ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

SCHOOL OF INFORMATION STUDIES FOR AFRICA

COMMUNICATION PATTERNS IN THE PURE AND APPLIED SCIENCES IN ETHIOPIA: A CITATION STUDY OF LOCAL JOURNALS

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

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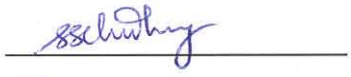
Dr. G.G. Chowdhury, Internal Examiner 

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DEDICATION

Not unto us, O **Lord**, not unto us, but unto thy name give glory for thy mercy and for thy truth's sake.

-- Psalm 115: 1

The Holy Bible (KJV).

ACKNOWLEDGEMENT

First and foremost, all glory, honour, praise and adoration be unto the Lord God Almighty, for faithfully sustaining my life and for having brought me this far. Without the unmerited favours of abundant health, strength and a sound mind bestowed upon me, I would never have managed the gruelling M. Sc. I. S. studies.

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May the eternal God richly bless you all.

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SISA, 1997.

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LIST OF ABBREVIATIONS AND ACRONYMS USED

AAAS - American Association for the Advancement of Science

AAU - Addis Ababa University

AIDS - Acquired Immune Deficiency Syndrome

ANOVA - Analysis of variance

AUA - Alemaya University of Agriculture

CD-ROM - Compact Disc - Read Only Memory

ENA - Ethiopian News Agency

EJAS - Ethiopian Journal of Agricultural Science

EMJ - Ethiopian Medical Journal

ESTC - Ethiopian Science and Technology Commission

ETA - Ethiopian Telecommunications Authority

FAO - Food and Agriculture Organization

GDP - Gross Domestic Product

IAR - Institute of Agricultural Research

IDRC - International Development Research Centre

ILRI - International Livestock Research Institute

IMI - Immediacy Index

IPB - Institute of Pathobiology

IPF - Impact Factor

ISDN - International Standard Digital Network

IT - Information technology

JCR - Journal Citation Reports

LAN - Local Area Network

NSTC - National Science and Technology Council

NAPRECA - Natural Products Research Network for Eastern and Central Africa

NASTIS - National Science and Technology Information Services

PADIS - Pan African Development Information Systems

R & D - Research and Development

S & T - Science and Technology

SAREC - Swedish Agency for Research Development with developing countries

SAS - Statistical Analysis Software

SCI - Science Citation Index

SINET - SINET: Ethiopian Journal of Sciences

SISA - School of Information Studies for Africa

SSCI - Social Science Citation Index

TCP/IP - Transmission Control Protocol/Internet Protocol

UNECA - United Nations Economic Commission for Africa

UNESCO - United Nations Educational Scientific and Cultural Organization

USAID - United States Agency for International Development

WHO - World Health Organization

ABSTRACT

This thesis entails a citation analysis study of selected source journals in the pure and applied sciences, in Ethiopia. The basic aim was to determine the communication patterns of scientists in Ethiopia through the documents that they cited in the research articles, over a ten-year period from 1985 to 1994.

By employing a selection criteria-based purposive sampling technique, three source journals were selected namely: Ethiopian Journal of Agricultural Sciences (EJAS); Ethiopian Medical Journal (EMJ); and SINET: Ethiopian Journal of Sciences (SINET). Bibliographic data from a total of 4496 citations were processed, analyzed and presented in accordance with the set objectives. dBASE IV, SAS and WordPerfect 5.1 software were thus used.

Results obtained, showed that the frequency distribution of the age of cited documents, conformed to a type of exponential distribution. It was also found that most of the cited documents (at least 77.34 percent) were published outside Ethiopia, and also at least 74.36 percent of the cited documents comprised primary sources of information. The most prolific and most cited authors were determined as well as the most frequently communicated subjects in each source journal, respectively.

Ultimately, several suggestions pertaining to the future betterment of the observed communication patterns, were posed. Possible future roles of the local libraries and information centres supporting S & T research activities in Ethiopia were highlighted, on the basis of the implications of the communication patterns observed.

1 INTRODUCTION

1.1 Prologue

The relevance of science and technology (S & T) to economic development has been amply demonstrated throughout the world and is a matter of little dispute (UNECA Pan African Development Information System and AAAS Sub-Saharan Africa Program 1995). Information is at the very heart of both S & T as well as economics. The infrastructure that enables information access is critical to a thriving S & T system and society itself.

1.1.1 Definitions

According to the definition provided by Webster's third new international dictionary of the English language unabridged (1965, 2032), the term ***science*** refers to "(a branch) of study concerned with the observation and classification of facts and especially with the establishment or strictly with the quantitative formulation of verifiable general laws by induction and hypothesis". The Longman dictionary of contemporary English (1987, 934) defines the same term as "(the study of) knowledge which can be made into a system and which usually depends on seeing and testing facts and stating general and natural laws: a branch of such knowledge... such as biology, chemistry, physics and sometimes mathematics".

Thus, a scientist is one who works in a science discipline. A scientist can also be a researcher, meaning that he/she is engaged in a serious and detailed study of a science subject, that is aimed at learning new facts, scientific laws, testing laws and so on

(Longman dictionary of contemporary English 1987).

In this thesis, the meaning of the term ***pure science*** was adapted from Webster's third new international dictionary of the English language unabridged (1965, 1845). This science is taken in its essential character and is apart from applications; it is concerned basically with theory rather than practice. Similarly, the term ***applied science*** is taken to mean the science that is put into practical use, is concerned with concrete problems or data rather than fundamental principles and is useful for a utilitarian or contributory purpose.

The meaning of the term ***technology*** was adapted from Longman's dictionary of contemporary English (1987, 1087), and refers to "(a branch of) knowledge dealing with scientific and industrial methods and their practical use in industry; practical science".

1.2 Background to the study

Scientists/researchers, are both consumers as well as producers of information. Information is critical to the performance of their tasks, and at the same time they have the professional imperative to publish and the personal goal of contributing to the pool of knowledge to be accessed by others (UNECA Pan African Development Information System and AAAS Sub-Saharan Africa Program 1995). The publishing of scientific papers satisfies a scientist/researcher's psychological need for recognition and acceptance (Shalini and Khan 1987). Here, the principle of "publish or perish" is perhaps more applicable to academics and scientists than to engineers (Sridhar 1985).

According to Berman and Eaglstein (1994), journals play a fundamental role in the

development of all disciplines and professions. They disseminate knowledge written by contemporary scholars and aid in the continuing development of a profession's knowledge base. Scientists/researchers interact using formal communication channels by publishing papers in journals and presenting papers in conferences, and so on. This is a cyclical process of production, transference and consumption of information. With this connotation in mind, the term ***communication*** is taken to include the twin activities of ***information transfer*** and ***information use***. The publishing of research results in the form of an article/paper is an act of ***information transfer***. On the other hand, the sources of information consulted/used while writing an article, a paper and so on, demonstrate ***information use*** (Shalini and Khan 1987).

Access to local or regional information in Africa presents its own set of challenges, with most African scientific journals publishing irregularly (due to limited and uncertain funding) and research remaining unpublished as "fugitive" or "grey" literature or otherwise in databases. Adipala Ekwamu, Editor of *African Crop Science Journal* cites a number of reasons for the poor performance by the African Journals. Among them are the following (UNECA Pan African Development Information System and AAAS Sub-Saharan Africa Program 1995, 5):

(i) many journals have tended to rely heavily on foreign donors for funding;

(ii) African governments or institutions have not given significant support to publishers in Africa, thereby causing the few publishing houses available to be either poorly equipped or inefficient; and

(iii) most of the journals tend to be local rather than regional, thereby bringing about a very limited circulation of information published in Africa.

As attested by McCain and Bobick (1981), due to the rising subscription costs, shrinking

budgets, and lack of space for current holdings, a growing number of journal-use studies have come up. Librarians are trying to determine viable collection development policies which will make optimum use of money and space available while meeting the current and anticipated needs of library patrons. It is true to assert that the scientists/ researchers who publish articles in scientific journals, constitute a small elite group within the whole S & T community in Ethiopia. However, they are the think tanks behind a considerable portion of S and T innovations in the country. More often than not, the scientists/researchers in Ethiopia, use the local libraries to obtain the necessary supporting literature when writing their research articles. In this connection, it is essential for the library collection development policies set up, to have the information needs of these individuals at heart.

Research work that is undertaken, in order to publish articles in scientific journals is based upon a certain environment. It is therefore imperative that the prevalent conditions in Ethiopia, be addressed first so as to provide a sound setting for subsequent discussions. A relevant description of the country is therefore furnished in chapter 2, with a particular emphasis, on the general state of affairs in the local S & T sector.

1.3 Statement of the problem/justification

S & T research takes a significant portion of the Ethiopian government's investments (Bhagawan 1989, 6; Science and Technology Popularization Department 1996). Despite this, the outputs of the research projects seem not to significantly alleviate the developmental problems of the populace.

In the Third World Countries in general, this problem has been widely adduced to the

duplication of efforts by scientists. In Africa and particularly in Ethiopia, this could be emanating from inappropriate exchange of ideas among scientists/ researchers undertaking various research projects in the local S & T sector. To date, not much is known about the nature of the primary (and also secondary) sources of information consulted by scientists in Ethiopia, in order to publish their research outputs. This could most likely be the reason why, as pointed out by Odeinde and Alabi (1985), less utilized journals have kept on being acquired by the local libraries thereby constituting a significant problem which library administrators have to address and contend with.

This study aims at establishing the factors that characterize the communication patterns of scientists in Ethiopia, through journals. The extent to which scientists in other countries have an impact on S & T research locally, is also of primary interest.

1.3.1 Justification of the study

The outputs of any research process are the results received. For many types of research, the results are manifested as new products or techniques. Research results only become valuable when they are made known to individuals or organizations that can apply them. One of the most important official modes of reporting these results for a majority of fields is in scholarly journal articles (Lancaster 1991).

In Ethiopia, there is a dearth of investigations concerning the nature of sources that are used by scientists for the purposes of communicating their research findings to other scientists and to the public in general using the local journals. It is important to find out for example which authors have a great impact on the research articles that are published locally; whether much of the consumed information comes from books, journals, internal

reports and so on and whether it is mostly from local or foreign sources. It is hard to interview all the authors for the mentioned purposes, given the mobility of scientists/researchers and the fact that some may have been faced off from active participation in their workplaces either through death, change of careers, promotions, transfers to remote locations or many other unforeseen circumstances. In such cases, plausible proof of the use of the sources lies in the references that are cited in the published research articles.

1.4 Objectives of the study

The **overall objective** of this study is to quantitatively evaluate the citations in the main articles of the selected local journals in the pure and applied science disciplines in Ethiopia (from 1985 to 1994), with a view to establishing the communication patterns involved and suggesting the possible future implications on the basis of the observed patterns.

The **specific objectives** that would assist in attaining the above overall objective are:

i.) To establish the prevailing communication patterns of scientists in Ethiopia who publish articles in the respective selected local journals.

ii.) To identify the most prolific authors with respect to the publishing of S & T research results using the selected local journals.

iii.) To identify the various types of documents used by authors of articles in the selected local journals, for publishing research findings and to what extent each type of document is used.

iv.) To highlight the possible future roles of the local libraries and information centres supporting S & T research activities in Ethiopia, based on the

envisaged implications of the observed trends.

1.5 Hypotheses/assumptions

The hypotheses for this research are stated as follows:

(i) During the period 1985 to 1994 inclusive, scientists in Ethiopia in the pure and applied sciences communicated (through scholarly publications) to a lesser extent with the local counterparts than with international experts.

(ii) From 1985 to 1994 inclusive, scientists in Ethiopia in the pure and applied sciences, communicated with their counterparts to a greater extent through primary sources of information namely journals and so on, compared to the secondary sources of information namely books, and so on.

1.5.1 Assumptions

In stating the above hypotheses, it was essential to embrace the following basic assumptions underlying the use of simple citation counts, as stipulated by Smith (1981) and later, by Egghe and Rousseau (1990, 216):

(i) Citation of a document implies the use of that document by the citing author. According to Smith (1981), this assumption has two parts:

- The author refers to all, or at least to most important documents used in the preparation of his or her work.
- All documents listed were used, meaning that the author refers to a document only if that document has contributed to his or her work.

(ii) Citation [of a document] reflects the merit (quality, significance, impact) of that document.

(iii) Citations are made to the best possible [or available] works. Studies of reference

behaviour have shown that authors sift through all of the possible documents that are accessible to them and carefully select those judged to be the best for the purpose of being cited.

(iv) The cited document is related in context to the citing document. The fact that citation indexes can be used to retrieve relevant documents supports this assumption.

1.6 Significance of the study

The observation made by the Research and Publications Office (1994) of Addis Ababa University, is that the existence of scholarly publications [including journals] is absolutely necessary for the proper development of a healthy research and development tradition in Ethiopia.

Presently, many libraries and information centres in developing countries (including Ethiopia) face looming problems of donor fatigue, leading to a 'credit squeeze' on funds which may be used to subscribe for relevant journals needed by the respective users. As observed by McCain and Bobick (1981), the number of new journal titles in the sciences has grown at an alarming pace while subscription prices for established journals have been rising at a rate much higher than the general rate of inflation. Libraries have been forced to cancel some subscriptions in order to keep up with increasing costs.

Other problems include: the slow process of selecting and acquiring printed journals; problems of obtaining the hard currencies; storage and retrieval of both the journals as well as the information contained therein; problems of keeping journals in order, once users have used them; lack of adequate and expandable storage space; shareability of the journals acquired; general expenses incurred concerning both the preservation of the

backdated journal issues in the archives and preventative measures against their physical deterioration due to adverse external factors within the environment.

A significant problem that is definitely going to be manifested in Ethiopia, is how to respond to the future proliferation of electronic journals. Though the locally published journals may not be in any immediate danger, available literature indicates that electronic-journals are rapidly increasing in number (Butler 1984; Manoff *et al* 1992). According to recent estimates there are more than 400 electronic journals in existence (Parang and Saunders 1994; Leslie 1994), of which perhaps 70 are refereed (Cronin and Overfelt 1995). If the developed countries were to decide to drastically reduce their use of printed journals in their S & T research and significantly increase the publishing of journals in digitised form, what would the fate of scientists in the affected disciplines in Ethiopia be? What would the future hold for libraries and information centres in Ethiopia, whose *raison d' etre* is the acquisition, processing and dissemination of S & T information? Information provision during the 21st Century is bound to be very efficient (with much less wastage of effort, money, time and storage space) and very interactive. If libraries and information centres in Ethiopia are to retain their roles in society in the future, their respective managers should be prepared to respond to the shifting trends accordingly.

The first step in getting answers to the questions raised, is by undertaking an audit of the situation at hand. Evaluation of the communication patterns of the scientists/researchers through the sources that they cited, may perhaps be a convenient approach to the stated intention.

1.6.1 Application of the study results

The information resulting from this study is particularly useful for the purposes of planning for science and technology information services in Ethiopia. One may be able to tell (to some extent) what supportive information sources are used and are therefore required by scientists locally, in order to publish research articles in local journals. One may also be able to approximately observe the long-term trends of aspects within a particular discipline, that may not necessarily be clearly perceivable at a particular point in time. Thus, the need to boost a particular information service can be proven; or even decisions concerning whether to adopt the recent innovations in information technology can be taken.

The study, therefore, sheds some light on important implications concerning the future of various issues to do with the efficiency of acquisition and management of document collections in S & T research libraries and information centres in Ethiopia.

1.6.2 Beneficiaries of the study

Managers of libraries/information centres supporting scientific research, various science policy planners and decision makers in Ethiopia are the targeted consumers of the information emanating from this study. The financial sponsors of the various journals in the pure and applied science domains for example Swedish Agency for Research Development with developing countries (SAREC), Ethiopian Science and Technology Commission (ESTC), Addis Ababa University (AAU), other involved or interested institutions and professional associations may also benefit from the findings of this study in the way of data that they can use for making suitable decisions.

In the long run and on the basis of the appropriate decisions taken, it is hoped that better information services (in Ethiopia) for supporting research projects in the pure and applied sciences will be realized. Ultimately, a 'trickling-down' effect of benefits to the people of Ethiopia in the form of appropriate scientific and technological advancement is anticipated, thereby contributing to the much desired economic development of the country.

1.7 Scope and limitations of the study

This section furnishes demarcations of the boundaries within which the research effectively operates and beyond which it does not endeavour to cover. The limiting factors to the depth and breadth of the research are also hereby highlighted.

1.7.1 Scope of the study

○ Nowadays there are various modes of communication of scientific information including: books, monographs, theses, reports and all types of serials. There are also a number of electronic modes of communication involving technologies such as telex, fax, radio, video- and tele- conferencing, Bulletin Board Systems (BBSs) through E-Mail and Message Services (EMMSs), CD-ROM and Internet. However, this particular study focuses on the traditional mode of communication namely, through published documents.

○ The selected pure and applied science journals for the study comprise only those that appear in the profile prepared by the Ethiopian Science and Technology Commission (Science and Technology Popularization Department 1994). It contains information on thirty two (32) scholarly publications that are published in Ethiopia by local institutions and local professional associations. Sixteen (16) of them were identified as journals in

the pure and applied sciences (see Appendix II). The rest were found to be newsletter type of publications. However, in determining the ones which met the criteria for inclusion in the study, only the journals either in the Ulrich's International Directory of Periodicals (January 1996, Microfiche edition) or in the international CD-ROM databases, were considered for selection.

- A ten year period starting from the beginning of 1985 to the end of 1994 was chosen as the time span for this study, reflecting the available journals containing the primary information regarded to be of greater relevance to current research needs in the pure and applied sciences, in Ethiopia. During the defined time span 1985 - 1994 inclusive, it was presumed that exactly similar conditions were experienced by all the journals considered in this study.

The study was restricted to the establishment of communication patterns of the authors of articles in the selected journals, by which their communication behaviours were inferred. References cited at the end of the main articles in the selected journals were studied to achieve this aim. If communication behaviours were to be studied directly, it would have necessitated the use of an entirely different methodology because it would have involved the study of issues like citer motivations and so on.

