Ethiopian Science and Technology Commission

FIRST NATIONAL CONFERENCE ON SCIENCE AND TECHNOLOGY POLICY OF THE PEOPLE'S DEMOCRATIC REPUBLIC OF ETHIOPIA (NACOSTEP I)

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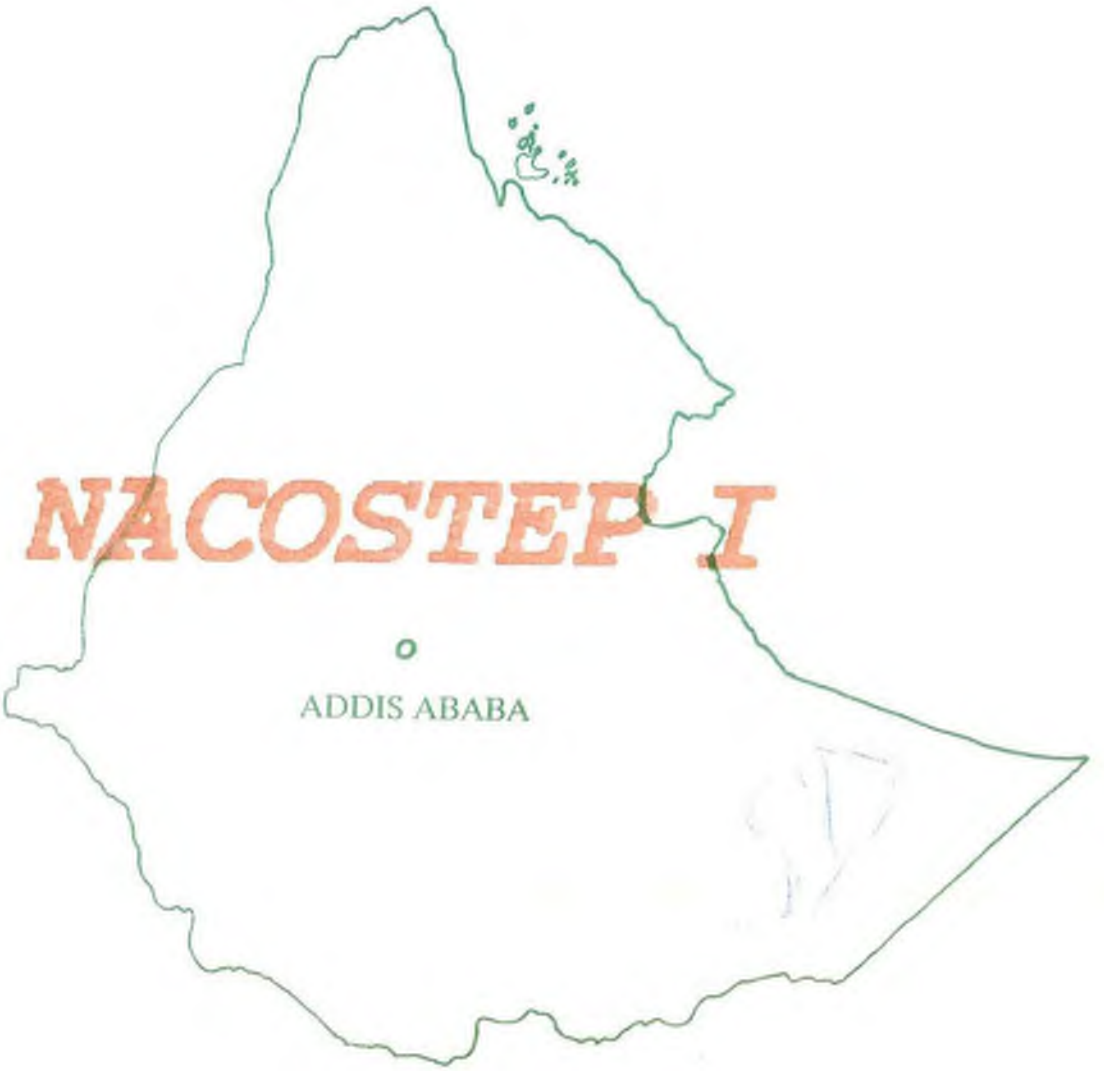

I. ASSESSMENT OF CURRENT SITUATIONS AND PROBLEMS OF S&T IN ETHIOPIA

(VOLUME I)

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PEOPLES DEMOCRATIC REPUBLIC OF ETHIOPIA
ETHIOPIAN SCIENCE AND TECHNOLOGY COMMISSION ESTC

