1) Fully disagree (2) Partly disagree (3) Neutral (4) Partly agree (5) Fully agree

PART VI Alternative Livelihoods

122. Would you like to change the activities you are now doing for a living?

123. Do you have any skills to change your occupation if necessary?

(1) Yes (2) No

124. **If your answer to Q N. 122 is yes**, what kind of skills do you have?

____

125. **If your answer to the Q. N. 123 is no**, would you be interested in attending any training program, if offered?

(1) Yes (2) No

126. **If your answer to the Q. N. 125 is yes,** what kind of training would you like to undertake?

____

127. **If your answer to the Q. N. 125 is no,** what non-forest economic activities do you undertake, if any?

____

128. How much does this contribute to your income?

____

129. Have you ever participated in an alternative livelihood programme?

(1) Yes (2) No

130. **If the answer to the Q. N. 129 is yes**, what were the activities under this programme?

130.1 Plantation of trees
130.2 Artifacts
130. 3 Others, specify

____

131. Were they successful?

132. What alternative livelihood would you consider appropriate:

132.1 For your community?

132.2 For you?

Appendix-2: Check List to Guide Interviews (Individual Participants Surveyed)

Livelihood/Occupation details

- What are your main activities?
- Do you have direct/indirect access to the forest?

If yes, how and in which forest do you operate?

- How do you get firewood, do you buy it directly from the guards?
- Do you buy it from somebody else?
- Do you collect it yourself?
- **If you buy it from the guards,** how much do you usually buy it for?
- **If you buy it from somebody else,** how much do you usually buy it for?
- About how many people are permanently engaged in this kind of business?
- Are you married?
- Who is the head of the household you belong to?
- Do you have children of your own? (son/daughter)
- Do you normally carry your children (son/daughter) with you when collecting firewood?
- How old are they?
- Do they also carry fuelwood themselves?
- Do they attend school?
- Which one? (school's name, zone)
- What time do they go to school?

Market

- Which market do you sell your products in (local/export market)?
- How far is it from the firewood collecting point?
- How do you carry the firewood to the market?
- Who do you sell your product to
- How much do you sell the bundle of firewood you carry to market?
- How does the current law affect your activities?

What problems do you encounter with the current forest laws?

- How difficult is it to comply with the current forest laws?

Illegal fuelwood collection activities

- What is your idea of illegal activities? (What do you think constitute illegal activities?)
- What do you think are the causes of illegal activities?
- Does illegal firewood collection affect your business in any way?
- How do you handle these effects?

- What do you think could be done to reduce illegal activities?
- How would successful reduction of illegal firewood collection affect your business?

Alternative livelihood activities
- Have there been any past livelihood programs here?
- Which one has worked?
- Which one has not?
- And why?
- Suggest ways of improving those that did not work well.

Declaration

I, the undersigned, declare that this thesis is my original and real work that has not been given for a degree in any other university and that all sources of materials used for the thesis have been duly acknowledged.

Declared by

Candidate

Confirmed by

Advisor

19.12

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

SCHOOL OF INFORMATION STUDIES FOR AFRICA

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

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE OF STUDIES

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

By

Rachel Atieno Rege

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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.

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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.

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 Kearl, 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 knowledgable 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 recieve information through the research networks, and then passes 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.

References and annexes are at the tail end of the thesis.