1.7.2 Limitations of the study

Constraints that limited the extent of this study are as follows:

- Scope of the study: - as already mentioned in section 1.7.1
- Resources available: - due to time constraint and limited funds available, the tasks had to be scaled down to a manageable and meaningful

size, at the same time ensuring that the reliability of collected data was not compromised. Therefore a sample of the journals was selected, each covering a ten year period from 1985 to 1994 inclusive.

- Absence of the local journals in the available Science Citation Index CD-ROM databases (1990,1991 and 1993 editions respectively). This considerably slowed down the process of entering the desired data elements into the computer. Therefore an alternative, time consuming and labour intensive manual technique was used for the same purpose.
- Only journal articles were considered in this study, while there are other means of communication in the printed form too, such as seminar/conference papers, research reports, monographs and so on.
- Due to the limited size of memory for processing data using SAS (about 3,000 records at a time, at most) only the first author of the documents considered in this study were entered into the computer for the purposes of analysis.

1.8 Organization of the thesis

This thesis begins with the relevant definitions. The objectives, hypotheses, justification, significance, scope and limitations of the study are duly furnished in the first chapter.

The geo-political status of Ethiopia is covered in the second chapter. A highlight on the ESTC and the sectorwise distribution of R & D funds is given. The libraries/ information centres and local scholarly publications in Ethiopia are briefly mentioned.

Chapter three gives an account of the literature reviewed on the prominent developments in scientific journals and citation analysis, *inter alia*.

Chapter four gives a detailed description of all the tools, materials, methods (including the sampling technique) employed in this study as well as the respective justifications.

Chapter five deals with all the intricacies of the analysis of the collected data. This refers to the consolidation, organization, summarizing and presentation of the data in a form that is most suitable for making deductions.

Penultimately, the envisaged implications in line with the observed communication patterns are provided in chapter six.

The conclusions and recommendations based on the implications of this study are finally discussed in chapter seven. Possible areas of extension of the study are also suggested.

2 ETHIOPIA - COUNTRY PROFILE

2.1 Geo-political data of Ethiopia

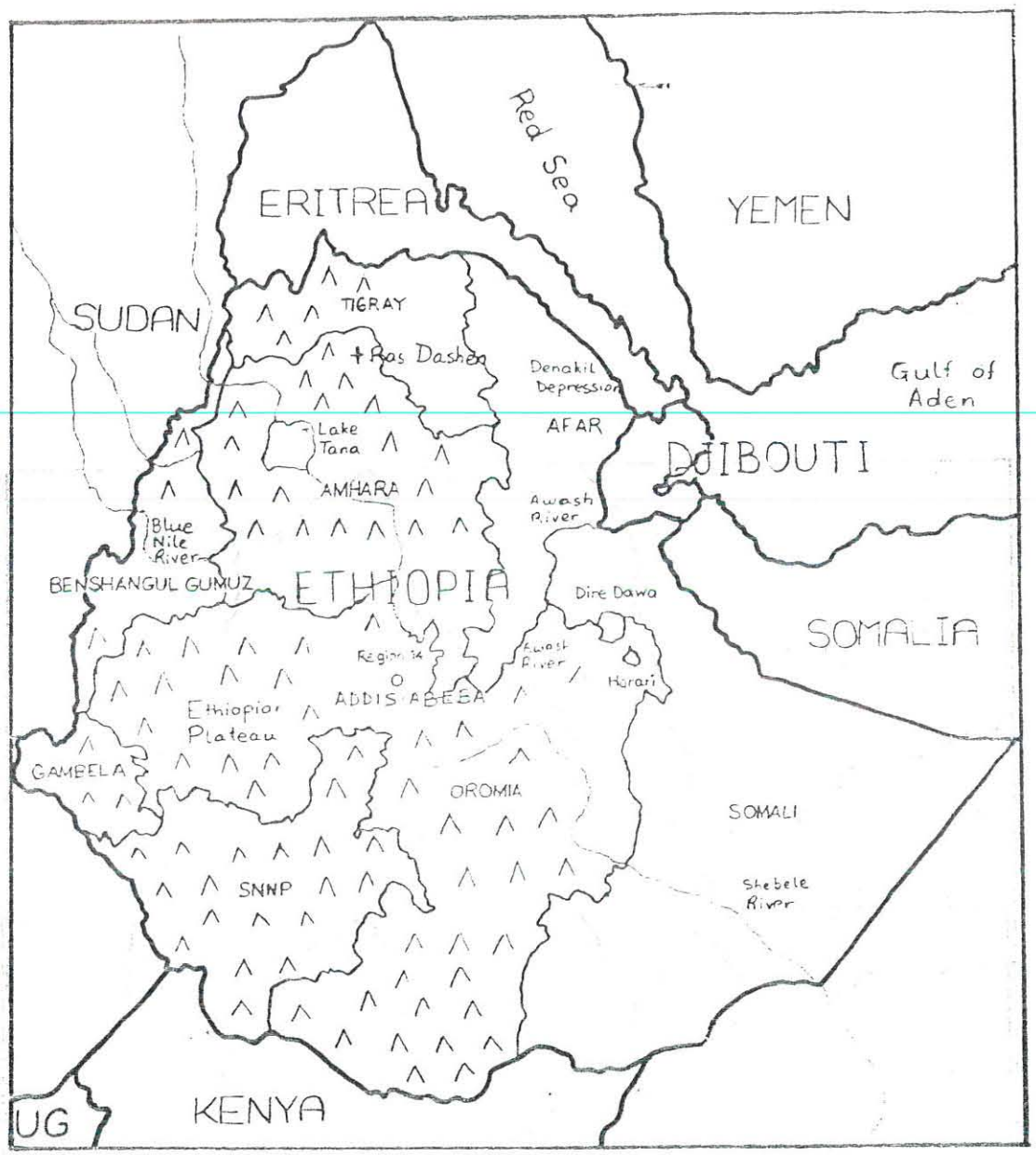
(a) Position

The Federal Democratic Republic of Ethiopia is a land locked country in eastern Africa, forming the hinterland of the Horn of Africa (see Figure 2.1). Her boundaries stretch from latitude 3° N to latitude 15° N and from longitude 33° E to longitude 48° E, thereby enclosing an area of 1,130,138 square kilometres (436,349 square miles) of land. Ethiopia's western neighbour is Sudan; to the south, she shares a border with Kenya and to the east and southeast with the Republic of Djibouti and Somalia respectively. To the north and northeast lies Eritrea, which became independent of Ethiopia in May 1993 (Last 1995). Addis Ababa, the capital of Ethiopia is located centrally on a plateau about 2,500 metres above sea level (UNESCO 1987, 104).

(b) Sovereignty and political divisions

According to UNESCO (1987, 104), on the whole, Ethiopia has been an independent country for many centuries except during the Italian occupation of 1936-1941. Formerly divided into 14 provinces, Ethiopia was reorganized as 24 administrative regions and 5 autonomous regions under the 1987 constitution. Currently, there are 14 administrative regions in Ethiopia, once again.

Figure 2.1 Map of Ethiopia: administrative divisions and physical features



(c) Population

There has never been a full population census in Ethiopia, but a census that was conducted in May 1984 was estimated to have reached 85 percent of the population. Excluding Eritrea, the results showed that the population was 39,868,501 (Last 1995). Based on these figures, the country's estimated total population was extrapolated to 54,938,000 people by mid-1994. The average annual population growth rate for Ethiopia in the period 1985-93 was 3.0 percent (Last 1995), with a fertility rate of roughly 7.5 percent. UNESCO (1987) estimated that about 85 percent of the total population in Ethiopia live in the rural areas and are mainly engaged in agricultural practices, mainly at the subsistence level.

(d) Land resources

The heart of Ethiopia is a high tableland known as the Ethiopian plateau, covering more than a half of the total area of the country. The plateau is split diagonally in a northeastern to southwestern direction by the Rift Valley. Many rivers and deep valleys traverse the plateau. The area is capped by mountains, the highest of which is Ras Dashen (4620m/15,157 ft) (Microsoft Corporation 1994). The northeastern edges of the plateau are marked by steep escarpments which drop some 1220m (about 4000ft) to the Denakil Desert. To the west, the plateau descends less abruptly to the desert of Sudan, and to the southwest toward Lake Turkana in Kenya. The highland of Ethiopia is generally made of folded and fractured crystalline rocks capped by sedimentary limestone and sandstone and by thick layers of volcanic lava.

(e) Climate

The climate of Ethiopia varies mainly according to elevation. There is the tropical zone

below approximately 1830m (about 6000ft) with average annual temperature and rainfall of 27° C (about 80° F) and 510mm (about 20in) respectively. On the other extreme end, there is the temperate zone above an altitude of 2440m (about 8000ft) with average annual temperature and rainfall of about 16° C (about 61° F) and 1270 to 1780mm (about 50 to 70 in) respectively. Between these two extremes lies the subtropical zone. The main rainy season occurs between June and September, followed by a dry season that may be interrupted in February/March by the short rains (Microsoft Corporation 1994).

(f) Minerals

Ethiopia is said to have considerable mineral resources including: iron ore, alluvial gold, platinum, tungsten, copper, gypsum, lead, sulphur salt, diatomite, phosphorous potash , soda ash, different clays and so on (UNESCO 1987; Microsoft Corporation 1994). However, less than 20 percent of the country has been geologically mapped and subsequently exploited, to date.

(g) Energy resources

According to UNESCO (1987, 106), about 93.4 percent of the energy utilized is derived from traditional biomass fuels such as firewood, charcoal, cattle dung and crop residues. The remaining 6.6 percent is obtained from imported petroleum and locally generated hydroelectric power. Exploration that was carried out in the Ogaden Region (now called Somali Region) in 1973-74 for natural gas and crude oil indicated that there were workable commercial deposits of both, but no exploitation has yet been meaningfully undertaken.

(h) Industrial enterprises

Industrial development in Ethiopia is still very much in its infancy. Manufacturing is primarily oriented toward the processing of agricultural commodities. The textile industry, according to Microsoft Corporation (1994), ranks second to food processing. The contribution of the industrial sector to the GDP is in the order of 10 percent. Half of this is from the traditional handicraft and cottage industry and half from modern industry UNESCO (1987, 106).

(i) Public health services

Public health services in Ethiopia are inadequate, especially in the rural areas. The main health problems arise from several factors including: a preponderance of the young and adolescents in the population (about 50 percent below 15 years of age); a high rate of malnutrition; inadequate health services and several communicable and vector-borne diseases. Malnutrition is the most significant health problem, according to UNESCO (1987, 106), and is responsible for the very high infant and child mortality rate. The major diseases are malaria, schistosomiasis, trypanosomiasis, venereal diseases (including AIDS), typhoid fever, tuberculosis, and intestinal worms.

(j) Agriculture

Agriculture is the mainstay of the Ethiopian economy. Traditional agriculture by primitive methods, including the raising of livestock is the most characteristic form of Ethiopian economic activity and provides a livelihood for 87 percent of the population (Microsoft Corporation 1994; UNESCO 1987, 105). The same constitutes more than half of the GDP and accounts for nearly all of the country's exports (including coffee, tea, hides and skins). Practically all the food consumed in the country (cereals, vegetables,

dairy products and so on) are thus produced. Ethiopia has the highest cattle population in Africa according to UNESCO (1987, 106), of approximately 31 million head (Microsoft Corporation 1994). Other animals raised are sheep (23.4 million), goats (17.5 million), poultry birds (57 million), camels (1 million) and fewer horses, mules and donkeys.

Among the main constraints to the development of agriculture in the country are: insufficient application of modern methods of agriculture, including modern farming equipment, fertilizers and other inputs; frequent droughts; animal diseases; soil erosion and bad terrain due to too steep a slope in much of the highland areas (UNESCO 1987).

The country's forest resources cover about 4 percent of the total surface area, but exploitation for firewood, charcoal and timber far exceeds all reafforestation endeavours at present.

(k) Telecommunication facilities

The introduction of telecommunication facilities in Ethiopia dates back to 1894, according to a brochure prepared by the Ethiopian Telecommunications Authority (ETA). The national telecommunications service is owned by the Ethiopian government and is provided by the ETA, an autonomous entity with the exclusive rights for the construction, operation and maintenance of telecommunication facilities except military communications.

According to Lishan (1996), analog telephone, digital leased lines and radio links to rural areas are the major services of the national operator. So far, the ETA provides services

like telephone, telex, telegraph and facsimile. The Pan African Development Information System (PADIS), a regional institution under the Addis Ababa-based United Nations Economic Commission for Africa (UNECA), was instrumental to the setting up of a national electronic network in Ethiopia, mainly for supporting E-mail facilities (Lishan 1996). This service, as observed by Lishan (1996), has a great capability of connecting members of the local research community to each other and to colleagues worldwide.

During the period December 1996 - January 1997, the ETA took a major step forward by introducing the Internet to its customers in Ethiopia (Ethiopian News Agency (ENA) 1997, 1). It is expected that the Internet will enable individuals, enterprises and government institutions to exchange written documents, computer files, news stories and opinions with the network of the International Computer Federation, within seconds and at a low price. According to Ato Fanta Adane, the head of the Ethiopian Internet Bureau, the Internet hub now in Ethiopia has the capacity to serve at least 5,000 clients.

Nevertheless, rural telecommunications still remains operator assisted. Packet switching and ISDN (International Standard Digital Network) are under consideration (Lishan 1996).

(l) Economy

According to Microsoft Corporation (1994), in the late 1980s, Ethiopia was one of the world's poorest nations with an annual per capita income averaging only US$ 120 (to date, the annual per capita income has not exceeded US$ 130). Average life expectancy at birth was only 47 years; the infant mortality rate was 135 per 1000 live births and famine was a constant threat. In 1991/92, the Ethiopian economy nearly collapsed. The

GDP was more than 7 percent lower than that of the previous year (Last 1996).

When the Transitional Government assumed power from the former Dergue regime, it began to engineer economic recovery. In fact, in 1992/93 the Ethiopian economy recovered the ground that had been lost in the year before by 7.6 percent in real terms and is still continuing to grow (Last 1996). The task of putting Ethiopia back on the road to economic development is well on the way. Notwithstanding, according to UNESCO (1987) and Duri (1995), the major constraints to development in Ethiopia include the following:

- drought and soil erosion;
- inadequate infrastructure;
- shortage of financial resources;
- effects of past political regimes;
- shortage of skilled manpower; and
- disease.

2.2 Scientific research and development in Ethiopia

As observed in section 2.1, the peoples of Ethiopia are still victims of the problems of drought and famine, scarce employment opportunities, shortage of energy and other pressing needs. Hence, in order to bring about massive social and technological changes; to accelerate agricultural and industrial productivity; to facilitate the means for a rational conservation and use of natural resources and the provision of basic necessities of life (namely: food, clothing, shelter, education, energy, health and so on); to modernize communication networks; to generally improve the standard of living of the peoples of Ethiopia and to keep abreast with the envisaged technological advancements of the 21st century, extensive popular and sustained S & T capacity building is a requirement

(Transitional Government of Ethiopia 1993).

Based on the country's development policy directives, and in view of the need to alleviate the basic problems of the peoples, priority has been given to research and development in:

(a) Health and population planning;

(b) Agriculture;

(c) Natural resources development and environmental protection;

(d) Water resources development;

(e) Energy;

(f) Industry;

(g) Transport and communications;

(h) Mineral resources;

(i) Education; and

(j) New and emerging technologies.

2.2.1 Ethiopian Science and Technology Commission

The Ethiopian Government in December 1975, through the government proclamation (No. 62 of 1975), established the Ethiopian Science and Technology Commission (ESTC) (Bhagawan 1989; UNESCO 1987). The commission was established as an expression of the realization and appreciation by the former Provisional Military Government of what was then known as the Socialist Republic Ethiopia, of the vital role of S & T in economic development. The ESTC is the main national S & T policy making body in Ethiopia and is charged with the mandate "to encourage, guide, coordinate and support" research that is relevant to and important for economic and social development

(Bhagawan 1989). According to the Transitional Government of Ethiopia (1993), the ESTC is the central organ empowered with the responsibilities and mandate to plan, promote, coordinate, finance and oversee science and technology activities of the country. The two most significant aims of the ESTC are:

(a) to encourage, strengthen and guide the search for scientific knowledge and the pursuit of technological development that is applicable to the alleviation and surmounting of the hardship in the life of the broad mass of Ethiopians as well as raising their productivity; and

(b) to encourage, strengthen and guide the search for Ethiopia's natural resources and the development of those technologies which applied thereto, serve to win optimum yields in all sectors (Bhagawan 1989).

The ESTC is a government institution, headed by a Commissioner and is governed by its own regulations. The Commission is accountable directly to the Prime Minister of Ethiopia. It is also responsible to advise the Ethiopian Government on issues of S & T, implement the government's S & T policy and follow up the appropriate and immediate application [and dissemination] of R & D results (Transitional Government of Ethiopia 1993).

In line with the envisaged role of science and technology (S & T) in national development, other functional organizations have also been set up within the general structure for the coordination, promotion and development of S & T activities in Ethiopia. These are namely:

(i) The National Science and Technology Council (NSTC) - the highest decision making body for S & T policy and plan of action. It is chaired by the Prime Minister of

Ethiopia, with the Commissioner of Science and Technology as it's secretary. Under it falls the ESTC.

(ii) The Technical Advisory Committee of The National Science and Technology Council - the body that consolidates and advises the ESTC on any technical matters concerning S & T. It comprises renown and experienced scientists and engineers drawn from different branches of the ESTC, and is chaired by the Commissioner of ESTC.

(iii) The Science and Technology Operational Institutes and Centres - the various research institutes, technology centres, design enterprises and S & T support services in various sectors and higher educational establishments which are responsible for the actual performance of S & T activities.