NATIONAL SCIENCE AND TECHNOLOGY POLICY OF ETHIOPIA

ASSESSMENT OF CURRENT SITUATIONS AND PROBLEMS OF SCIENCE AND TECHNOLOGY

VOLUME I

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PREFACE

The need for science and technology policy began to be felt more strongly since the Popular Revolution of Ethiopia in 1974. Although a variety of important science and technology issues have, from time to time, been raised and discussed no attempt had been made to formulate a coherent S&T policy for the country. The important role that science and technology can play in socio-economic development began to be recognized and appreciated in the past few years. This awareness has led to the recognition by the Workers' Party and the Government of Ethiopia that there is an urgent need to formulate a national science and technology policy. Two important steps taken in this regard are the inclusion of a chapter in the Country's Ten-year Perspective Economic and Social Development plan, and the issuance, by the Party, of a general policy in the sphere of science and technology. It is now realized that a coherent and comprehensive science and technology policy should be formulated to create and guide a more viable and dynamic S&T system in the country. The Ethiopian Science and Technology Commission has undertaken this important task of drafting a S&T policy, and in an attempt to do this systmatically, it has proceeded as follows.

It was realized at the outset that the drafting of a S&T policy should be preceded by an assessement of the S&T situation of the country for the purpose of identifying the major weaknesses that have hindered the creation of a self-reliant and viable S&T system. This was done and the result of the survey has been compiled in a report. The Party's policy on science and technology and the Ten-Year Perspective Plan of the country were also carefully studied to ensure the conformity of the policy to be drafted with these documents.

The experience of other countries in the formulation and implementation of the S&T policies were carefully considered by reading and studying several documents on this topic. Four teams of experts were also sent to various countries to study the methodology used and the issues considered in formulating a science and technology policy. The countries visited were the People's Republic of China, Bulgaria, Egypt and India. The visits lasted for a period of two to four weeks. These study visits formed the basis for the preparation of comprehensive reports by each group.

It was also considered useful to obtain consultants who would assist in the drafting of the S&T policy. Two consultants were therefore obtained through the assistance of the United Nations Financing System for Science and Technology for Development and the UNDP. These two consultants studied the S&T situation by consulting compiled reports and data and through

of four weeks and prepared a report on their findings and forwarded their recommendations. Two other expert advisors were also obtained from the State Committee for Science and Technology of the Soviet Union to assist in this national endeavor. They studied the draft policy as well as the S&T situation in the Country for about three weeks and prepared their comments in a report.

A committee was subsequently constituted to draft the national science and technology policy of the country. This committee, after several attempts prepared the first draft. This draft was forwarded to various individuals and organizations for comments. The comments received were carefully studied and incorporated in the second draft of the policy. It was then found useful to consider the various aspects of the draft before it is presented to the National Conference on Science and Technology Policy Formulation for discussion and further elaboration. To this effect the senior staff members of the Commission organized a two-day workshop at which the draft policy was revised chapter by chapter. This third draft of the policy is to be presented at the National Conference on S&T policy formulation for further revision. The revised fourth draft of the policy would then be forwarded to the Government for consideration and approval.

CHAPTER I

INTRODUCTION

A. BRIEF HISTORICAL OVERVIEW OF SCIENCE AND TECHNOLOGY SITUATION IN ETHIOPIA.

1. Early Ethiopian civilizations indicate a number of achievements in the fields of the application of science and technology. This is especially true in civil engineering and architectural works. Remnants of impressive architecture of pre-christian and christian times are found between the Red Sea coast and Axum, and beyond at Lalibella, Gondar and Harar.Columns as those of Adulis, foundations and ruins of temples and churches as those of Yeha, Debre Damo and Atsbi Dera, the famous obelisks of Axum, the Reservoirs and dams of Saffra,the rock-hewn churches of Lalibella, castles of Gondar, and the walled city of Harar are important examples.

2. There are also rich collections of art in silver and gold work and manuscripts of very high literary and artistic value in the churches, monasteries and royal palaces and mosques. Among the manuscripts one finds some volumes on medicine, horology and astrology. Ethiopia is one of the few early civilizations which had invented their own alphabets and number systems. This in itself is an achievement of paramount significance.

3. The domestication of certain crops such as teff,coffee etc., are important examples of achievements in the field of agricultural technology. Even the traditional plow, when farmers in many parts of the world were still practicing the hoe-culture cultivation, is a living testimony to the inventive and innovative capacity of traditional Ethiopia. The many hundred years old terraced farms in some parts of Harar and Konso are good examples of farmers' understanding of soil and water conservation techniques.