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

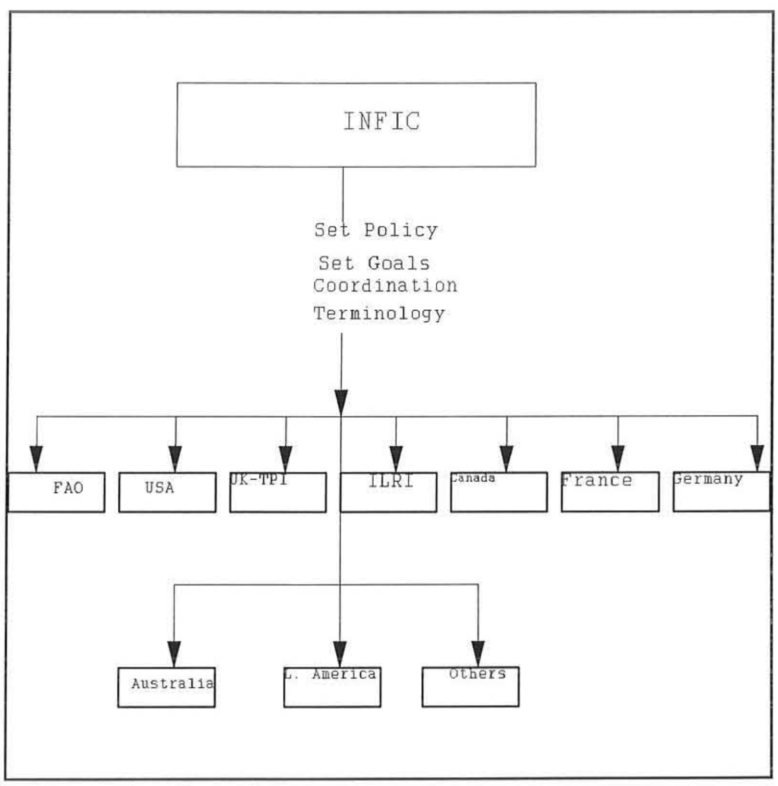
These centres are dissemination centres. They perform the following functions:

- 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 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).

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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).

ICIPE 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 Developpment 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 communnication 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 under Conservation of Biodiversity Programme, specifically under Plant Genetic Resources.

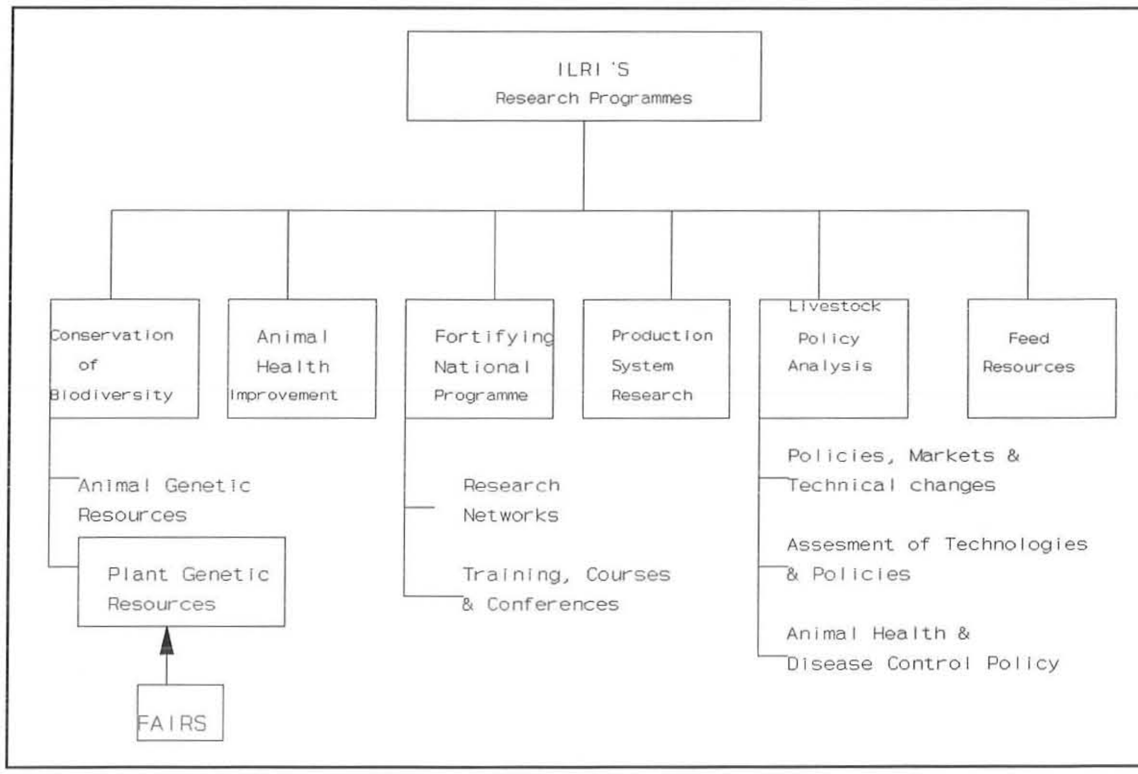

Figure 4.1: Organizational structure of ILRI's Research Programmes

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.