2.2.2 Sectorwise distribution of the national R & D budget

A summary of the research and development funding allocation to major sectors in Ethiopia, for 1974/75 - 1983/84 is given in Table 2.1 below.

Table 2.2 Distribution of research grants by economic sectors - 1996

Economic Sector	Percentage in total of approved budget	Cost in Eth. Birr	Regional dist. of research projects	
			Addis Ababa	Other Towns
Agriculture and environmental protection	29.6%	250,167	-	16
Health and population planning	28.3%	239,000	8	12
Industry, construction, transport and communications	19.9%	167,870	7	4
Mines, water, energy and geo-information	22.2%	186,960	6	4
Education	-	-	-	-
Total	100.0%	843,977	21	36

Source:Science and Technology Popularization Dept. (1996,19).

The allotment of research funds[2] by priority areas in Table 2.2, shows that the highest number of approved proposals were in agriculture and environmental protection (16) and health and population planning (20). Though there were more approved projects in health and population planning, agriculture and environmental protection got the greater share of the research budget in 1996.

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[2] The budget for research during the year 1996 was Birr 1,000,000.00 which was allocated through the ESTC. A call was made to all potential researchers both in the public and private sectors in all regions of Ethiopia. 152 proposals were recieved out of which 57 were approved.

2.3 Library and information centres in Ethiopia

According to Adhana (1993, 285), the preservation of literary information consisting of inscriptions written on hard surfaces like granite obelisks and walls of rock, clay vessels, gold, silver, bronze and iron coins can be traced back to the 4th century A. D. when Christianity was introduced to Ethiopia.

Nowadays, a number of libraries and information centres in the country facilitate information provision to their respective patrons. Several organizations have imported computers since the 1980s but as observed by Adhana (1993), modern information systems had not been widely applied by the 1990s.

2.3.1 National library

Founded together with a National Museum by the former emperor, Haile Selassie in 1944, the National Library offers loan and reference facilities to the public, acting as a central public library and a national repository of Ethiopiana. In the 1960s, the library opened branches in several provincial centres, notably Debre Zeit, Yrgalem and Harar, stocking them with volumes from its own collection of more than 90,000 volumes. Plans are under way to house a national archives at the National Library (Adhana 1993, 286-287).

2.3.2 Academic libraries

According to Adhana (1993, 287), the library system of Addis Ababa University was founded in 1961. Having built on collections of the University College of Addis Ababa, established 11 years earlier, the University Library system presently comprises a number of libraries. These include Kennedy Library (the main library) and branch libraries like:

Law, Business and Economics, Medical, Engineering, Science and Agriculture libraries respectively. The collections were developed extensively, with assistance from the Ford Foundation and the United States Agency for International Development (USAID). In the early 1990s, the total collection exceeded 500,000 volumes.

The other university libraries are located at Alemaya University of Agriculture and at Mekelle University respectively.

2.3.3 Public libraries

The responsibility for public library services is carried out by the National Library with its inadequate funding. Nonetheless, a number of municipal and community libraries have grown in addition, mainly through local initiatives (Adhana 1993).

2.3.4 School libraries

According to Adhana (1993, 287), in the 1960s and 1970s, the Ministry of Education attempted to improve library services in secondary schools. School libraries still continue to lack adequate bookstocks and qualified staff by the 1990s.

2.3.5 Special Libraries and information centres

The most important special library in Ethiopia, according to Adhana (1993, 287) is the United Nations Economic Commission for Africa (UNECA) Library. It has a strong collection of African government and agency documents, periodicals and about 60,000 books on African Development. Also located on the UNECA premises is the Pan African Development Information System (PADIS). PADIS is a cooperative regional development information system that was created in January 1980 under the aegis of the

UNECA in Addis Ababa, Ethiopia. Other special libraries/information centres serve government agencies for example the ESTC, the National and Commercial Banks, the Institute of Public Administration, the Police and Air Force colleges.

Libraries are also available to serve research institutes and colleges in Ethiopia, like the following: Institute of Agricultural research; Jimma College of Agriculture; Jimma Institute of Health Sciences; Arbaminch Water and Technology Institute; Gondar Institute of Public Health; Ethiopian Health and Nutrition Research Institute; Ambo Plant Protection Research Centre; Institute of Pathobiology; Ethiopian Institute of Geological Surveys; and National Meteorological Services Agency.

Among the libraries sponsored by other countries include the British Council Library and the libraries of the French, German, Italian and Russian Cultural Centres respectively (Adhana 1993, 287). The J. Pagot Library at the International Livestock Research Institute (ILRI) - Addis Ababa, serves the information requirements of the researchers within that establishment.

2.4 Scholarly publications in Ethiopia

The first seed that created the conducive atmosphere for research and publication in Ethiopia, was planted in 1954 when the college of Addis Ababa was upgraded to the rank of University College of Addis Ababa (Science and Technology Popularization Department 1994). The establishment of the Ethiopian Medical Association and along with it the coming of the *Ethiopian Medical Journal* in 1962, was a major breakthrough for S & T publications in Ethiopia. Consequently, the growth in demand and readership of scholarly publications created the need to develop S & T forums to publish R & D

findings. Coupled with this, the pressure from the growing number of local institutions for local S & T publications played a great role for the springing up of S & T journals.

In order to enhance the efforts of professional associations in strengthening their publications, the Ethiopian Science and Technology Commission (ESTC) joined hands with the Swedish Agency for Research Development with developing countries (SAREC) to initiate a project entitled " Support for Professional Journals, Newsletters and Other Publications ", in 1984. This project was able to support ten (10) journals. This number grew to fourteen (14) in 1986 and sixteen (16) in 1988. According to the Science and Technology Popularization Department (1994), the total budget allocated and distributed through the project from 1984 to 1994 fiscal years amounted to 3, 760, 000 Swedish Kronors. During the period 1979 to 1994, the Research and Publications Office of Addis Ababa University also granted a total of Ethiopian Birr 0.25 million for the production of professional publications in Ethiopia (Research and Publications Office 1994).

To date, the professional/scholarly publications in Ethiopia are about 32 in number (see Appendix II). The major constraints identified by the Science and Technology Popularization Department (1994), concerning the production of these publications are:

(a) financial constraints;

(b) lack of printing facilities and equipment;

(c) heavy workload and other commitments on the part of contributors of research papers;

(d) difficulty of obtaining articles of good quality;

(e) lack of technical and administrative staff;

(f) lack of reviewers or unwillingness to review papers; and

(g) lack of information.

Despite the aforementioned problems, a few local publications have been able to receive some international recognition, by either being abstracted or indexed in some of the international databases. The *Ethiopian Medical Journal*, for instance, has been included in the Index Medicus from 1971, is listed in the Africa Index to Continental Periodical Literature, Cambridge Scientific Abstracts, African Index Medicus and since 1982, in Current Contents (Editorial Board, Ethiopian Medical Association 1983).

Other publications that have also received similar international acclaim are: the *Bulletin of the Chemical Society of Ethiopia* (has an international advisory board, is indexed in the Chemistry Citation Index and abstracted in the Chemical Abstracts and Environmental Abstracts); and both the *Ethiopian Journal of Agricultural Sciences* as well as the *African Livestock Research Journal* (are abstracted in the Agris database of the Rome-based Food and Agriculture Organization (FAO)). The *Ethiopian Medical Journal*, the *Bulletin of the Chemical Society of Ethiopia*, the *Ethiopian Journal of Agricultural Sciences* and the *African Livestock Research Journal* have also been included in the Ulrich's International Directory of Periodicals, Microform edition (January 1996).

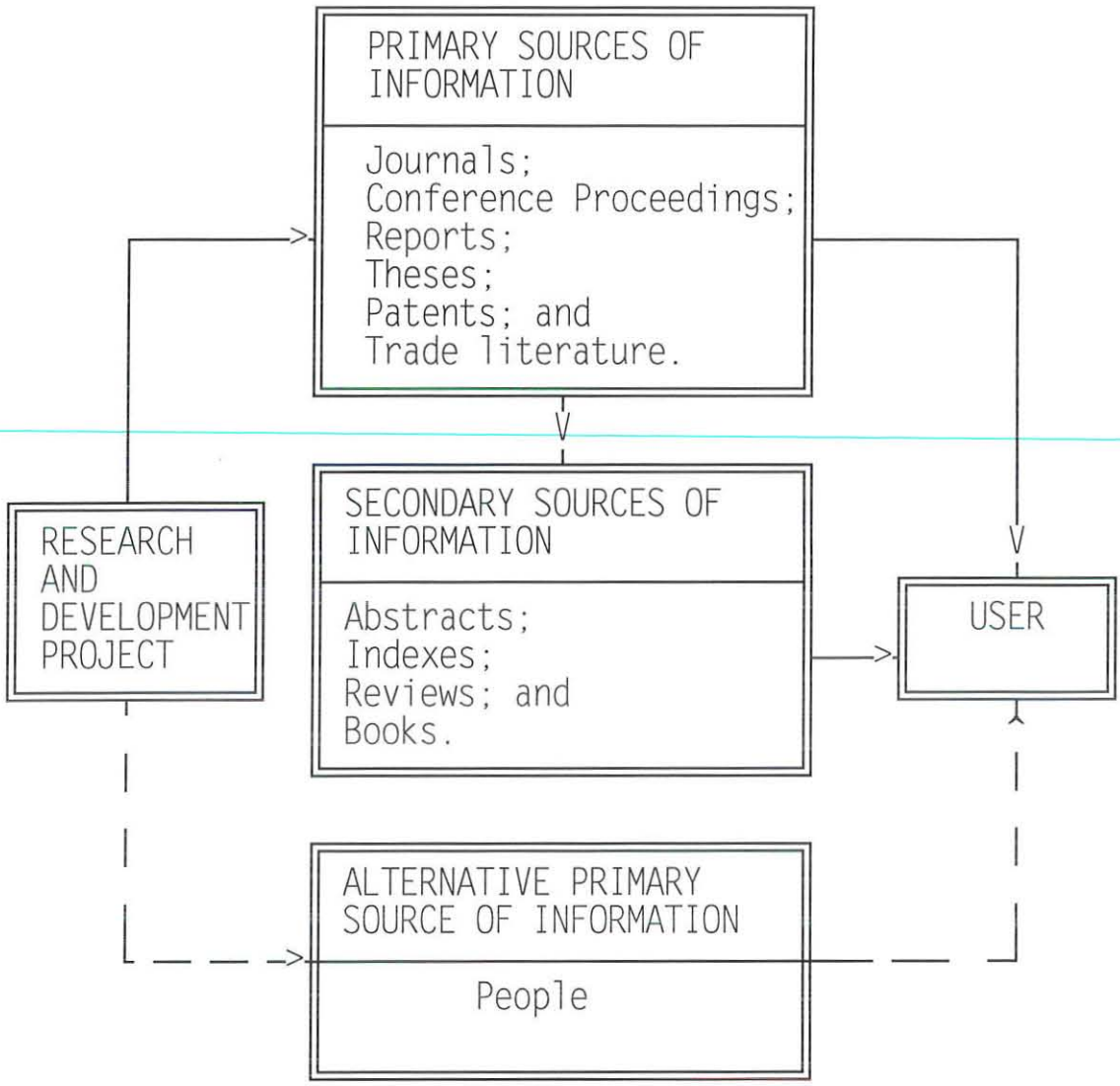
(iv) provide introductory and background information for work in unfamiliar fields; and

(v) provide specific information and data needed for the work in hand.

In the past, communication took place largely through personal contacts (Boyle's "invisible college") and was informal and unorganized. Nowadays, organized systems of communication are necessary and their scale and complexity continues to grow depending on various factors affecting S & T development (Atherton 1977). Communication of scientific and technological information embraces all relevant channels including non-documentary ones, thereby forming a series of alternative routes through the total communication system (Atherton 1977; Lambert and Lambert 1986). However, it is important to re-emphasize that the scope of this study focuses on the traditional mode of communication, through published documents.

Meetings, conferences and exhibitions are useful for spreading ideas and facilitating contacts. Exact information however, requires presentation in documentary form to which attention is drawn (Atherton 1977). For this reason, journals have always played a vital role in the communication of S & T information and have constituted an important section of the stock of the libraries which serve the respective disciplines.

Figure 3.1 Communication system for scientific and technical information



Adapted from: Lambert and Lambert (1986: 5).

New research which does not need to be kept secret for commercial or defense reasons nearly always has to be published in the form of articles or papers in journals (Lambert and Lambert 1986).

According to Harrod (1990, 343), a ***journal*** is defined as " a periodical issued by a society or institution and containing news, proceedings, transactions and reports of work

carried out in a particular field ". In supporting the same definition, The ALA glossary of library and information science (1983, 125) defined a ***journal*** as " a periodical, especially one containing scholarly articles and/or disseminating current information on research and development in a particular subject field ".

From both definitions, one can therefore discern that the superset of the journal is the periodical. According to Keenan (1996, 8), a ***periodical*** is the " most common type of serial published at regular or irregular intervals and carrying primary material". Harrod (1990, 472-473) defined a ***periodical*** as " a publication with a distinctive title which appears at stated or regular intervals, generally oftener than once a year, without prior decision as to when the last issue shall appear. It contains articles, stories or other writings by several contributors. At the General Conference of UNESCO, held in Paris on November 1964, it was agreed that a publication is a periodical 'if it constitutes one issue in a continuous series under the same title, published at regular or irregular intervals , over an indefinite period, individual issues in the series being numbered consecutively or each issue being dated' ".

The superset of both the journal and the periodical is the ***serial***. All the sources consulted, concurred that a ***serial*** is " a publication in print or non-print form, issued in successive parts usually having numerical or chronological designations and intended to be continued indefinitely (usually multi-authored and sequentially numbered. Serials may include periodicals, newspapers, annuals (reports, yearbooks, directories, and so on), journals, memoirs, proceedings, transactions, and so on of societies and numbered monographic series" (Harrod 1990, 561; ALA glossary of library and information science 1983, 203; Keenan 1996, 9; Lambert 1985).

Most of the space in journals is taken up by full papers. These have a well defined format and are usually refereed (evaluated by independent assessors for originality, validity and quality). Many journals publish a mixture of three types of papers: full papers (containing the main research articles that present new information and data); short papers (for publishing more limited findings); and preliminary communications (where authors want their research made public very quickly because of its significance or where there are rival teams working in the same field) (Lambert and Lambert 1986).

Journals are basically divided into two main types - **primary journals** and **secondary journals** (Lambert 1985).

- **Primary journals** or **archival journals** as they are sometimes known, are the main vehicle for the publication of original research in S&T.
- **Secondary journals** digest, comment on and interpret the research which has been published in primary journals (Grogan 1982). Secondary journals can be:
  - Review journals;
  - Technical journals;
  - Trade journals;
  - Controlled circulation journals; and
  - Hobby journals.

3.2.1 Historical development of scientific journals

On Monday, the 5th of January 1665, when Sieur De Hedeville walked across Pont Neuf in Paris with the *first* number of *Journal des Scavans*, he had made an innovation of great importance to the sciences. He had produced the first scientific journal. That same year, Oldenburg, the secretary of the Royal Society in Great Britain also issued a

of Technology in 1976 and the Birmingham and Loughborough Electronic Network Development (BLEND) Project which took place from 1980 - 1984 in the UK (Schauder 1994).

According to Schauder (1994), the potential of the Internet and related academic networks for the publishing of electronic journals received almost no attention in the literature on electronic publishing until 1990 when a multitude of articles started to appear. By March 4, 1993, it was estimated that there were 41 journals and 182 newsletters that were published electronically (presently, more than 400 electronic journals exist and the number is continuing to increase exponentially). New problems are manifested with the advent of electronic journals. Among them is the ownership of intellectual property. Copyright laws have not yet been satisfactorily adjusted to suit the distinctive characteristics of digital media and have been the cause of a huge legal debate. These characteristics, according to Manoff *et al.* (1992) are:

1) ease of replication; 2) ease of transmission and multiple use; 3) plasticity of digital media; 4) equivalence of works in digital form; 5) Compactness of works in digital form; and 6) Nonlinearity.

3.2.2 Global disparities in information technology

(a) The Internet

The Internet, a relatively sophisticated public network, offers repositories of papers that can be actively searched using the File Transfer Protocol (FTP), as well as newer and rapidly improving tools like Archie, Gopher, WAIS and the World Wide Web (WWW). Using the Internet, according to December (1994), one is able to send a document to all Internet users-over fifteen million people-through electronic mail (Heslop and Angell

(1994, 2) estimated that by 1998, the Internet is expected to exceed 100 million users world wide). However, such a mass mailing would probably be met with derision by most recipients because of the lack of selectivity, traditionally executed by the editorial control. On the Internet, this control process arises not from any one individual or institution but from interaction within information communities, which shape (but not necessarily control) information content and dissemination. On the Internet, any user of information has the capability of becoming a producer, without much ado.

Networking, according to Heslop and Angell (1994, 2-3) is a simple concept that forms the basis of the Internet. It entails the sharing of resources among computer users, including: information, the computers themselves, and human expertise. Rather than duplicate the resource at many sites, the resource is centralized and can be accessed by any user through connections between computers. The fundamental structure of a relation between two computers connected via the Internet is the ***client/server*** model. A ***client*** is any computer remotely connected to a host computer called a ***server***, to run programs via the network.

To connect different types of computers together and transfer information successfully between them requires a set standard of rules, called ***protocols***. The Transmission Control Protocol/ Internet Protocol (TCP/IP) is the glue that holds all the different computer systems together on the Internet. TCP/IP ensures that data is routed correctly by defining the address used to send information across the Internet. Whereas the developed countries are now fully acquainted with this type of information technology and are constantly exploring new areas in it, the developing world (particularly Africa) is still lagging behind, with many countries yet to acquire the Internet. About twenty

(20) out of fifty three African countries were connected to the Internet, by 1996 (Panel on Planning for Scientific and Technological Information (STI) Systems in Sub-Saharan Africa 1996).