4. In the area of medicine, the treatment of a variety of diseases, the correction of dislocated and/or broken bones,the art of midwifery, and the utilization of traditional drugs had their origin in the dim past .

5. The attempts of Ethiopian emperors for example, Lebenedengle and Tewodores to build their own arms etc. is a shining demonstration of their deep desire to achieve self-reliance in defense capability. They must have realized that independence itself cannnot be preserved unless the country had a strong and self-reliant defence structure.

6. Nevertheless in the past few hundred years the country has fallen behind in the pursuit of technology and have thereby suffered a severe social, economic and political decline. In Ethiopia today,there is an urgent need for a resurgence of the old spirit of quest for knowledge in order to bring about a renaissance in the field of science and technology.

7. It is no doubt that during its long and eventful history, Ethiopia had passed through successive advances and stagnations in her technical and cultural developments. It is also not difficult to see that the beneficiaries of the scientific and technological achievements in ancient and traditional Ethiopia were exclusively those in the royal and religious establishments. That is to say that the scientific and technical culture did not penetrate to the population and so the masses did not benefit much from such achievements. In fact, some formidable obstacles were put on the way of the broad masses so that they were excluded from enjoying the benefits of science and technology. These included a variety of ways which discouraged people with inquiring, investigating, inventing and innovating minds from following up their curiosities and urges to solve S&T problems. All sorts of derogatory names and social blocks were used to downgrade and ostracize those who worked for example on pottery, metals, weavery, leather making farming and livestock husbandry.

8. These situations continued to prevail for centuries and except perhaps in the field of armaments, in the other sectors traditional technologies reigned supreme and entered the twentieth century as they are without any appreciable improvement or modification.

9. During the early part of the twentieth century modern technology began to be imported in large quantities. From 1908-1936 salt refinery and beer brewery and tobacco manufacturing factories as well as a printing house were established in the country with unpackaged imported technologies. These technologies were simply planted and no attempts were made to assimilate them. Besides the operators of these technologies were expatriates and the nationals were never given the opportunity to master them.

10. The construction of Djibouti-Addis Ababa railway line which was completed in 1917 was considered to be a major capital investment in modern technology which helped open Ethiopia to the outside world on a large scale. Furthermore as a result of the establishment of the few modern hospitals, school and telegraphic lines and the importation of small scale construction equipment, hand tools, household materials, retail commodities, etc., foreign technologies began to be introduced especially to bigger towns and cities of the country in evermore larger quantities and

Ethiopia soon became an ideal dumping ground for the commodities and cultural values of industrialized countries. As a result of these and other related reasons Ethiopia's national science and technology capabilities were forced to be limited to traditional technologies only.

11. During its brief occupation of Ethiopia from 1936-41, Fascist Italy by amassing huge military hardwares, transport and communication equipment,medical instruments and supplies,road building and housing construction equipment, household and commercial items, etc., into the country had attempted to introduce and disseminate modern technologies on a grand scale. These technologies were dismantled and carried away to British colonies of East Africa and South Asia soon after the liberation of the country. Besides, the engineers,technicians and other professionals of Fascist Italy were taken away as prisioners of war to British colonies of East Africa and were forced to serve there till the end of the Second World War.

12. Even though modern technology was began to be introduced into the country during the beginning of the twentieth century, there were no economic as well as technological polices, institutional arrangements and regulatory mechanisms to direct and guide the whole process.It is interesting to note that Japan in the 1870s was able to accelerate the building of strong economic and scientific capabilities by establishing appropriate institutional arrangements and regulatory measures.

13. The " Legal Notice" of 1950 which was meant to attract foreign investments into the country as well as the "Agricultural and Industrial Development Proclamation" of 1954 were both measures to facilitate exploitation by foreign capitalists and were never formulated in such a way as to promote the national scientific and technological capability building. The technologics of those organizations and factories which were established by using these proclamations as a protective shield, for example, the sugar factories and the cotton and banana plantations in the Awash valley and the Addis Ababa, Asmara and DireDawa textile factories, had not been assimilated and implanted into the national scientific and technological system. It is now some 20-58 years since the Akaki Textile Factory, the Addis Ababa Brewery and the Addis Ababa Cement Factory were established and yet, because their technologies were not assimilated into the national scientific and technological milieu,when the Combolcha Textile Factory, the Harar Brewery and the Muger Cement Factory were established recently, their technologies had to be imported entirely in unpackaged form.