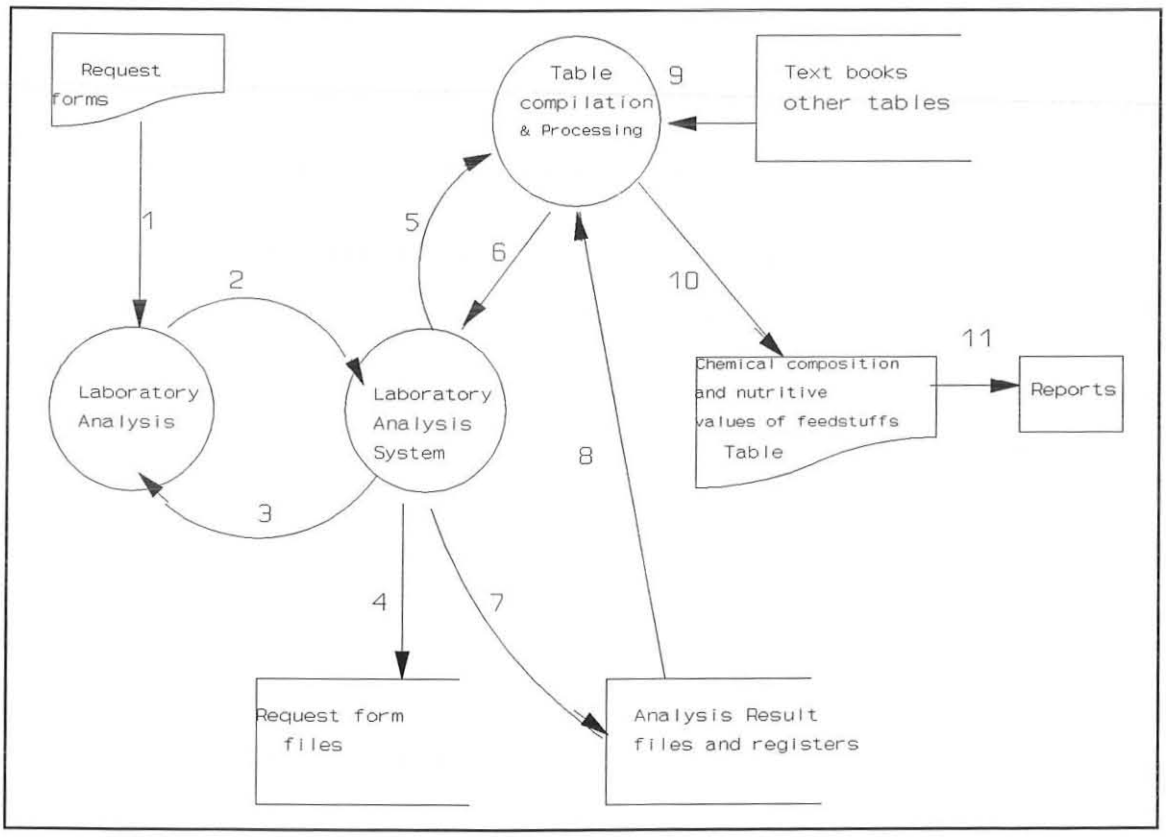

Figure 4.2: DFD OF THE FEED INFORMATION SYSTEM

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.