(b) CD-ROM systems

CD-ROM systems are also being integrated with networks. In short, the 'virtual library' is under construction. However, this progress has been particularly slow in coming to the Third World Countries, especially to regions such as Latin America and Sub-Saharan Africa. According to an observation by Jacobson (1994), it is often repeated today that where land was the principal source of wealth in the feudal economies, and capital during the industrial era, in the post-industrial age, the principal source of wealth is information. Of the 1433 CD-ROM titles published world wide in 1993, only 31, just over 2 percent came from the Third World. These figures, according to Jacobson (1994), suggest that information might be a weapon in the fight for business growth, but it remains to be used with effect.

3.3 Citation studies on scientific journals

A scientific paper does not stand alone: it is embedded in the literature of the subject. The nature of this embedding is specified by the use of footnotes/reference lists (Egghe and Rousseau 1991).

Much of the investigative work carried out on the structure and usage of journal literature depends upon the analysis of the references cited by authors in their papers. ***References*** are defined as " a list of publications to which an author has made specific reference; usually placed at the end of a book, sometimes in chapter order. The entries are usually

arranged in number, corresponding numbers appearing in the text. References are also referred to as ***citations*** " (Harrod 1990, 521). Garfield (1989) defined a ***citation*** as " a reference to one document by another as a source of information, support for a point of view, or as an authority for a statement of fact". According to Baird and Oppenheim (1994), the author in citing a document in his/her paper may be: criticizing an earlier item; building on it; using it to enhance his/her argument; or may be acknowledging an earlier pioneer. An author may perhaps make a citation simply to imply that he/she has read widely around his/her subject. A citation therefore links the earlier cited paper to the later one that cites it, meaning there is a [semantic] relationship between the whole/part of the cited document and the whole/part of the citing document.

3.3.1 Historical development of citation analysis

Citation analysis is a familiar methodology in the information community. It is a bibliometric technique[3] that deals with the relationships between the citing and the cited documents. According to Zunde (1971), there are three main application areas in citation analysis:

(i) qualitative and quantitative evaluation of scientists, publications and scientific institutions;

(ii) modelling of the historical development of science and technology;

(iii) information search and retrieval.

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[3] Bibliometrics is the study of the quantitative aspects of the production, dissemination and use of recorded information; mostly published or semi-published literature (Tague-Sutcliffe 1992, 1; Lancaster 1991, 1). Bibliometrics is related to the term scientometrics - the study of the quantitative aspects of science as an economic activity. According to Lancaster (1991, 2), a count of the number of science publications in a country is both a bibliometric and a scientometric study.

The term bibliometrics was recently expanded into the term informetrics - the study of quantitative aspects of information in any form, not just records or bibliographies and in any social group, not just scientists (Tague-Sutcliffe 1992).

Citation studies are concerned with such phenomena as: which authors are most cited, which journals are most cited and what linkages exist through citation (who cites whom, which journals cite which journals, what subject area are cited in the literature of a particular discipline, and so on) (Lancaster 1991).

Although Eugene Garfield is regarded as the pioneer in this bibliometric technique, it is recorded that an article by Gross and Gross in 1927 was perhaps the first citation analysis (Ravichandra Rao 1983). Gross and Gross suggested the use of citation counts in measuring the adequacy of a college library. Studies in citation analysis received a considerable importance when the Science Citation Index was introduced.

Eugene Garfield in 1956, started compiling the Science Citation Index using his knowledge of Shepherd's Citations - a service founded in 1873, for the US legal profession. Using his own funds, Garfield set up his own company, DocuMation Inc. but soon it changed its name to the Institute for Scientific Information (ISI). In 1963, the first edition of the Science Citation Index (SCI) was published by the ISI, and covered the literature of the calendar year 1961 (Egghe and Rousseau 1991). In 1964, a machine-readable database of the Science Citation Index became available (Lambert 1985). The Social Science Citation Index (SSCI) was launched in 1973. Now, thousands of major commercial, academic and scientific libraries worldwide use citation indexes, in print, online or on CD-ROM (Baird and Oppenheim 1994).

According to Smith (1981), the development of citation analysis was marked by the invention of new techniques and measures, the exploitation of new tools, and the study of different units of analysis. These trends led to a rapid growth in both the number and

the types of studies carried out, using citation analysis. The easiest technique to use is the **citation count**, done by determining how many citations have been received by a given document or set of documents over a period of time from a particular set of citing documents. When this count is applied to articles in a particular journal, it can be refined by calculating the **Impact Factor** - a measure that Eugene Garfield developed (Baird and Oppenheim 1994). It is the average number of citations received by articles published during the same period. This measure allows one to compare the "impact" of journals which publish different segments of the literature. The **Impact Factor** (IPF) is a better measure for the scientific importance of a journal than the total number of citations because it takes the total number of publications into account (Egghe and Rousseau 1990, 255). A two year period for the calculation of the IPF was adopted by the *Journal Citation Reports* (JCR) (Lancaster 1990, 20).

Another bibliometric measure, the **Immediacy Index** (IMI) is supposed to show how fast new ideas published in the journal are taken up by the scientific community (Egghe and Rousseau 1990, 255) and is a measure of how quickly the papers in a journal are cited (Lancaster 1991, 22).

Denoting the number of citations in the year Y to papers published in the year Z by $CIT_Z(Y)$, the number of publications in the year Y by PUB(Y), the impact factor in the year Y by IPF(Y) and the immediacy index in the year Y by IMI(Y), then it follows that:

$$IPF(Y) = \frac{CIT_{Y-1}(Y) + CIT_{Y-2}(Y)}{PUB(Y-1) + PUB(Y-2)} \quad \ldots\ldots\ldots\ldots\ldots (i)$$

Equation (i) symbolizes that, the Impact Factor (IPF) is the ratio:

(No. of citations received in yr. 3 by articles published in yrs. 1 & 2) to (No. of articles published in yrs. 1 & 2).

$$IMI(Y) = \frac{CIT_Y(Y)}{PUB(Y)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (ii)$$

and Equation (ii) symbolizes that, the immediacy index, according to the definition followed by the JCR, is the ratio:

(No. of citations received in yr. X by items published in yr. X) to (No. of items published in yr. X).

(Egghe and Rousseau 1990, 256; Lancaster 1991, 20-22).

Two techniques were also devised to identify documents that are likely to be closely related: **bibliographic coupling** (introduced by M. M. Kessler (1963) of Massachusetts Institute of Technology) and **cocitation analysis** (introduced by Small (1973) and Marshakova (1973)). Two documents are bibliographically coupled if their reference lists share one or more of the same cited documents. Two documents are cocited when they are jointly cited in one or more published documents (Smith 1981; Egghe and Rousseau 1990, 235-249).

Studies have also been done on the **obsolescence** of scientific literature. The study of **obsolescence** is related to changes in the use of documents over time. As noted by Ravichandra Rao (1983, 214), authors such as Line and Sandison (1974), Jain (1969), Kent *et al.* (1979) in their Pittsburgh study, and Fussler and Simon (1969) attempted to prove the hypothesis that use [of documents] declines over time. Brooks (1970) claimed that the decline of use over time, conforms closely to a negative exponential distribution.

He hypothesized that the number of references to an issue was a function of its age and assumed the function to be a geometric distribution. According to Egghe and Rousseau (1991, 267), Nakamoto (1988) observed a remarkable symmetry in **diachronous citation rates** (where one considers a fixed group of documents, for example one year's issue of periodicals and studies the evolution in citations as time, t, increases) and **synchronous citation rates** (where one is concerned with the distribution of citations to documents of different ages during a given span of time).

Garfield in 1979, pointed out potential problems with citation studies, including the lack of quality indicators of the particular scholarly work, intentions of citing authors not being clear, potential bias for recent publications and the fact that all citations in many studies are weighted equally (Anglin and Towers 1992). Moreover, the use of the Science Citation Index in evaluating citation counts has its own merits and demerits. Some of the problems are due to multiple authorship, self citation, homonyms (several authors having the same name), change of fields by scientists, the variation of citation counts from year to year and also from one region to another, the errors in bibliography, among other factors (Ravichandra Rao 1983; Egghe and Rousseau 1991; Smith 1981). C. Y. J. So, after reviewing studies that address some of Garfield's concerns, concluded in 1988 that "... citation analysis is a very useful method if it is employed carefully". Nevertheless, according to Baird and Oppenheim (1994), citation analysis studies have been successfully used in the past, to enable various important decisions to be taken, including:

the evaluation of scientific research; science management functions; prediction of Nobel Prize winners by assessing scientists; assessment of flow from research to development; and assessment of the impact of one country on another country's research.

3.3.2 Criticisms of the citation analysis method

As Chubin observed: "... many critics have rejected citation analysis as meaningless numerology...Protagonists however, have been equally cavalier in ignoring and dismissing critics as uninformed, misguided 'nonbelievers'" (MacRoberts and MacRoberts 1989). According to Broadus (1987), the first recorded criticism of the citation method occurred when Brodman produced her well-known denunciation of the citation method in 1944. This attack though well cited, was not well conceived, but she achieved indirectly what she wanted to do. The fact that the paper has received so many citations can be used as evidence that not always are cited materials the "best".

MacRoberts and MacRoberts (1989) gave a list of event-data problems of citation analysis as being the following:

(i) Formal influences not being cited.

(ii) Biased citing.

(iii) Informal influences not being cited.

(iv) Self-citing.

(v) Different types of citations.

(vi) Variations in citation rate related to type of publication, nationality, time period, and size and type of speciality.

(vii) Technical limitations of citation indices and bibliographies:

a. Multiple authorship. b. Clerical errors. c. Synonyms.

d. Coverage of literature. e. Homonyms.

Lambert (1985), also listed a number of criticisms of citation analysis, as follows:

- The extent to which citations can be relied upon as an indicator of active use is

evidence that differences in the research trends between the respective countries were likely attributable to the fact that the three periodicals were published in different countries.

A research was conducted by Marcias-Chapula (1990), on the progress related to the content and citation analysis of the Pan American Health Organization (PAHO)'s journal of medical education, *Educacion Medica y Salud.* Multiple authorship and the use of books and grey literature, were some of the patterns found. The use of scientific journals as cited sources represented 21.21 percent of all cited sources in the journal, thus ranking third after books (34.67 percent) and technical reports (28.93 percent). In descending order, the highly citing and cited countries were Brazil, Mexico and Colombia. Both the citing and cited sources were mainly published in Spanish, and Bradford's law was confirmed when analyzing the cited journals in the field.

Many studies have been conducted pertaining to scientific literature in Nigeria. Bozimo (1983) carried out a study that was intended to examine the state of the national scientific effort in Nigeria. She found that 43.4 percent of the articles published in the *Nigerian Journal of Science* came from the University of Ibadan. According to her findings, the *Journal of the Chemical Society* (London) was the most often cited, followed by the *Journal of the American Chemical Society.* She concluded by saying that the results of the study seemed to bear out the situation described before by Charles Cooper: " The lack of pressures on science from the local economy means that the main determinants of research orientation are the individual decisions of research workers; and these research workers take their lead from the international orientation of research. The scientific community in underdeveloped economies are outposts of advanced country

science with very limited links with the economic and social realities which surround them".

In another study, Alabi (1984) subjected journal citations in the *Bibliography of entomological research in Nigeria: 1900 - 1973* to a Bradford analysis. As one of the results, he inferred that the bibliography was 93 percent complete in terms of journals and 84 percent complete in terms of articles. It was further noticed that the observed value for the total number of authors was just over 50 percent of the actual figure, thereby suggesting that Bradford's Law may not be as applicable to author distribution as it is for literature. On the other hand, the investigation revealed that only 3 journals out of 216 listed in the bibliography formed the core while 21 authors out of 650 constituted the core.

Gupta (1993) analyzed a bibliography of geoscientific literature of Nigeria for the period 1904-1979, to test the applicability of Lotka's Law and the negative binomial distribution model to author productivity distribution patterns. He found out that the law could apply in its original form as the inverse square law in all cases.

Aziagba (1993), studied references made at the end of articles published in the *Nigerian Journal of Microbiology*, with the aim of identifying the book collections used by microbiologists in Nigeria. The ages of the materials as well as the forms of the literature confirmed that retrospective and up-to-date information was necessary for research in that field.

3.3.3.1 Citation studies in Ethiopia

Apparently, there is a shortage of published citation studies in Ethiopia. Perhaps the most prominent published study was the one done by Gupta (1991) on the *Ethiopian Medical Journal* for the two years - 1977 and 1987. He found that the distributions of citation frequencies of both the years was negative exponential type. By examining the half-lifes for both years, he concluded that the research trends for medical sciences in Ethiopia was very different from the universal trend.

Other citation studies have mostly been class exercises done at SISA, as part of the Master of Science in Information Science degree or the Bachelor of Science in Library Science degree coursework.

A good example is the unpublished senior essay by Mengst'ab Kidane (1993), on *The usage patterns of library materials in the Institute of Agricultural Research (IAR) library.* He studied the citations of 180 scientific papers contributed by researchers at the institute. It was evident that conference proceedings and research reports were the most important materials for the researchers of the institute. On the other hand, theses and dissertations were the least important. The study concluded that there was a weak relationship between the current acquisition of journals and their actual use by the researchers of IAR.

A bibliometric study was conducted by Dinberu (1994), as part of his research for the Masters degree thesis, at SISA. By examining 5500 records based on the *Ethiopian history and society: a bibliography of Ethiopian studies 1957-1990* by J. Abbink and a few citations collected from journals on Ethiopian studies, he proved that the data had a negative exponential distribution. Both Bradford's Law and Lotka's Law were applied

to the data to examine journal productivity and author productivity patterns respectively. Lotka's law was found to fit the distribution pattern of author productivity in Ethiopian studies. Using the formula given by Egghe and Rousseau (1991), the 80/20 rule did not apply to the data. It applied only as 80/31 in journal productivity 80/48 in author productivity.

3.3.4 Present and future trends concerning citation studies

Whether the technological changes available to the next generation of researchers will undermine the role of paper in the process of scholarship, remains to be seen.

What is already available are information facilities for electronic publishing and document handling such as the Xanadu Hypertext System (Smith 1981); Project Jefferson, developed at the University of Southern Carolina (USC); Visual Courseware Machine (VCM), developed at Massachusetts Institute of Technology (MIT); Intermedia; and sports and medical hypermedia[4] information systems (Jorgensen and Jorgensen 1991). The basic unit of the hypertext system is the windowing document. With the full text of documents available in machine-readable form, a reader may either explore a document or step through a window to explore the next document such as the one referred to in a footnote. After that, the reader may return to the preceeding document or proceed on tangents that become available, by searching for information in other documents as he/she may wish and as provided by the hypertext links. Thus the links

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[4] Hypermedia systems currently include video, still video, sound, text, computer generated animation, and facsimile. Hypertext (which is limited to textual information) is a subset of hypermedia. Hypermedia makes use of extensive links and paths . Links are a means of connecting fragments of information so that users can jump from one fragment or document to another by activating the link either through iconographic buttons, menus or the selection with a mouse (Jorgensen and Jorgensen 1991).

with citations represented are converted into electronic form and therefore according to Smith (1981), new possibilities for analysis of citations will arise out of these developments.

Nevertheless, as pointed out by Jorgensen and Jorgensen (1991) some problems with citations involving hypermedia systems exist:

(i) Multiple citation formats in hypermedia systems, just as in print media, are confusing to the users;

(ii) There is a lack of visual cues differentiating one source from another;

(iii) Users may suffer from disorientation within what is referred to as the 'seamless environment' of the information space;

(iv) There is a lack of document permanency in online information because unlike the printed page, documents in hypermedia systems can be edited or added without a visible indication that a change was made;

(v) Many complex copyright issues will continue to be raised, because it is currently possible to send copyrighted information from one user to another over an electronic network, thereby infringing on the proprietor's right to distribute the work.

Jorgensen and Jorgensen (1991) concluded by suggesting that "there must be a commitment [by hypermedia systems developers] to correct bibliographic and citation deficiencies [citation source-linkages and related issues of copyright] in these new systems if the library community is to avoid the further separation of source from citation. An awareness of the problems, however, is the essential first step in this endeavour".

4 METHODOLOGY

4.1 Introduction

The formidable problem that follows the task of defining the research problem is the design of the research project. A research design, according to Kothari (1990, 39), is " the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure ". It constitutes the blueprint for the collection, measurement and analysis of data. This chapter gives a description of the various methods and tools employed in the study that pertain to: data sources, data collection, data processing and data analysis.

An *analysis of records research* as Martyn and Lancaster (1981, 77) referred to a study of a type like this one, is concerned with indirect or unobtrusive methods of studying phenomena of interest to librarians and other information practitioners. Analysis of records types of research include bibliometric studies and the analysis of circulation/other records maintained by libraries.

Among the bibliometric studies are studies like:

citation analysis studies [like as this particular study]; studies involving the frequency of occurrence of word in texts (application of Zipf's Law); author productivity studies (application of Lotka's Law); literature scatter studies (application of Bradford's Law); and obsolescence studies (Martyn and Lancaster 1981; Ravichandra Rao 1983). The reasons forwarded in chapter 1, section 1.3.1 provide justification as to why **document**

analysis was employed as the principal survey tool in this study. **Literature survey** was also used as a supplementary survey tool.

According to Bailey (1982, 304), among the advantages of carrying out studies such as this are the following:

(i) They allow research on subjects to which the researcher does not have physical access, and thus cannot use any other method;

(ii) Occurrences over a long period of time can be studied. Many times the objective of the research is a trend;

(iii) Mostly involve a relatively lower cost and can therefore be inexpensive compared to large-scale surveys.

Conversely, Bailey (1982, 305-306) outlined disadvantages of these types of studies, some of which are the following:

(i) Data must be adjusted for comparability over a long period of time, especially if some external events cause changes that are so drastic that the unit of analysis used for the entire period produces misleading results;

(ii) Coding difficulties arising from differences in length and format may sometimes occur;

(iii) They are limited only to verbal (written) patterns. Nonverbal (non-written) patterns cannot be directly observed but may only be inferred.

4.2 Data for the study

This study basically used bibliographic data as raw data inputs. Keenan (1996, 19), defined a bibliographic citation as " details of an item that enable it to be identified

completely and unambiguously ". Bibliographic citations are sets of data elements that give clear and accurate bibliographic descriptions of documents. These data elements are able to show what kind of document was referred to and other related details such as author of the document, title, year of publication, place of publication, publisher, edition and so on.

Egghe and Rousseau (1990, 218) and Harsanyi (1993) pointed out some difficulties with citation studies involving multi-authored works, among which is the allocation of credit to the authors of such works. In order to simplify the sorting of the data thereby redeeming time and also limited size of computer memory, only the names of the authors appearing first among the listed names of authors in multi-authored works, were entered into the computer for analysis. This applied to both the citing and the cited documents respectively.

Apart from the indigenous Ethiopian names, the names of all non-Ethiopian authors were entered as: surnames in full, followed by initials of other names. This was done in order to impede as much as possible, the envisaged inaccuracies when indexing the data by names. It was observed that despite this precaution, it still remained difficult to eliminate the rest of the problems of citation analysis that are highlighted by Egghe and Rousseau (1990, 217-219); MacRoberts and MacRoberts (1989) and Smith (1981). These include problems like the occurrences of homographs/homonyms (several scientists with the same name and initials, who publish in the same field) and synonyms (an author's name with a variable number of initials).

Other data elements considered were: the type of documents referred to (journals,

technical reports, books, monographs, theses and others); titles of documents cited; their respective years of publication; the title of citing journal and its year of publication. It was also important to indicate whether the cited documents were published locally or otherwise. Authorities like: the available volumes/CD-ROM databases of Books-in-Print in the case of books and monographs, or the available volumes/ microfiches of Ulrich's International Directory of Periodicals and the Union list of periodicals in Ethiopia were useful for getting the relevant details.

4.2.1 Time span covered by the study

The study covered a ten year time span, ranging from 1985 to 1994 inclusive. This enhanced the observation and comparison of the resulting trends in the analyzed data. The time span covered by the study was chosen in view of the fact that literature in the sciences usually becomes obsolete at a relatively faster rate than literature in other branches of knowledge. For this reason, primary information emanating from research that was undertaken in a period earlier than the one chosen would not be of much relevance to current research in both the pure and applied sciences. The collected data related to the same time period, was counted in the same manner, was compiled as well as analyzed using the same definitions, as recommended by Moore (1983).

4.2.2 Sampling of the data

All the items under consideration in any field of inquiry constitute a 'universe' or 'population'. A complete enumeration of all the items in the population is known as a 'census inquiry' (Kothari 1990, 18). It was presumed that the greatest accuracy for the collected data could have been achieved through a census inquiry, by studying all the available journals in both the pure and the applied sciences, over the specified time span.

In order to select the sample journals for the study, the following set of selection criteria was conceived:

(i) The journal should be one that is published in Ethiopia

either by a local organization, a local institution or a local professional association. The journal should be included in the Profile of Science and Technology professional publications in Ethiopia, published in 1994 by the Ethiopian Science and Technology Commission.

(ii) The journal should be one that is included either in the

Ulrich's International Directory of Periodicals (January 1996 Microform edition) or indexed/abstracted in one or more of the international databases, nowadays commonly on CD-ROM.

(iii) The journal should strictly cover topics within the

various pure and applied science disciplines and should contain articles/papers that report original research work that was carried out by the respective authors.

(iv) The journal should have been in consistent production for

the entire period covered by the study, from the beginning of 1985 to the end of 1994;

The sampling frame (the complete list of all units from which the sample was drawn) comprised the sixteen (16) journals shown in Table 4.1, that were obtained from the profile of scholarly publications published by the Ethiopian Science and Technology Commission (see also Appendix II). From the sample frame, a sample of three (3) journals were picked in order to be studied. One (1) journal was thus picked from the pure sciences, and two (2) journals from the applied sciences (see Appendix I).

Table 4.1 Sampling frame of journals in the pure and applied sciences in Ethiopia

(A) Pure science journals in Ethiopia:

- *Bulletin of the Chemical Society of Ethiopia*
- *SINET: Ethiopian Journal of Sciences*
- *IPB Research Report Series*
- *Journal of Biological Sciences*
- *Hissab Journal*
- *Ethiopian Journal of Science and Technology*
- *Journal of Ethiopian Statistical Association*

(B) Applied science journals in Ethiopia:

- *Ethiopian Medical Journal*
- *SEBIL journal*
- *Ethiopian Journal of Health Development*
- *African Livestock Research Journal*
- *Bulletin of the Jimma Institute of Health Sciences*
- *Ethiopian Pharmaceutical Journal*
- *Zede: journal of the Ethiopian Association of Engineers and Architects*
- *Ethiopian Journal of Agricultural Sciences*
- *Bulletin of Crop Protection*

By invoking the given sample selection criteria, the journals in the sample frame that fully met all the conditions were included in the sample, as per the justifications briefly given below:

(A) Pure sciences:

○ *SINET: Ethiopian Journal of Sciences*

- Is published by the Faculty of Science (Addis Ababa University).
- Appears in the Ulrich's International Directory of Periodicals (January 1996 Microform edition).
- Covers various science disciplines.

criteria. As a result they were excluded from the sample for this study.

4.2.3 Data collection sites

This study was exclusively conducted in Addis Ababa city. All the journals under consideration were readily available in the various libraries and information centres concerned with the respective subject areas covered, within the locality.

The libraries and information centres of primary importance, to this study, as data collection sites were the following:

- Ethiopian Science and Technology Commission (ESTC) library[5];
- Institute of Ethiopian Studies (IES) library[6] - AAU;
- Faculty of Science Library - (AAU);
- Faculty of Medicine library - (AAU); and
- Institute of Agricultural Research (IAR) library.

The publishers of the respective journals under consideration were also approached for some of the data, where it was possible.

For secondary information to this study, the relevant facilities available for use were the following: the UNECA library, the UNECA/PADIS information and documentation centre, ILRI library, the British Council library and so on. The Addis Ababa University (AAU), main campus-based Research and Publications Office was very useful for

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5 The ESTC library acts as a repository centre for many of the scientific documents that are published in Ethiopia. This is in addition to catering for the information needs of its respective patrons.

6 The IES library diligently collects and maintains holdings of a number of the scientific documents that are published in Ethiopia as part of its Ethiopiana collection.

obtaining the background information to the journals studied.

4.2.4 Method of data collection

All the journals considered in this study were not covered in the available Science Citation Index (SCI) CD-ROM databases (1990, 1991 and 1993 editions, respectively). For this reason, it was not possible to collect raw data for the study from the CD-ROM databases by copying it as files onto a diskette or onto the computer network at SISA. Therefore, the required data had to be manually extracted from each one of the references found at the end of the respective main articles of the selected journals. One by one, the data elements were keyed into the computer for the purposes of processing and analysis. The data thus collected, reflected a 95 percent level of confidence.

A similar method of collecting data directly from the source journals was employed by authors like: Sengupta (1970), Marcias-Chapula (1990), Aziagba (1993) and Haiqi (1995), to name a few.

4.3 Application software used for data analysis and presentation of findings

The commitment to software was restricted to the facilities available at the computer laboratories at SISA. The application softwares used in the study are based on MS-DOS version 6.20 disk operating system. All the softwares are available on the network at SISA, which operates on the Novell NetWare network operating system. In this study, three application softwares were used:

(i) **dBASE IV** (c) 1990 - For the purposes of creating database files for the collected data, encoding and sorting the data.

(ii) **SAS** (Statistical Analysis System) software system, Release 6.04 - for the

purposes of statistical data analysis.

(iii) **WordPerfect 5.1** for the word processing of the resulting reports.

In order to justify the aforementioned software tools used in this study, it is obligatory to hereby take a closer look at each one of them and the respective facilities offered.

- **dBASE IV** - This is a relational database management software. According to Weston (1992), this means that it can relate data in several different files at once, by means of a common field.

  dBASE IV enables one to do a lot of things with raw data inputs. Among these are the following (Weston 1992, 11): creating a database; changing field lengths; designing forms; querying the database; creating indexes; sorting the database; linking database files; creating reports; and saving as well as printing reports. All these factors rendered dBASE IV very useful for the intended purpose.

- **SAS** Software, Release 6.04 - This is a software system for the statistical analysis of data. Once the raw data inputs were sorted in dBASE IV, the processed outputs became inputs into SAS. This was achieved by importing the results obtained from dBASE IV, into appropriate SAS programs. SAS was selected for this study because, according to the SAS Institute Inc. (1988, xi), it provides tools for the following purposes:

  * **information storage and retrieval** The SAS system reads data values in virtually any form and then organizes the values into a SAS data set. The data can be combined with other SAS data sets using file handling operations;

  * **data modification and programming** A complete set of SAS statements is available for modifying data;

* **report writing** In addition to the preformatted reports that SAS procedures produce, one can design and produce printed reports in any form, including output files on disk;

* **descriptive statistics** Procedures are available which are able to assist one to do the following:

  - provide simple descriptive statistics, such as averages and standard deviations
  - produce bar charts, pie charts and plots
  - produce and analyze contingency tables
  - rank and standardize data

* **file handling** SAS software has tools for editing, subsetting, concatenating, merging and updating data sets. Multiple input files can be processed simultaneously and several reports can be produced in one pass of data.

♦ **WordPerfect 5.1** - The last report was produced by importing the reports generated by SAS into WordPerfect through the DOS text-editor. WordPerfect 5.1 is a powerful yet easy-to-use word processing program in which one can create a variety of programs. According to Fox and Metzelaar (1990, 1-2), WordPerfect offers a full range of editing capabilities as well as advanced printing and utility options. Pull-down menus are added as an alternative to the regular menus, and they are activated from the keyboard. Using the options provided, one is able to do the following:

  - Import files;
  - Set and change text format and appearance;
  - Create mathematical formulas and tables;

5 DATA ANALYSIS

5.1 Introduction

With the methodology of this study clearly identified and the required data collected, the question that naturally posed itself next, was : 'what was to be done with the raw data collected?'. According to Wilkinson and Bhandarkar (1984, 283), the next focus of attention is on the data analysis. This usually involves a number of closely related operations that are performed with the purpose of summarizing and organizing the collected data in a manner that enables the yielding of answers, either to the research questions posed or the hypotheses stated.

As Wilkinson and Bhandarkar (1984, 283) observed from the literature that was available to them, some authors preferred to make a clear distinction between analysis of data and processing of data, in the following manner:

(a) ***Processing of data*** refers to concentrating, recasting and dealing with data so that it is as amenable to analysis as possible.

(b) ***Analysis of data*** refers to seeing the data in the light of the hypotheses or research questions and the prevailing theories and ultimately drawing conclusions that are amenable to theory formulation as possible.

Other authors seemed not to subscribe to such a precise differentiation of the two terms; for them, analysis of data seemingly involves processing, namely all operations designed to draw generalizations or test the hypotheses. This conception of analysis of data is

perhaps more inclusive than the former.

5.2 Coding of the collected data

Coding of data consists of assigning symbols, (usually numerals) to each answer which falls into a predetermined class. In other words, coding may be regarded as the classification process that is necessary for subsequent tabulation. Through coding, the raw data collected is transformed into symbols that may be counted and tabulated (Wilkinson and Bhandarkar 1984, 284).

In this study, the coding of the collected raw data was executed with the help of the dBASE IV database management application software. Three dBASE IV database files, namely EJAS.DBF, EMJ.DBF and SINET.DBF (representing each selected source journal for which raw data was collected namely; *Ethiopian Journal of Agricultural Sciences* (henceforth abbreviated as EJAS), *Ethiopian Medical Journal* (henceforth abbreviated as EMJ) and *SINET: Ethiopian Journal of Sciences* (henceforth abbreviated as SINET) respectively) were created. The desired data elements were thereafter entered according to the data structure table depicted in Table 5.1, for each respective database file.

Table 5.1 Data structure for the entry of data elements

Num	Field Name	Field Type	Width	Dec	Index
1	CITERNAME	Character	40		N
2	CITERYEAR	Numeric	4	0	N
3	AUTHCITED	Character	40		N
4	TITL_CITED	Character	60		N
5	YR_PUCITED	Numeric	4	0	N
6	PUBTYPECIT	Character	1		N
7	ETHIOPUB	Character	1		N
8	KEYPHRASE	Character	25		N

With respect to Table 5.1 above, the Field Names for each of the data items entered, were taken to have the following meanings:

CITERNAME - The name of the first author (if among a given list of authors) of a particular article in the respective issue of the source journal under study.

CITERYEAR - The year of publication of the source journal issue under study.

AUTHCITED - The name of the first author (if among a given list of authors) of each of the respective cited publications in the source journal article under study.

TITL_CITED - The title of each of the respective cited documents in the source journal article under study.

YR_PUCITED - The year of publication of each of the respective cited documents, in the source journal article under study.

PUBTYPECIT - The type of each of the respective documents cited as a reference in the source journal article under study. The following representative characters

Table 5.2 Summarized information about the raw data collected

	Eth. J. Agric. Sci.	*Eth. Med. J.*	*SINET: Eth. J. Sci.*
First issue considered	Vol. 7, No. 1, Jan. 1985.	Vol. 23, No.1 Jan. 1985.	Vol.8, No.1&2 1985
Last issue considered	Vol. 14, No.1& 2, Jun. 1994.	Vol. 32, No. 4 Oct. 1994.	Vol.17, No. 2 Dec. 1994
Total number of issues considered	12	33	17
Total number of articles considered	80	150	53
Total number of authors of articles considered	78	103	45
Total number of cited references entered	1059	2466	971
Average No. of cited references per article	13.24	16.44	18.32
Average No. of articles per author	1.03	1.46	1.18

Thus as is evident from Table 5.2, a total of 4496 records were created, corresponding to an equivalent number of references that were cited by a total of 226 individual authors/ scientists, in 283 articles. The raw data was collected over the ten - year period, from 1985 to 1994 inclusive. This period covered was uniform for all the three source journals under study.

After the data elements were entered into dBASE IV, they were proof-read to ensure that the spelling of the data entered in each field was precise. This was crucial for the accurate indexing of data and its subsequent analysis.

The data was thereafter indexed on each field so as to be able to obtain the respective frequencies of various occurrences and also to prepare them to be exported into the SAS statistical analysis software. Indexing of the data was preferred to sorting it, although like sorting, indexing enables one to reorganize a database file in a particular order. However, according to Ashton-Tate (1992), instead of creating a new, sorted file, indexing creates an internal file of index key values and record numbers. In that manner, a great deal of disk storage space was economized.

5.3 Statistical analysis of the data

Once the indexed data was imported into the SAS statistical analysis software and converted into SAS data sets, it was subjected to a series of operations, which are described in detail, in due course of this chapter. Exactly the same operations were executed for indexed data corresponding to each of the three source journals under study.

The procedure used to import data from dBASE IV files to SAS was:

Proc DBF = DB3 = <dBASE filename. OUT> = <Output filename>

(See Appendix III).

Most of the operations executed on the data involved the determination of frequencies of occurrence, percentages and cumulative frequencies and cumulative percentages, respectively. The output was then ranked from the highest frequency of occurrence to

the lowest in various frequency tables.

Taking into account, the extremely large volume of information emanating from the data that was processed in this way, a decision was taken to exhibit only the first twenty (20) items in the respective ranked outputs, so as to be able to economize, as much as possible on the permissable space.

Discussions on the ensuing results obtained from the analysis will hereinafter be approached in the order of the first three specific objectives of the study, that were stipulated in section 1.4 of chapter 1, for each of the source journals under study.

5.3.1 Ethiopian Journal of Agricultural Sciences (EJAS)

5.3.1.1 OBJECTIVE (i) - Communication patterns in EJAS

5.3.1.1.1 Age of documents cited in EJAS

The scientists in the agricultural sciences were observed to have referred to/cited documents that were about **12 years** of AGE on the average (plus or minus roughly 11 years) as shown in Table 5.3 below. AGE was obtained in SAS by means of a procedure which subtracted all the YR_PUCITED[7] values from the CITERYEAR[8] values.

Table 5.3 Mean and standard deviation of AGE of documents cited in EJAS

No. of Obs. (citations)	Min. AGE (in Yrs.)	Max. AGE (in Yrs.)	Mean AGE (in Yrs.)	Std. Dev. of AGE (in Yrs.)
1059	0	105	12.37	10.68

When ranked in a decreasing order of the frequency of occurrence, it was found that documents which were **seven (7) years** of AGE were the most frequently cited

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7 The YR_PUCITED field is defined in section 5.2

8 The CITERYEAR field is defined in section 5.2

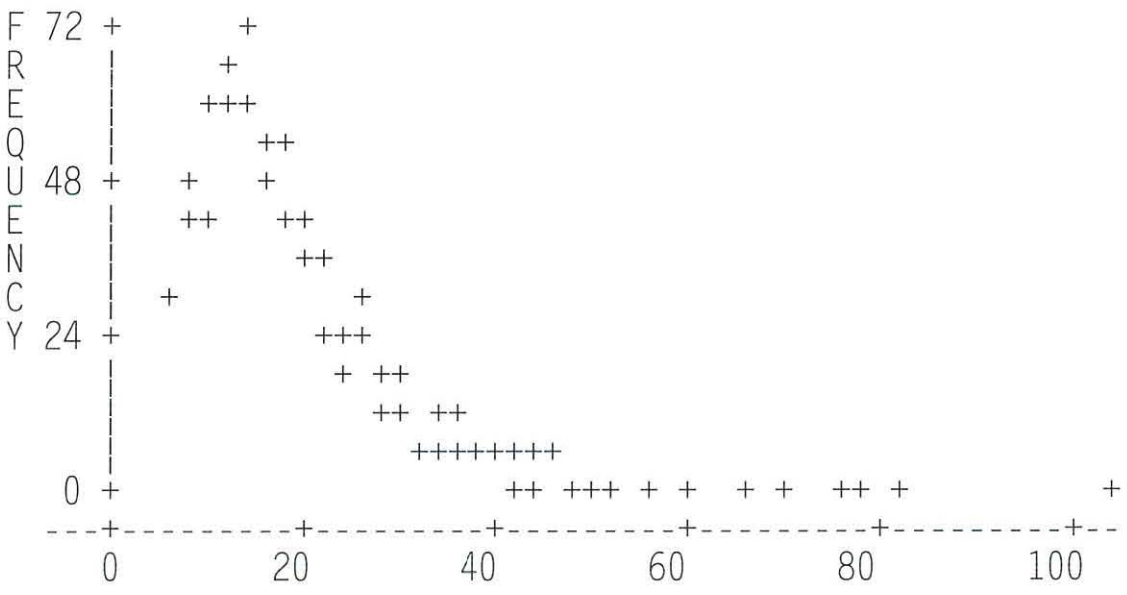
(amounting to **6.5 percent** of all the documents that were cited in EJAS, within the period that was covered by the study). The rest of the AGEs of the documents followed the sequence indicated in Table 5.4 below.