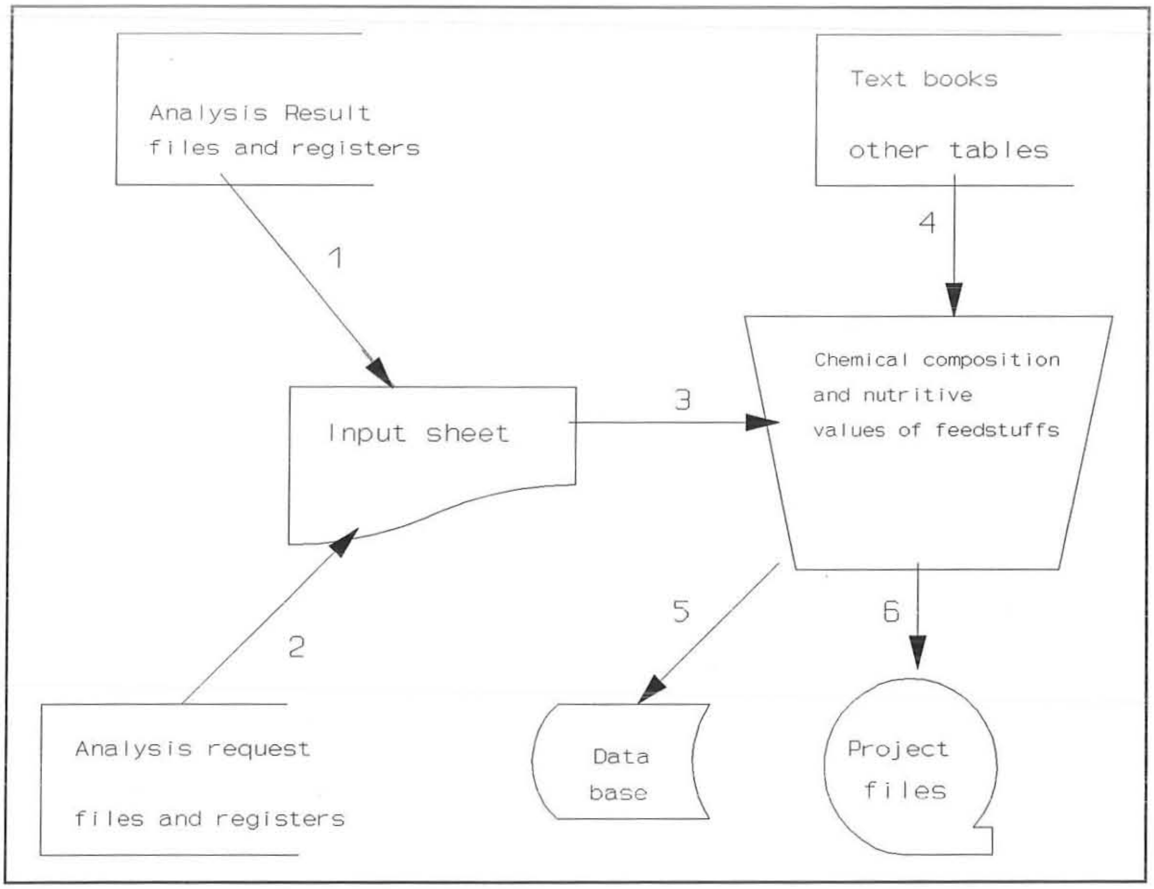

Figure 4.3: DFD of the System's Processes

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 accesibility 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 standardardized, 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	(0.00%)	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

	STATUS FREQUENCY						
SPECIALIZATION	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 that 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
Agriculture	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%)
Forage 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%)
Pasture 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 disperity 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

	CONSTRAINTS FREQUENCY			
SPECIALIZATION	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 descripption:** 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 animo 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 propposes 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.

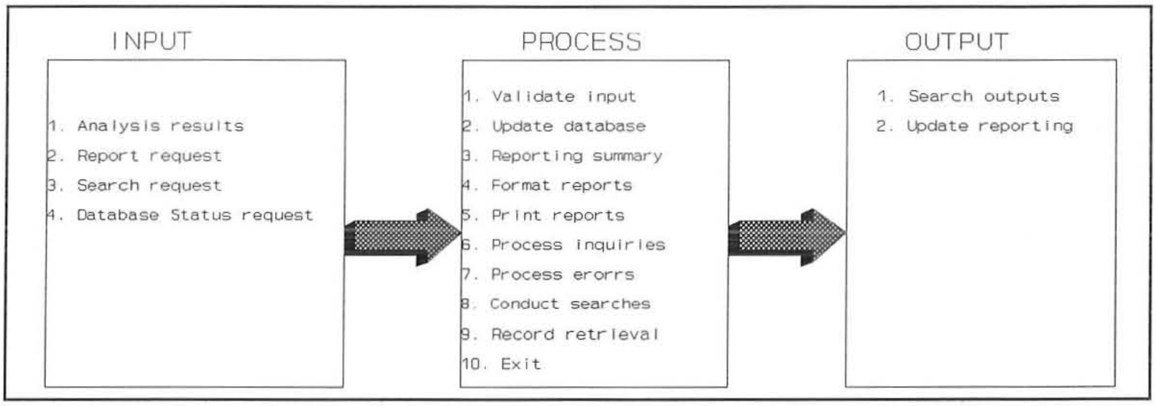

Figure 6.1: FAIRS IPO CHART

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.