Table 5.4 Ranked frequency distribution of AGE of documents cited in EJAS - top twenty

Rank	AGE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	7	69	6.5	69	6.5
2.	6	65	6.1	134	12.7
3.	4	58	5.5	192	18.1
4.	5	57	5.4	249	23.5
5.	8	57	5.4	306	28.9
6.	10	56	5.3	362	34.2
7.	12	53	5.0	415	39.2
8.	9	48	4.5	463	43.7
9.	1	47	4.4	510	48.2
10.	2	42	4.0	552	52.1
11.	3	40	3.8	592	55.9
12.	13	40	3.8	632	59.7
13.	11	39	3.7	671	63.4
14.	14	34	3.2	705	66.6
15.	16	34	3.2	739	69.8
16.	0	32	3.0	771	72.8
17.	19	27	2.5	798	75.4
18.	17	24	2.3	822	77.6
19.	20	24	2.3	846	79.9
20.	15	21	2.0	867	81.9

The FREQUENCY of the documents cited was then plotted against the AGE. The outcome corresponded to the plot in Figure 5.1.

Figure 5.1 Plot of FREQUENCY vs AGE of documents cited in EJAS



AGE (of documents cited in EJAS, 1985 - 1994)

From the features of the distribution represented by the above plot, it was suspected that the frequency of documents cited when their respective ages were taken into consideration, resembled the frequency curve of an exponential distribution. According to Ravichandra Rao (1983, 78), the density function of the simplest type of exponential distribution is:

$$f(x) = \theta e^{-\theta x},\ x \geq 0 \ldots\ldots\ldots\ldots\ldots\ldots (iii)$$

The distribution function is given by:

$$F(X \leq x) = \int_{t=0}^{t=x} \theta e^{-\theta t}\, dt = 1 - e^{-\theta x},\ x \geq 0 \ldots\ldots (iv)$$

The mean and standard deviation of this type of exponential distribution are identical, and are given as:

$$\mu = \sigma = \frac{1}{\theta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (v)$$

Thus, the frequency curve of the exponential distribution exhibits a unimodal feature (it has one maximum value), a lack of symmetry (it is skewed to the right (positive skewness)) and has a long tail extending to the right, that is in the positive direction. Equation (iii) implies that the following negative linear equation holds true, on applying natural logarithms to both sides of the equation:

$$\ln(f(x)) = -\theta x + \ln\theta \ldots\ldots\ldots\ldots\ldots (vi)$$

Therefore by substituting **ln(FREQ)** in the place of **ln(f(x))** and **AGE** in the place of **x** into equation (vi) above, ln(FREQ) was regressed on AGE to find out if there existed any linear relationship between the two variables of the form given by the following equation:

$$\ln(FREQ) = -\theta AGE + \ln\theta,\ \textit{where } \theta \textit{ is a positive constant} \ldots (vii)$$

-Θ, in this case, is actually the gradient of the linear equation, whereas lnΘ is the y-intercept.

The results of the F-test in SAS, in which ln(FREQ) was regressed on AGE, are summarized in Table 5.5.

Table 5.5 Analysis of variance (ANOVA) table for EJAS

Model: MODEL1
Dependent Variable: ln(FREQ)

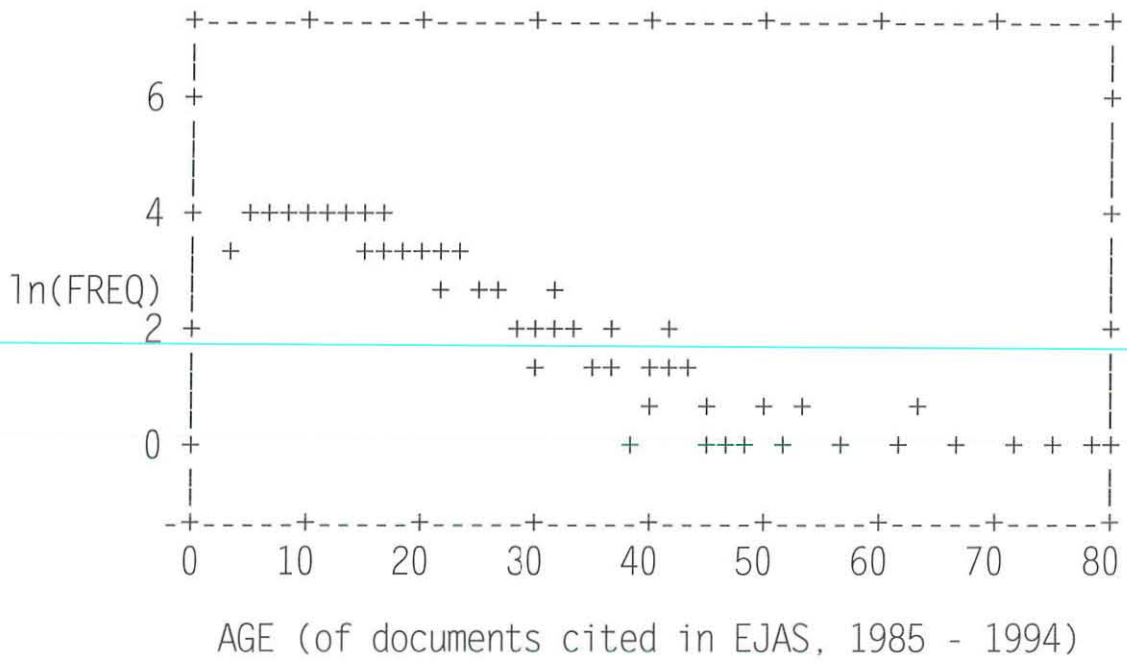
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	104.28469	104.28469	207.597	0.0001
Error	56	28.13116	0.50234		
C Total	57	132.41585			

Root MSE	0.70876	R-square	0.7876
Dep Mean	1.99494	Adj R-sq	0.7838
C.V.	35.52800		

According to the values obtained from the regression of ln(FREQ) on AGE, it was found (from the ANOVA table in Table 5.5) that the calculated F value = 207.597. The value of n was 58 (namely the total number of unique observations, also corresponding to the upper limit of the ranking of frequency of the age of cited documents (see Table 5.4)). At $\alpha = 0.05$ (at 95 percent confidence level (or 5 percent level of significance)), the F - table showed (by employing a simple linear interpolation technique) that; $F_{\alpha}(1, n-2) = F_{0.05}(1, 56) = 4.016$. Since the calculated F value was greater than $F_{0.05}(1, 56)$, meaning that $207.597 > 4.016$, then the result implied that there existed a significant linear relationship between ln(FREQ) and AGE of documents cited in EJAS from 1985 to 1994

inclusive. In fact this linear relationship was found to be a negative one, as depicted in the SAS output of the plot of ln(FREQ) against AGE in Figure 5.2.

Figure 5.2 Plot of ln(FREQ) vs AGE of documents cited in EJAS



This result indicates that the frequency distribution of the AGE of the documents that were cited in articles published in EJAS from 1985 to 1994 inclusive, most likely conforms to a type of exponential distribution. Further tests would enable one to ascertain exactly which type of exponential distribution it fits.

5.3.1.1.2 Nature of the messages communicated through the documents cited in EJAS

By importing the indexed KEYPHRASE data from dBASE IV into SAS in a similar manner and converting it into a SAS data set, a ranked frequency distribution of the KEYPHRASE was obtained. From this ranked list, it was evident that the subject which was communicated most frequently from the cited author to the citing author was **Crop**

pests. It had a frequency of occurrence of **36** (corresponding to **3.6 percent** of all the unique subjects that were communicated to the respective citing authors in EJAS, from 1985 to 1994 inclusive). (See Table 5.6 below).

Table 5.6 Ranked frequency distribution of KEYPHRASE of documents cited in EJAS - top twenty

Rank	KEYPHRASE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	Crop pests	36	3.6	36	3.6
2.	Insect pests	34	3.4	70	6.9
3.	Plant diseases	14	1.4	84	8.3
4.	Soil science	14	1.4	98	9.7
5.	Coffee diseases	11	1.1	109	10.8
6.	Crop production	11	1.1	120	11.9
7.	Bacterial wilt	10	1.0	130	12.9
8.	Soghurm diseases	10	1.0	140	13.9
9.	Soil analysis	10	1.0	150	14.9
10.	Fertilizers	9	0.9	159	15.8
11.	Maize	9	0.9	168	16.7
12.	Microbiology	9	0.9	177	17.6
13.	Potato research	9	0.9	186	18.5
14.	Bacteriology	8	0.8	194	19.2
15.	Digestibility of	8	0.8	202	20.0
16.	Livestock produc	8	0.8	210	20.8
17.	Mastitis	8	0.8	218	21.6
18.	Wheat diseases	8	0.8	226	22.4
19.	Animal microbiol	7	0.7	233	23.1
20.	Animal nutrition	7	0.7	240	23.8

5.3.1.1.3 Authors cited in articles published in EJAS

In a similar manner, the names of the authors cited in EJAS were ranked, from the most frequently cited to the least frequently cited. It was found that **Institute of Agricultural Research** (IAR) of Ethiopia, was the most cited corporate author with **28 occurrences** (2.6 percent)), followed by Food and Agriculture Organization (FAO) with (10) occurrences (0.9 percent). **Tsedeke Abate** was the individual author who was cited the greatest number of times (**ten (10)**, accounting for **0.9 percent** of all cited authors in EJAS articles between 1985 and 1994). (See Table 5.7).

Table 5.7 Ranked frequency distribution of cited authors in EJAS - top twenty

Rank	AUTHCITED	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	Institute of Agr	28	2.6	28	2.6
2.	Food and Agricul	10	0.9	38	3.6
3.	Tsedeke Abate	10	0.9	48	4.5
4.	Gryseels, G.	9	0.8	57	5.4
5.	Anon.	8	0.8	65	6.1
6.	AOAC	6	0.6	71	6.7
7.	Central Statisti	6	0.6	77	7.3
8.	Crow, T. J.	6	0.6	83	7.8
9.	Ethiopia, Minist	6	0.6	89	8.4
10.	Jutzi, S. C.	6	0.6	95	9.0
11.	Mesfin Abebe	6	0.6	101	9.5
12.	Parker, C.	6	0.6	107	10.1
13.	Kaiser, W. J.	5	0.5	112	10.6
14.	Melaku Worede	5	0.5	117	11.0
15.	Tesfaye Tesemma	5	0.5	122	11.5
16.	De Lotto, G.	4	0.4	126	11.9
17.	McDowell, R. E.	4	0.4	130	12.3
18.	Singh, S. R.	4	0.4	134	12.7
19.	Westphal, E.	4	0.4	138	13.0
20.	Adjei-Twum, D. C	3	0.3	141	13.3

5.3.1.2 OBJECTIVE (ii) - Identification of prolific authors in EJAS

The names of the citing authors/scientists in Ethiopia, who contributed the papers that were published in EJAS, the source journal were also ranked in a decreasing order of the frequency in which their names either appeared first in the given list of author names, or appeared alone (CITERNAME). It was found that no particular author could be regarded as having a significant monopoly of production of research articles, that were published in EJAS during the period 1985 -1994 inclusive. **Hailu Gebre** and **Teshome Shenkoru** were first in the ranking with **two (2) articles** each (2.6 percent), to their credit.

Table 5.9 Ranked frequency distribution of PUBTYPECIT (the type of documents cited in EJAS)

Rank	PUBTYPECIT[9]	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	J	429	40.5	429	40.5
2.	C	138	13.0	567	53.5
3.	B	135	12.7	702	66.3
4.	M	118	11.1	820	77.4
5.	R	93	8.8	913	86.2
6.	P	58	5.5	971	91.7
7.	N	54	5.1	1025	96.8
8.	T	21	2.0	1046	98.8
9.	A	13	1.2	1059	100.0

(a) Total No. of documents cited in EJAS = 1059

(b) Total No. of documents cited in EJAS, that were published in Ethiopia = 240 (20.66%)

(c) Total No. of documents cited in EJAS, that were published outside Ethiopia = 819 (77.34%)

(d) Total No. of Primary sources of information cited in the EJAS issues surveyed = 793 (74.88%)

(e) Total No. of Secondary sources of information cited in EJAS issues surveyed = 266 (25.11%)

From the statistical data given above, one can discern that the authors of articles that were published in EJAS between 1985 and 1994, heavily cited documents that were published outside Ethiopia by a large majority (77.34 percent). This was indicative of a greater amount of communication with international experts than with local counterparts.

Further, it is also apparent that these same authors of articles published in EJAS also heavily cited the primary sources of information (74.88 percent), as opposed to the primary sources of information. This was indicative of the greater relevance and therefore the subsequent need of more recently produced documents which probably contained more up-to-date results or techniques.

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[9] The meanings of the letters representing the type of cited documents which were listed under the PUBTYPECIT field, are furnished in section 5.2.

Finally, the titles of the documents cited were ranked in a decreasing order of frequency of the cited title. The SAS output results showed that **proceedings** led with **30 occurrences** (2.8 percent). The most highly cited Ethiopian publication in EJAS, during the period covered by the study, was itself (EJAS) with 13 occurrences (1.2 percent) (see Table 5.10).

Table 5.10 Ranked frequency distribution of TITL_CIT (the titles of documents cited in EJAS) - top twenty

Rank	TITL_CIT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	Proceedings of t	30	2.8	30	2.8
2.	Crop Sci.	18	1.7	48	4.5
3.	Paper presented	14	1.3	62	5.9
4.	Phytopathol.	14	1.3	76	7.2
5.	Eth. J. Agric. S	13	1.2	89	8.4
6.	J. Dairy Sci.	13	1.2	102	9.6
7.	Agron. J.	10	0.9	112	10.6
8.	Can. J. Plant Sc	9	0.8	121	11.4
9.	J. Agric. Sci.	9	0.8	130	12.3
10.	J. Food Sci.	9	0.8	139	13.1
11.	Bull. Entomol. R	8	0.8	147	13.9
12.	Progress report	8	0.8	155	14.6
13.	Exp. Agric.	7	0.7	162	15.3
14.	Am. Potato J.	6	0.6	168	15.9
15.	Ann. Appl. Biol.	6	0.6	174	16.4
16.	Ann. Rev. Phytop	6	0.6	180	17.0
17.	Aust. J. Exp. Ag	6	0.6	186	17.6
18.	ILCA Bulletin	6	0.6	192	18.1
19.	J. Anim. Sci.	6	0.6	198	18.7
20.	Official methods	6	0.6	204	19.3

5.3.2 Ethiopian Medical Journal (EMJ)

5.3.2.1 OBJECTIVE (i) - Communication patterns in EMJ

5.3.2.1.1 Age of documents cited in EMJ

The scientists in the medical sciences were observed to have referred to/used documents that were about **13 years** of AGE on the average (plus or minus approximately 12 years) as shown in Table 5.11 below. AGE was obtained in a similar manner to that in section 5.3.1.1.1.

Table 5.11 Mean and standard deviation of AGE of documents cited in EMJ

No. of Obs. (Citations)	Min. AGE (in Yrs.)	Max. AGE (in Yrs.)	Mean AGE (in Yrs.)	Std. Dev.of AGE (in Yrs.)
2464	0	149	13.30	12.11

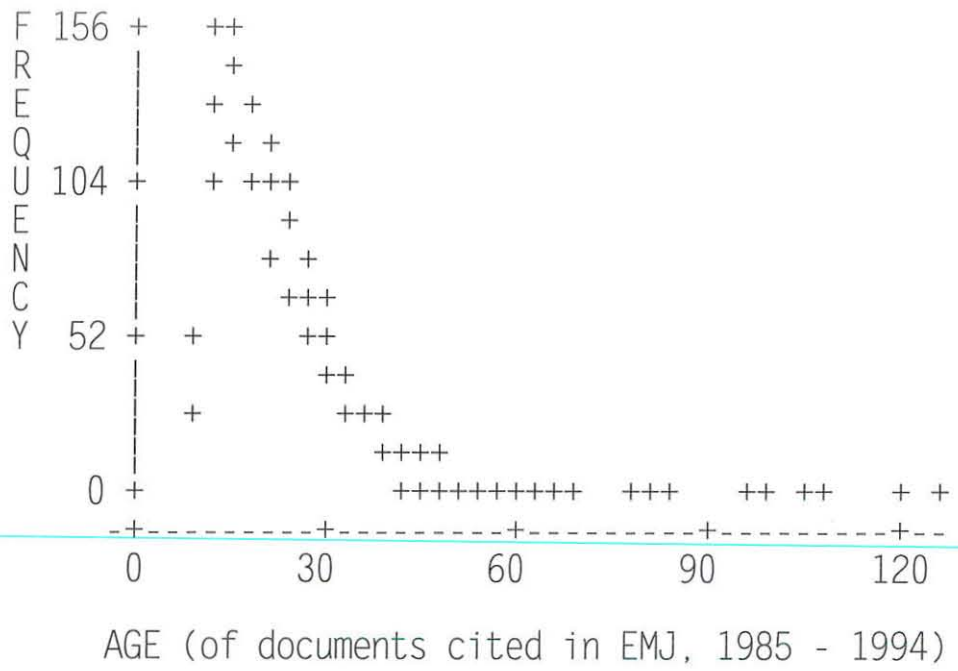
When ranked in a decreasing order of frequency of occurrence, it was found that documents which were **five (5)** years of AGE were most frequently cited (6.3 percent of all the documents cited in EMJ between 1985 - 1994) (see Table 5.12).