<u>6.1.1.1.1 ILCA Laboratory Analysis Request Form</u>

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

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

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: VITAMIN:

NUTRITIVE VALUE:

ANTI-NUTRITIONAL CHARACTERISTICS:

FEEDING LEVELS (SPECIFY ANIMAL GROUP & AGE)

COMMENTS:

NAME: __________

Figure 6.2: Input Sheet

1. 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

WELCOME TO

FEED ANALYSIS INFORMATION

RETRIEVAL SYSTEM

(FAIRS)

SCHOOL OF GRADUATE STUDIES, SISA, AAU.

DEVELOPED BY

RACHEL A. REGE

1996

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 *************

DATA BASES

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:  XXXXXXXXXXXXXXXX.
COMMON  NAME:  XXXXXXXXXXXXXXXXXXXXXXXXXX.
INTERNATIONAL  FEED  NUMBER:  XXXXXX
FEED  DESCRIPTION:  XXXXXXXXXXXXXXXXXXXXX
COUNTRY  CODE:  XXXXXX
CENTRE  OF  COLLECTION:  XXXXXXXXXXXXXXXX
ALTITUDE:  XXXXXXXXXXXX
RAINFALL:  XXXXXX  mm.
SOIL  TYPE:  XXXXXXXXXXXXXXXXXXXXX
```

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: XXXXXXXXXXXXXXXXX

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 carter 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.

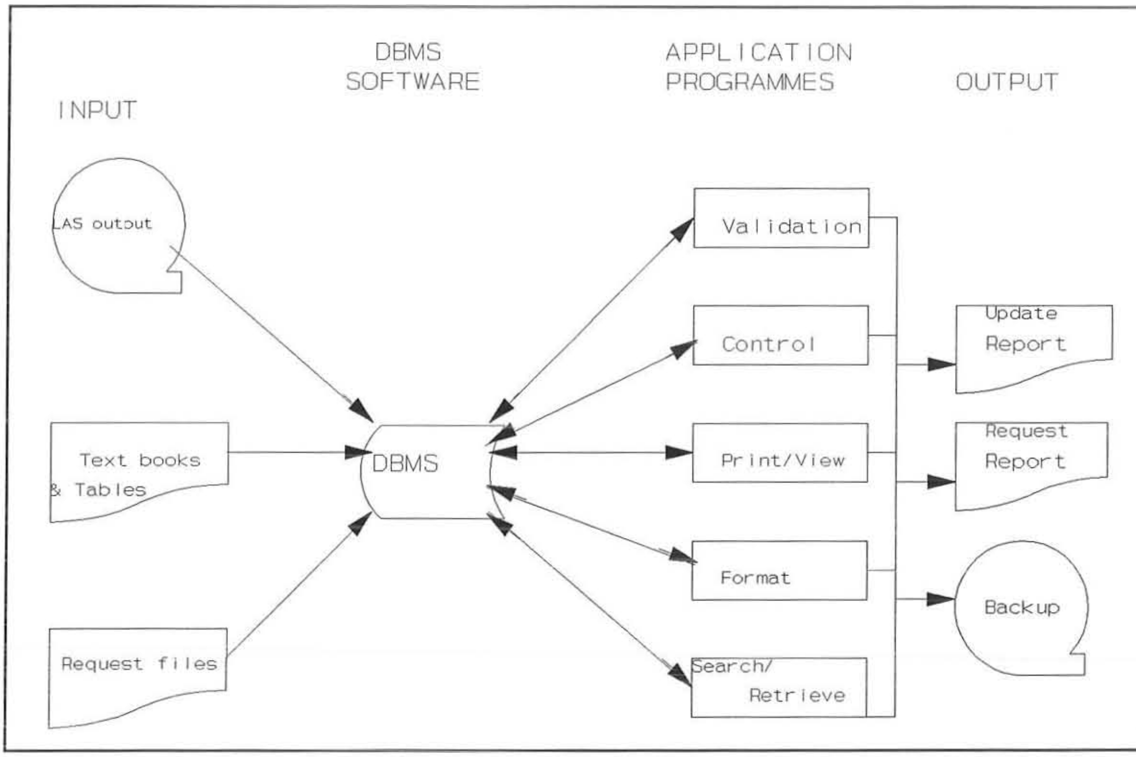

Figure 6.10: Database Schema

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, LYSINE, METHIONINE, PHENYLALANINE, SERINE, THREONINE, TRYPTOPHAN, VALINE)

7. ANTI-NUTRITIONAL FACTORS (IF_NO, FEED_DESCRIPTION, MATERIAL, FACTORS, TREATMENT BEFORE FEEDING, EFFECT ON ANIMALS)

8.INTERNATIONALSTAGES 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.

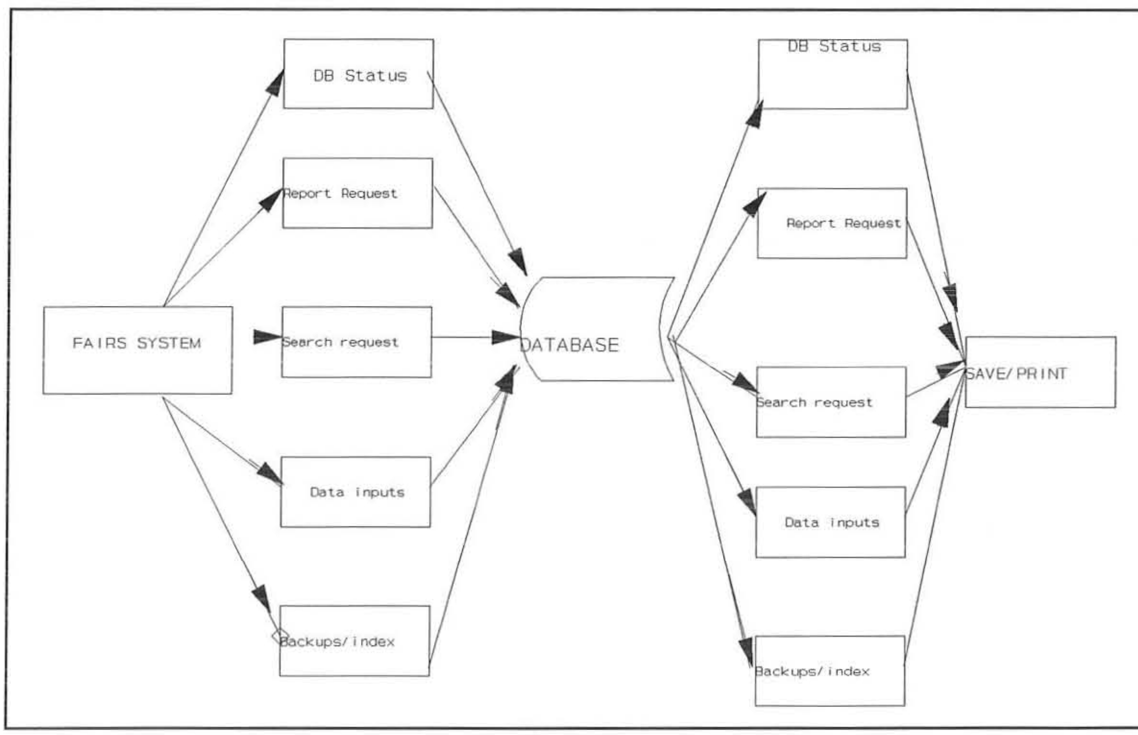

Figure 7.1: FAIRS schema

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.

WELCOME TO

FEED ANALYSIS INFORMATION RETRIEVAL

SYSTEM

(FAIRS)

SCHOOL OF INFORMATION STUDIES FOR AFRICA

SISA, AAU.

DEVELOPED BY

RACHEL A. REGE

JUNE 1996

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 selects 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: XXXXXXXXXXXXXXXXXXXXXXXXX

COUNTRY CODE: XXXXXXXXXXXXXXXXXXXXXXX

                    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: XXXXXXXXXXXXXXXXXX

INTERNATIONAL FEED NUMBER: XXXXXXXXXXXXXXXXX

COUNTRIES: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

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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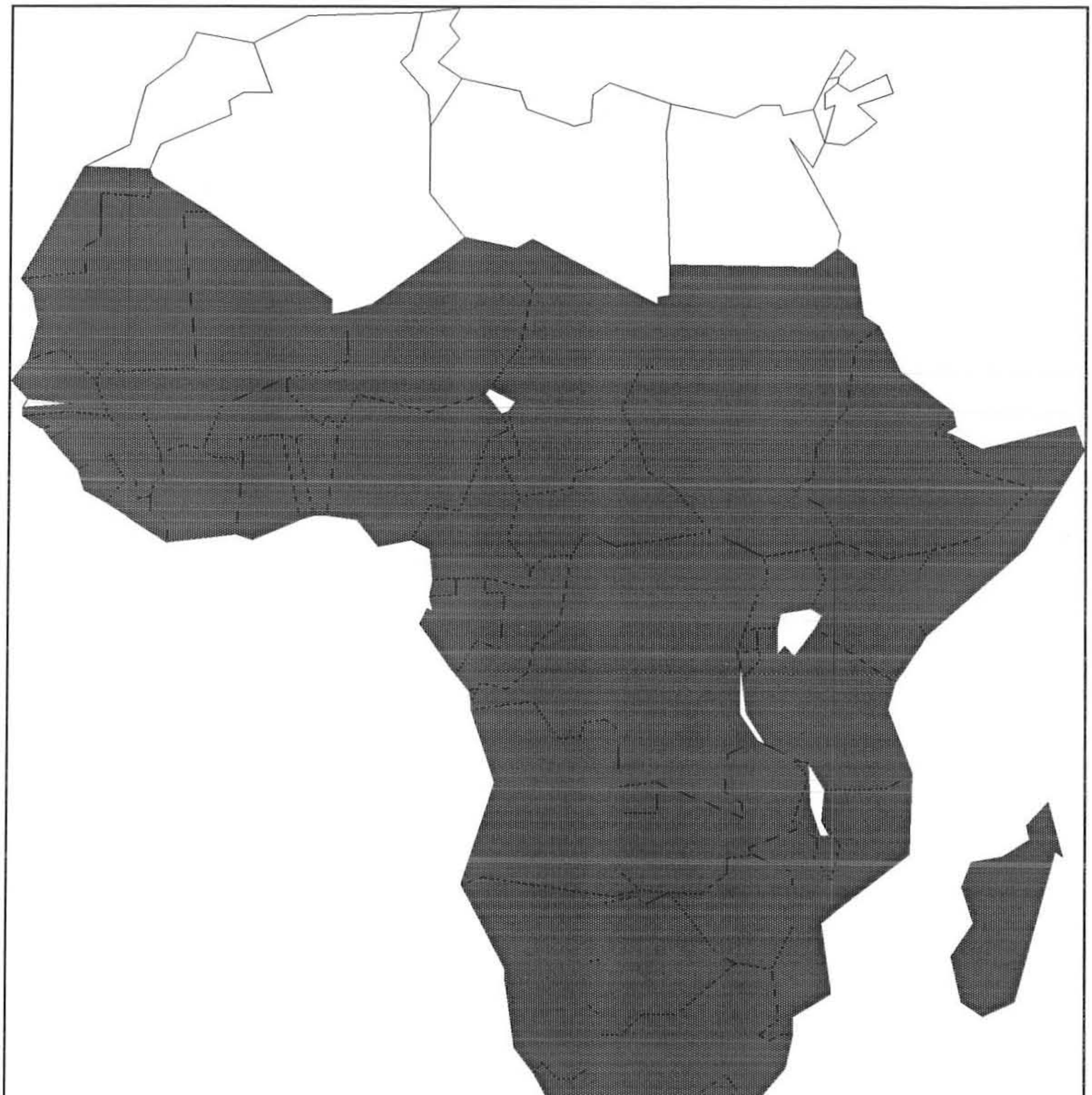
APPENDICES

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.

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.

[ ] 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 contain all the data elements in the systems' forms and structures, except for the elements which have multiple occurences 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 influ encing 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: 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 (DOMD% = 0.17DMD% - 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 D_2(ICU/kg)[a]
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Vitamin D_3 (ICU/kg)[a]
TYPE: Numeric
LENGTH: Six digits
VALUE: Derived
RANGE: 0001 - 9999

DATA ELEMENT NAME: Vitamin B_{12} (*m*g/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 mesg
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 mesg
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 mesg
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 mesg
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 mesg
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
```

```
        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 = "FEDLIMT"
  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