Table 5.12 Ranked frequency distribution of AGE of documents cited in EMJ - top twenty

Rank	AGE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	5	155	6.3	155	6.3
2.	4	151	6.1	306	12.4
3.	6	146	5.9	452	18.3
4.	3	135	5.5	587	23.8
5.	8	133	5.4	720	29.2
6.	7	119	4.8	839	34.1
7.	12	111	4.5	950	38.6
8.	9	106	4.3	1056	42.9
9.	11	103	4.2	1159	47.0
10.	2	99	4.0	1258	51.1
11.	10	98	4.0	1356	55.0
12.	15	98	4.0	1454	59.0
13.	14	91	3.7	1545	62.7
14.	13	83	3.4	1628	66.1
15.	18	72	2.9	1700	69.0
16.	16	68	2.8	1768	71.8
17.	20	66	2.7	1834	74.4
18.	17	64	2.6	1898	77.0
19.	21	57	2.3	1955	79.3
20.	19	52	2.1	2007	81.5

The FREQUENCY of the documents cited was then plotted against the AGE. The outcome corresponded to the plot in Figure 5.3. It was also suspected that the frequency of documents cited, when their respective ages were taken into consideration, resembled the frequency curve of an exponential distribution. An F - test was therefore carried out on the data to find out whether it could fit an exponential distribution.

Figure 5.3 Plot of FREQUENCY vs AGE of documents cited in EMJ



The results of the F - test in SAS, in which ln(FREQ) was regressed on AGE, are summarized in Table 5.13.

Table 5.13 Analysis of variance (ANOVA) table for EMJ

Model: MODEL1
Dependent Variable: ln(FREQ)

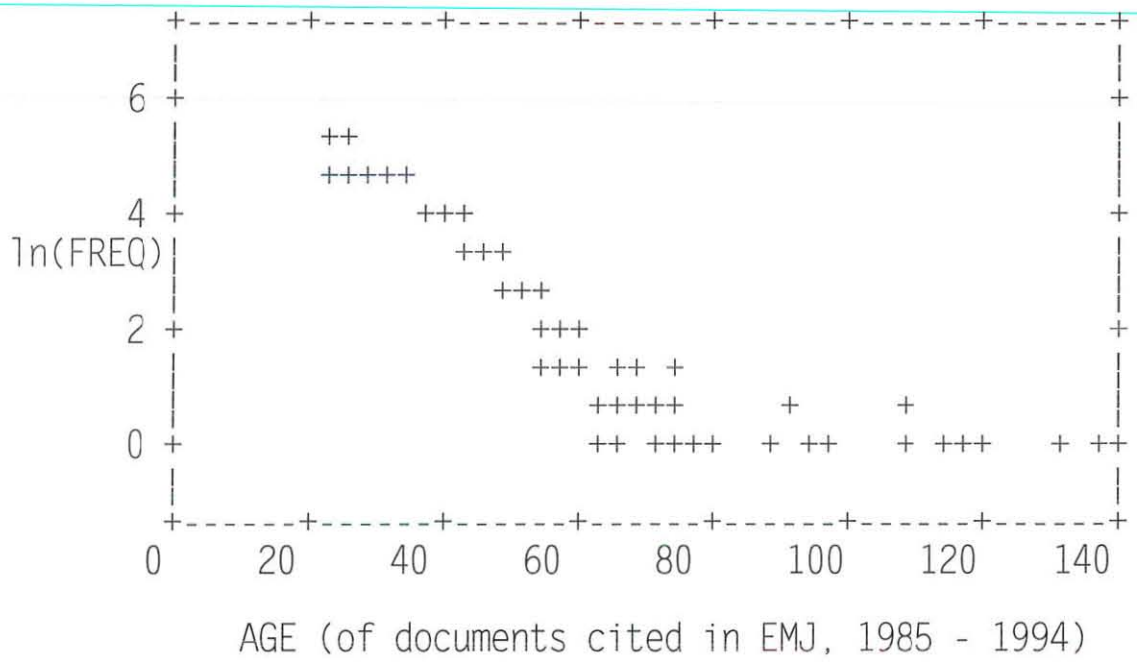
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	1	173.15910	173.15910	155.112	0.0001
Error	72	80.37686	1.11635		
C Total	73	253.53596			

Root MSE	1.05657	R-square	0.6830
Dep Mean	2.14608	Adj R-sq	0.6786
C.V.	49.23265		

At $\alpha = 0.05$ (at 95 percent confidence level (or 5 percent level of significance)), the F - table showed (by employing a simple linear interpolation technique) that; $F_{\alpha}(1, n-2) =$

$F_{0.05}(1, 72) = 3.984$. Since the calculated F value was greater than $F_{0.05}(1, 72)$, meaning that 155.112 > 3.984, then the result implied that there was a significant linear relationship between the natural logarithm of the frequency of occurrence - ln(FREQ) and AGE of documents cited in EMJ from 1985 to 1994 inclusive. In fact this linear relationship was found to be a negative one, as depicted in the SAS output of the plot of ln(FREQ) against AGE in Figure 5.4.

Figure 5.4 Plot of ln(FREQ) vs AGE of documents cited in EMJ



The result obtained by regressing ln(FREQ) on AGE generally indicated that the AGE of the documents that were cited in articles published in EMJ from 1985 to 1994 inclusive, most likely conforms to a type of exponential distribution. The exact distribution may be confirmed by running extra tests on the data.

Table 5.16 Ranked frequency distribution of CITERNAMEs of scientists who contributed articles to EMJ - top twenty

Rank	CITERNAME	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	Endemariam Tsega	8	5.3	8	5.3
2.	Milkias Shamebo	5	3.3	13	8.6
3.	Mulugeta Mengist	5	3.3	18	11.9
4.	Ephraim Daniel	4	2.7	22	14.6
5.	Zein Ahmed Zein	4	2.7	26	17.3
6.	Lester, F. T.	3	2.0	29	19.3
7.	Bagenholm, G.	3	2.0	32	22.3
8.	Hailu Birrie	3	2.0	35	24.3
9.	Hailu Kefenie	3	2.0	38	26.3
10.	Johnson, O.	3	2.0	41	28.3
11.	Redda Tekle Haim	3	2.0	44	30.3
12.	Tekleab Mekbeb	3	2.0	47	32.3
14.	Abraham Assefa	2	1.3	49	33.6
15.	Amha Kebede	2	1.3	51	34.9
16.	Belay Abegaz	2	1.3	53	36.2
17.	Fekade Adugna	2	1.3	55	37.5
18.	Leykun Jemaneh	2	1.3	57	38.8
19.	Seyoum Taticheff	2	1.3	59	40.1
20.	Seyoum Yoseph	2	1.3	61	41.4

5.3.2.3 OBJECTIVE (iii) - Identification of types of documents cited in EMJ articles

After ranking the SAS output of PUBTYECIT from dBASE it was found that the authors who published articles in EMJ between 1985 to 1994, cited a total of **1718 journals** (**69.7 percent** of the total number of documents cited), followed by 262 newsletters (10.6 percent). The rest of the publications cited in EMJ, followed the hierarchy depicted in Table 5.17. Abstracts were the least cited documents, having only 10 occurrences (0.4 percent of all the documents cited in EMJ during the period 1985 - 1994).

Table 5.17 Ranked frequency distribution of PUBTYPECIT (the type of documents cited in EMJ)

Rank	PUBTYPECIT[10]	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	J	1718	69.7	1718	69.7
2.	N	262	10.6	1980	80.3
3.	B	158	6.4	2138	86.7
4.	M	145	5.9	2283	92.6
5.	R	89	3.6	2372	96.2
6.	C	37	1.5	2409	97.7
7.	P	35	1.4	2444	99.1
8.	T	12	0.5	2456	99.6
9.	A	10	0.4	2466	100.0

(a) Total No. of documents cited in EMJ = 2466

(b) Total No. of documents cited in EMJ, that were published in Ethiopia = 335 (13.58%)

(c) Total No. of documents cited in EMJ, that were published outside Ethiopia = 2131 (86.42%)

(d) Total No. of primary sources of information cited in EMJ issues surveyed = 2153 (87.31%)

(e) Total No. of secondary sources of information cited in EMJ issues surveyed = 313 (12.69%)

The data given above also suggests that there existed a greater amount of communication between international experts and local medical scientists than among the local experts, by a large majority (86.42 percent).

There was also an indication that the local medical scientists cited more of the documents that had a greater likelihood of having been published recently, namely the primary sources of information, also by a large majority (87.31 percent).

Finally, the titles of the documents cited were ranked in a decreasing order of frequency of the cited title. The SAS output results showed that **EMJ** led with **236 occurrences** (9.6 percent). The most highly cited Ethiopian publication in EMJ, during the period

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10 The meanings of the letters representing the type of cited documents which were listed under the PUBTYPECIT field, are furnished in section 5.2.

covered by the study, was itself (EMJ). (see Table 5.18).

Table 5.18 Ranked frequency distribution of TITL_CIT (the titles of documents cited in EMJ) - top twenty

Rank	TITL_CIT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	Eth. Med. J.	236	9.6	236	9.6
2.	East Afr. Med. J	110	4.5	346	14.0
3.	Lancet	105	4.3	451	18.3
4.	N. Engl. J. Med.	83	3.4	534	21.7
5.	Trans. R. Soc. T	58	2.4	592	24.0
6.	Bull. WHO	53	2.1	645	26.2
7.	Br. Med. J.	51	2.1	696	28.2
8.	Am. J. Trop. Med	42	1.7	738	29.9
9.	Trop. Geog. Med.	42	1.7	780	31.6
10.	Ann. Intern. Med	32	1.3	812	32.9
11.	JAMA	28	1.1	840	34.1
12.	Ann. Trop. Med.	27	1.1	867	35.2
13.	WHO Technical Re	26	1.1	893	36.2
14.	J. Trop. Med. Hy	21	0.9	914	37.1
15.	J. Pediatr.	20	0.8	934	37.9
16.	J. Infect. Dis.	19	0.8	953	38.6
17.	Arch. Intern. Me	18	0.7	971	39.4
18.	Arch. Dis. Child	17	0.7	988	40.1
19.	Acta Paediatr. S	16	0.6	1004	40.7
20.	Diabetes	16	0.6	1020	41.4

5.3.3 SINET: Ethiopian Journal of Sciences (SINET)

5.3.3.1 OBJECTIVE (i) - Communication patterns in SINET

5.3.3.1.1 Age of documents cited in SINET

The scientists in the sciences in general, were observed to have referred to/used documents that were about **14 years** of AGE on the average (plus or minus approximately 11 years) as shown in Table 5.19 below. AGE was obtained in a similar manner to that in sections 5.3.1.1.1 and 5.3.2.1.1, respectively.

Table 5.19 Mean and standard deviation of AGE of documents cited in SINET

No. of Obs. (Citations)	Min. AGE (in Yrs.)	Max. AGE (in Yrs.)	Mean AGE (in Yrs.)	Std. Dev.of AGE (in Yrs.)
971	0	148	13.67	11.16

When ranked in a descending order of the frequency of occurrence, it was found that the documents that were **seven (7) years** of AGE were the most frequently cited (**56 times**), amounting to 5.8 percent of all the documents that were cited in SINET, within the period that was covered by the study. (See Table 5.19 below).

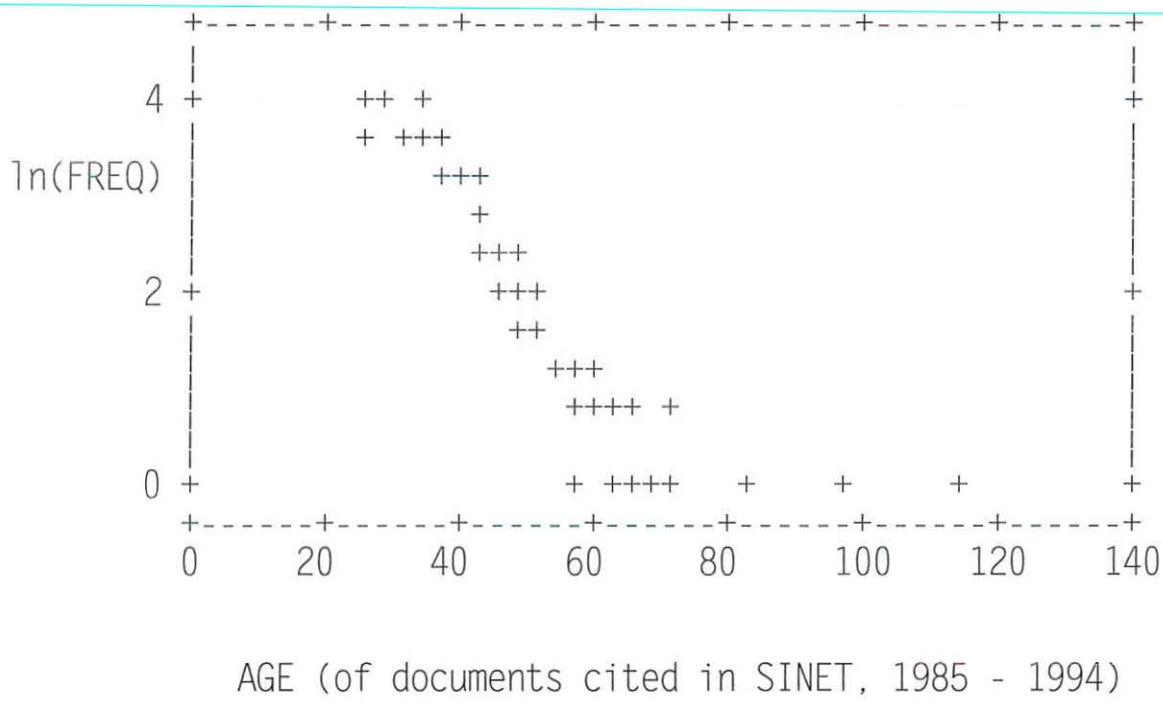
Table 5.20 Ranked frequency distribution of AGE of documents cited in SINET - top twenty

Rank	AGE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	7	56	5.8	56	5.8
2.	9	54	5.6	110	11.3
3.	10	53	5.5	163	16.8
4.	8	48	4.9	211	21.7
5.	14	45	4.6	256	26.4
6.	3	44	4.5	300	30.9
7.	5	44	4.5	344	35.4
8.	6	44	4.5	388	40.0
9.	12	39	4.0	427	44.0
10.	15	39	4.0	466	48.0
11.	16	37	3.8	503	51.8
12.	11	36	3.7	539	55.5
13.	13	36	3.7	575	59.2
14.	4	33	3.4	608	62.6
15.	2	31	3.2	639	65.8
16.	1	28	2.9	667	68.7
17.	19	26	2.7	693	71.4
18.	22	25	2.6	718	73.9
19.	17	24	2.5	742	76.4
20.	20	23	2.4	765	78.8

The FREQUENCY of the documents cited was then plotted against the AGE. The outcome corresponded to the plot in Figure 5.5. It was also suspected that the frequency of documents cited, when their respective ages were taken into consideration, resembled the frequency curve of an exponential distribution. An F - test was therefore carried out on the data to find out whether it could fit an exponential distribution.

$F_{0.05}(1, 54) = 4.024$. Since the calculated F value was greater than $F_{0.05}(1, 54)$, meaning that 106.357 > 4.024, then the result implied that there was a significant linear relationship between the natural logarithm of the respective frequencies of occurrence - ln(FREQ) and the AGE of documents cited in SINET from 1985 to 1994 inclusive. In fact this linear relationship could possibly be a negative one, as depicted in the SAS output of the plot of ln(FREQ) against AGE in Figure 5.6 below.

Figure 5.6 Plot of ln(FREQ) vs AGE of documents cited in SINET



The result obtained by regressing ln(FREQ) on AGE generally indicated that the AGE of the documents that were cited in articles published in SINET from 1985 to 1994 inclusive, most likely conforms to a type of exponential distribution. The exact distribution may be confirmed by running more tests on the data.

5.3.3.1.2 Nature of the messages communicated through the documents cited in SINET

Upon ranking the data collected in SINET in a decreasing order of frequency of the KEYPHRASE field, it was found that **Nonlinear equations** was the subject that was communicated most frequently, from the cited author to the citing author (18 occurrences (1.9 percent)). (See Table 5.22).

Table 5.22 Ranked frequency distribution of KEYPHRASE of documents cited in SINET - top twenty

Rank	KEYPHRASE	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	Nonlinear equati	18	1.9	18	1.9
2.	Schistosomiasis	16	1.7	34	3.5
3.	Intestinal paras	13	1.4	47	4.9
4.	Cutaneous leishm	10	1.0	57	5.9
5.	Chemistry histor	9	0.9	66	6.9
6.	Seed germination	9	0.9	75	7.8
7.	Onchocerciasis	8	0.8	83	8.6
8.	Baboon hybrids	6	0.6	89	9.3
9.	Oreochromis nilo	6	0.6	95	9.9
10.	Random number ge	6	0.6	101	10.5
11.	Stomatal closure	6	0.6	107	11.1
12.	Tilapia biology	6	0.6	113	11.8
13.	Demography	5	0.5	118	12.3
14.	Geological maps	5	0.5	123	12.8
15.	Science history	5	0.5	128	13.3
16.	Alcoholic drinks	4	0.4	132	13.8
17.	Calcite dissolut	4	0.4	136	14.2
18.	Essential oils	4	0.4	140	14.6
19.	Fish age and gro	4	0.4	144	15.0
20.	Newton's method	4	0.4	148	15.4

5.3.3.1.3 Authors cited in articles published in SINET

The names of the authors cited in SINET were ranked from the most frequently cited to the least frequently cited. It was found that **Aklilu Lemma**, was the most cited author with **10 occurrences** (1.0 percent), followed by Menzel, R. with 9 occurrences (0.9 percent). (See Table 5.23 below).

Table 5.25 Ranked frequency distribution of PUBTYPECIT (the type of documents cited in SINET)

Rank	PUBTYPECIT[11]	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	J	559	57.6	559	57.6
2.	B	127	13.1	686	70.6
3.	M	119	12.3	805	82.9
4.	T	42	4.3	847	87.2
5.	C	36	3.7	883	90.9
6.	P	35	3.6	918	94.5
7.	N	26	2.7	944	97.2
8.	R	24	2.5	968	99.7
9.	A	3	0.3	971	100.0

(a) Total No. of documents cited in SINET = 971

(b) Total No. of documents cited in SINET, that were published in Ethiopia = 126 (12.98%)

(c) Total No. of documents cited in SINET, that were published outside Ethiopia = 845 (87.02%)

(d) Total No. of primary sources of information cited in SINET issues surveyed = 722 (74.36%)

(e) Total No. of secondary sources of information cited in SINET issues surveyed = 249 (25.64%)

The data given above also suggests that there existed a greater amount of communication between international experts and local scientists than among the local scientists, by a large majority (87.02 percent).

There was also an indication that the local scientists cited more of the documents that had a greater likelihood of having been recently published, namely the primary sources of information, also by a large majority (74.36 percent).

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11 The meanings of the letters representing the type of cited documents which were listed under the PUBTYPECIT field, are furnished in section 5.2.

Finally, the titles of the documents cited were ranked in a decreasing order of frequency of the cited title. The SAS output results showed that **EMJ** led with **twenty seven (27)** occurrences (**2.8 percent**). The most highly cited Ethiopian publication during the period covered by the study,in SINET was EMJ. SINET came fifth in the ranking of cited documents. (See Table 5.26).

Table 5.26 Ranked frequency distribution of TITL_CIT (the titles of documents cited in SINET) - top twenty

Rank	TITL_CIT	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1.	Eth. Med. J.	27	2.8	27	2.8
2.	J. Chem. Ed.	17	1.8	44	4.5
3.	Am. J. Trop. Med	12	1.2	56	5.8
4.	Bull. Seism. Soc	12	1.2	68	7.0
5.	SINET: Eth. J. S	12	1.2	80	8.2
6.	SIAM. J. Numer.	10	1.0	90	9.3
7.	Nature	9	0.9	99	10.2
8.	Phys. Rev.	9	0.9	108	11.1
9.	Afar depression	8	0.8	116	11.9
10.	Econ. Bot.	8	0.8	124	12.8
11.	Physiol. Plant.	8	0.8	132	13.6
12.	Plant toxicology	8	0.8	140	14.4
13.	Ann. Rev. Plant	7	0.7	147	15.1
14.	J. Anim. Sci.	7	0.7	154	15.9
15.	American Journal	6	0.6	160	16.5
16.	Geological map o	6	0.6	166	17.1
17.	J. Immunol. Meth	6	0.6	172	17.7
18.	IEEE Transaction	5	0.5	177	18.2
19.	J. Coll. Sci. Te	5	0.5	182	18.7
20.	Oecologia	5	0.5	187	19.3

5.4 Summary of results obtained

After having analyzed the collected citation data from all the three source journals under study, the following findings were generally apparent in the journals:

- Both the very old and the very recent documents seemed not to have been cited as much as those that were between about four to fifteen years of age. In fact from the evidence given in the respective tests carried out, the frequency distribution of the respective ages of the cited documents suggests a

type of exponential distribution.

- Generally speaking, there was a significantly greater level of communication of scientific information (at least 77.34 percent), exhibited from scientists outside Ethiopia to those within the country than among the local counterparts, by a very large majority. This was deduced from the large number of documents not published in Ethiopia, that were cited in all the source journals under study.
- Primary sources of information (journals, newsletters, reports, conference proceedings, personal papers and theses) were heavily cited (at least 74.36 percent) compared to the secondary sources of information (books, monographs and abstracts). Specifically, journals were cited most frequently (at least 40.5 percent of all the cited documents) in all the source journals surveyed, whereas abstracts were the least cited. Books and monographs maintained a steady third and fourth position respectively in EJAS and EMJ, except in SINET where they rose to the second and third position respectively.
- The most prolific individual authors of articles in EJAS; EMJ; and SINET, were found to have been: Hailu Gebre and Teshome Shenkoru; Endemariam Tsega; and Berhanu Abegaz, respectively.
- The three most cited authors in EJAS; EMJ; and SINET, were found to have been: Institute of Agricultural Research, Food and Agriculture Organization (being corporate authors) and Tsedeke Abate (being an individual author); World Health Organization (corporate author), Endemariam Tsega and Lester, F. T. (individual authors); and Aklilu Lemma, Menzel, R. and Shibru Tedla (individual authors) respectively.
- The most frequently communicated subjects (or messages) in

EJAS; EMJ; and SINET were found to relate to crop pests followed by insect pests; schistosomiasis followed by onchocerciasis; and nonlinear equations followed by schistosomiasis, respectively.

6 INTERPRETATION OF THE FINDINGS

6.1 Introduction

The next step after analyzing the data is to study the results obtained with a view to determining with as much finality as possible, their implications. The task of analysis is hardly complete without interpretation of findings coming into play.

According to Wilkinson and Bhandarkar (1984, 283), if the end product of analysis is the setting up of certain general conclusions, then what these conclusions mean is the bare minimum of what is desired to be known. Interpretation is the way to this knowledge. Hence, interpretation is the operation which unravels the abstract in the concrete. It thereby helps in understanding the 'why' of the findings. Thus, interpretation serves a two-fold purpose. First, it gives an understanding of the general factors that seem to explain what has been observed and secondly, it provides a theoretical conception which can serve in turn as a guide for further studies.

6.2 Verification of hypotheses

Resulting from the statistical evidence that is documented in sections 5.3.1.3, 5.3.2.3 and 5.3.3.3, the respective percentages of cited documents that were published outside Ethiopia were found to have been 77.34 percent (in EJAS), 86.42 percent (in EMJ) and 87.02 percent (in SINET). These figures were all found to have been far greater than the percentages representing the cited documents that were published in Ethiopia. In so doing, both the cases whereby scientists in Ethiopia published their research outputs in

documents abroad and scientists abroad published their research outputs in documents in Ethiopia, were considered to be negligible. Therefore, hypothesis (i) was accepted, namely " during the period 1985 to 1994 inclusive, scientists in Ethiopia in the pure and applied sciences communicated (through scholarly publications) to a lesser extent with the local counterparts than with international experts ".

Further, resulting from the statistical evidence in the aforementioned sections, the respective percentages of primary sources of information (such as journals, newsletters, conference proceedings, reports and so on) that were cited were found to have been 74.88 percent (in EJAS), 87.31 percent (in EMJ), and 74.36 percent (in SINET). These proportions were all found to have been exceedingly greater than those representing the secondary sources of information (such as books, monographs, abstracts and so on). This applied to all the source journals under study. Therefore, hypothesis (i) was accepted, namely " from 1985 to 1994 inclusive, scientists in Ethiopia in the pure and applied sciences, communicated with their counterparts to a greater extent through primary sources of information namely journals and so on, compared to the secondary sources of information namely books, and so on ".

6.3 Possible causes and implications of the findings

(a) The resemblance of the frequency distribution of the AGE of the documents to a type of exponential distribution is suggestive of the apparent reluctance or negative attitude of the scientists/researchers in Ethiopia, towards applying obsolete ideas in their research papers. The same is also indicative of the fact that scientists/researchers, perhaps due to circumstances beyond their control, find the very recently produced documents hard to come by, for their use. Therefore in order to publish their research outputs in the local

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary of the study

This study began by pointing out the problem of not much being known about the nature of both the primary as well as the secondary sources of information that are consulted by scientists in Ethiopia, in order to publish research outputs in local pure and applied science journals. This was seen as a possible cause of many unused journals being acquired by libraries in Ethiopia.

Objectives were set, in order to establish the prevailing communication patterns of scientists in Ethiopia; to identify the most prolific authors of articles in the selected journals under study; to identify the various types of documents that were used by the respective authors to publish articles in the selected journals; and to suggest the possible future implications on the roles of libraries and information centres serving S & T concerns, with respect to the established communication patterns.

Sixteen (16) pure and applied science journals that are published in Ethiopia were identified and from them, a sample of three (3) source journals were picked, using a purposive sampling technique that employed a defined selection criteria. These source journals were: *Ethiopian Journal of Agricultural Sciences* (EJAS), *Ethiopian Medical Journal* (EMJ) and *SINET: Ethiopian Journal of Sciences* (SINET), respectively.

Using three application softwares namely dBASE IV, SAS and WordPerfect, a total of

continent and the rest of the world and also to augment the supply of current information required. The sooner this is done, the better because as electronic journals continue to increase, establishing completely new electronic journals could be an expensive risk, particularly since researchers would be reluctant to contribute research articles to journals of unknown status. Therefore it is highly possible that in the future, more electronic journals will keep evolving from the conventional printed journals as publishers increase their use of the new technology.

- The Internet in particular, should gradually form an integral part of reference services in libraries and information centres serving S & T research institutes in Ethiopia. In order to exploit the Internet in Ethiopia, all that is required is: a regular telephone line; 220-240 Volts AC supply; at least a 386 computer having 2 MB memory and 120 MB hard disk space and a graphics adaptor that is suitable for Windows applications (for the sake of providing a more up-to-date and friendlier user interface and other features); a modem (14.4 to 33.6 Kb/s); Internet Software and an Internet account with Ethiopian Telecommunications Authority (ETA). An Uninterruptable Power Supply (UPS) is also very necessary to cater for unexpected power fluctuations and power failures, thus protecting the electronic equipment. Depending on the feasiblity and available funds, there is always a need to include a backup computer and accesories like a printer and so on, as some of the requirements. For the registration with ETA, connection costs comprise rent, line connection charges and set-up fee. Initial costs of acquiring and setting up the technology may seem somewhat exorbitant at first, however over a long period of time the numerous ensuing benefits accrued would establish themselves as being comparatively

managers of these establishments a rough idea of when to carry out weeding exercises on the unused documents in order to create room for newly acquired ones. Other authors (co-authors) apart from the first one in the given lists of authors, should also be given consideration, in subsequent studies.

The citation data collected in future studies of this nature should be tested on how it conforms to established bibliometric laws such as Bradford's Law and so on. According to Alabi (1984), the usefulness of Bradford's law is felt more in special libraries where there is always the need to to meet the requirements of researchers in the field with relevant journals to support their research investigations.

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APPENDIX I

Background information[12] on the selected journals in the pure and applied sciences in Ethiopia

(1) *Ethiopian Medical Journal*

Parent institution: Ethiopian Medical Association
Date of first publication: July, 1962
Frequency of publication: Quarterly
Number of copies per issue: 850
Objectives:
- To disseminate research works related to medicine;
- To establish communication among members of the medical community; and
- To encourage and help physicians to produce articles in the field.

Target audience:
- Physicians, subscribers, contributors and so on.

Source of funds:
- Membership fees, sales and donations, namely AAU and ESTC/SAREC.

Remark:
- Appears in the Ulrich's International Directory of Periodicals (1996 Microform edition). It is also included in the international databases like: Index Medicus, Africa Index to Continental Periodical Literature, Cambridge Scientific Abstracts, Africa Index Medicus, and Current Contents.

(2) *Ethiopian Journal of Agricultural Sciences*

Parent institution: Co-sponsored by IAR, AUA, AAU and ESTC
Date of first publication: March, 1980
Frequency of publication: Biannually
Number of copies per issue: 500
Objectives:
- To publish original research findings in the areas of agricultural and related sciences;
- To establish professional communication among agricultural scientists within and outside the country;
- To provide an instrument of orderly dissemination of agricultural research information to extension agents, development agencies and to the farming community as a whole; and
- To promote the application of agricultural research findings and development experiences to the teaching process in the various fields of agriculture.

Target audience:
- Agricultural scientists and technologists.

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[12] This information was obtained from the profile of scientific publications that was prepared by the Ethiopian Science and Technology Commission (ESTC) (Science and Technology Popularization Department 1994) and the profile of scientific journals published by Addis Ababa University (AAU) (Research and Publications Office 1994), respectively.

Source of funds: - Donations from sponsors and SAREC.
Remarks: - Appears in the Ulrich's International Directory of Periodicals (1996 Microform edition). It is also abstracted in the Agris databases, that is prepared by the Food and Agriculture Organization (FAO) that is based in Rome, Italy.

(3) *SINET: Ethiopian Journal of Sciences*

Parent institution: Faculty of Science, (AAU)
Date of first publication: 1978
Frequency of publication: Biannually
Number of copies per issue: 500-1500
Objectives:
- To publish scientific papers in biology, geology, mathematics, chemistry, physics, statistics, agriculture, medicine and technology;
- To encourage Ethiopian researchers to focus on solving Ethiopian problems, particularly in the areas of science and technology; and
- To disseminate science and technology concepts and advances.

Target audience: - Researchers in all field of science, educators and students.
Source of funds: - Government budget, sales and donations from ESTC/SAREC.
Remark: - Appears in the Ulrich's International Directory of Periodicals (1996 Microform edition).

APPENDIX II

A PROFILE[13] OF LOCAL SCHOLARLY PUBLICATIONS IN ETHIOPIA

	Title	Year of 1st issue	Fr pa	Comments	Subject
1	*Eth. Med. J.* ♣ ◘	1962	4	oldest & most reputable	Medic.
2	*SEBIL J.* ♣	1988	1	regular	Agric.
3	*Eth. J. of Health Dev.* ♣	1984	2	regular	Medic.
4	*African Livestock Res. J.* ♣	1992	4	has technical problems	Agric.
5	*Bull. of Jimma Institute of Health Sci.* ♣	1990	5	has technical & admin. problems	Medic.
6	*Bull. of the Chem. Soc. of Ethiopia* ♣	1987	2	regular	Chem.
7	*Eth. J. of Dev. Res.*	1974	2	lack of articles & referees	Econ.
8	*J. of Eth. Studies*	1963	2	admin. problems	Anthro.
9	*J. of Eth. Lang. & Lit.*	1983	1	lack of articles	Lang.
10	*Eth. J. of Sci. (SINET)* ♣ ◘	1978	2	regular	Sci.
11	*NAPRECA Newsletter*	1984	2	lack of articles	Sci.

[13] Source: Science and Technology Popularization Department (1994) and Research and Publications Office (1994).

APPENDIX II (Contd.)

	Title	Year of 1st issue	Fr pa	Comments	Subject
12	*IPB Res. Report Series* ♣	1983	2	Lack of funds	Biol.
13	*Eth. Pharmaceutical J.* ♣	1976	1	admin. problems	Pharm.
14	*J. of Biol. Sci.* ♣	1993	1	new	Biol.
15	*Eth. Phytopathological Newsletter*	1976	4	inconsistent, lack of articles & funds	Biol.
16	*Eth. J. of Educ.*	1967	2	admin. problems & lack of funds	Educ.
17	*Newsletter of Agric. Res.*	1986	4	regular	Agric.
18	*Yememhiran Dimts J.*	1987	2	lack of funds	Educ.
19	*Zede: J. of the Eth. Ass. of Engineers & Architects* ♣	1963	2	regular & one of the oldest	Engin.
20	*Eth. J. of Agric. Sci.* ♣ ◘	1980	2	regular	Agric.
21	*Hissab J.* ♣	1963	2	regular, widely distributed & one of the oldest	Math.
22	*The Eth. Sci & Tech. J.* ♣	1987	2	lack of articles	Sci.

	Title	Year of 1st issue	Fr pa	Comments	Subject
23	*ESTC Newsletter*	1989	24	regular	Sci.
24	*Bull. of crop protection* ♣	1993	1	upgraded from a newsletter	Agric.
25	*Eth. Weed Sci. Soc. Newsletter*	1985	2	regular	Agric.
26	*Newsletter of Biol. Soc. of Ethiopia*	1992	-	-	Biol.
27	*Sci. & Tech. Digest*	1992	4	-	Sci.
28	*NASTIS Newsletter*	1993	2	-	Sci.
29	*Eth. Vet. Assoc. Newsletter*	1993	4	-	Agric.
30	*J. of Eth. Stat. Assoc.* ♣	1991	1	-	Math.
31	*Eth. Stat. Newsletter*	1990	4	-	Math.
32	*J. of Eth. Law*	1964	1	irregular	Law.

Key for Subject[14] abbreviations:

Medic. ≡ Medical Sciences
Agric. ≡ Agriculture
Chem. ≡ Chemistry
Biol. ≡ Biology
Sci. ≡ Science
Lang. ≡ Language and languages
Econ. ≡ Economics

[14] Subjects are actually the placement of the various publications in their respective broad subject areas. The Library of Congress List of Subject Headings (Cataloguing and Support Office, Collections Services 1994) was used for this purpose.

Anthro ≡ Anthropology
Educ. ≡ Education
Engin. ≡ Engineering
Math. ≡ Mathematics
Pharm. ≡ Pharmacy
Law. ≡ Law

Key for symbols used

♣ ≡ Journals in both the pure and applied sciences

◘ ≡ Journals selected for the study

Fr pa ≡ Frequency (of publication) per annum

NB: The abbreviations of the publication titles were improvised by the researcher for the purposes of this study.

DECLARATION

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

(Signed)

Raymond Wafula Ongus

June 7, 1997.

This thesis has been submitted for examination with my approval as a university advisor.

(Signed)

Dr. Gbade A. Alabi

June 7, 1997.