14. In pre-revolutionary Ethiopia the various economic sectors were under the direct control and influence of foreign capitalists and because their technologies were imported from abroad and the exorbitant amount of foreign exchange that was

paid was one important means of plundering the resources of the country . A study examining Ethiopian conditions prevailing in the industrial sector prior to the outbreak of the Revolution reveals the following:-

(a) Ethiopia was totally dependent on the developed countries for equipment and techniques.

(b) Ethiopia in the past 1945 period had been linked increasingly to the international market system... importing foreign technology both in the form of machinery, intermediate goods and equipment (embodied technology) and in the form of managerial and technical services (disembodied technology). Nevertheless, Ethiopia remains a less developed country whose reported annual per capita income at the end of the 1960's was almost the lowest in the world.

(c) Government policies, instutitions and legistlation had placed a minimum of curbs on foreign technology suppliers, and had in fact, provided them with many incentives, such as tax holidays, foreign exchange guarantees and tariff protection. The institutional framework was further characterised by the absence of comprehensive and effective procedures for the negotiation and screening of contracts, control of over-invoicing and under-invoicing as well as related transfer pricing practices, the monopolisation of key managerial and technical positions by expatriates and the unrestricted grant to foreigners of monopoly protection of industrial property.

(d) In the manufacturing industry as a whole, foreign equity holding was the most important single element and accounted for 48 percent of paid up capital in 1969/70. Of 34 industries scrutinized, 28, most of which were among the most dynamic and technology intensive, were dominated by foreign firms. As many as 38 out of 51 major firms which accounted for 76 percent of value added in the sector, were effectively foreign owned and/or managed - the firms from the industrialised countries had with some exceptions tended to concentrate in primary processing rather than import substituting activities.

(e) Most of the management contracts gave the foreign contractor extensive control of operations and often tied the purchase of intermediate imports to the management contractor or to suppliers nominated by him. In the case of direct supply of machinery and equipment, the study found that virtually all firms buying such machinery made losses consistently which may be attributable to the fact that the machinery supplied was often overpriced, sold in excessive quantities or inappropriate.

(f) Foreign firms starting operations in Ethiopia had often been able to obtain and maintain control of the market for the final goods principally through tariff protection and franchise

agreements giving exclusive production rights.

(g) The rates of return declared on foreign investment in Ethiopia systematically understated the true size of returns because of overvaluation of the capital and equipment initially supplied by foreigners and undervaluation of returns through overpricing of intermediate imports and/or underpricing of intra-firm exports. On the assumption of a modest fifty percent overpricing on imports of capital goods and intermediate goods by the manufacturing sector, the foreign exchange cost to Ethiopia of these malpractices alone came to about US$48 million in 1969/70. This was more than half of the net value added in manufacturing for that year.

15. In the foreign managed enterprises, all responsible posts down to foreman or supervisor level were most frequently reserved for expatriate-personnel. Ethiopians were mainly employed in the unskilled and semi-skilled categories which paid minimal wages. This was justified by the claim that suitably qualified Ethiopians were not available. If this were true at the first establishment of the industries in the country, Ethiopians under studies and apprentices were not trained to replace expatriate specialists as required by law. However adherence to this provision in the state owned airline, telecommunications, electricity supply and cement manufacturing enterprises for example saw the rapid building of significant national capability in the assembly or installation of the most complex imported equipment, their operation, repair and maintenance. The buildup of a national consulting engineering and design capability was also greatly impeded by the express preference that foreign and international lenders of investment capital showed for" international consultants" even in the public sector enterprises.

16. The above brief assessment pretty well summarizes the situation that existed in pre-revolution Ethiopia in the field of science and technology. No conscious and concerted efforts were made to either improve the traditional technologies or to assimilate imported modern technologies. Thus Socialist Ethiopia received a very meagre inheritance in terms of scientific and technological institutions and human resources.

17. Since the eruption of the Revolution some important actions were taken to deal with the S&T constraints of the country. Such actions included among others the following:-

(a) Action at National level

(i) A National Science and Technology Commission was established in December 1975 to encourage, guide, co-ordinate and support the search for scientific knowledge and the pursuit of technological development applicable to alleviating hardship in the lives of the broad mass of Ethiopians as well as to raising

their productivity.

(ii) A higher Education Commission (now under the Ministry of Education) was set up in January 1977, to organize the higher education system which is responsive to the needs of the broad masses and to building the national scientific and technological capability essential for socialist development.

(iii) A Central Planning Supreme Council (the present Office of National Committee for Central Planning)was established in October 1978 , and Government ministries were restructured. Responsibility for R&D in their respective fields of activity as well as the application of R&D results were made part and parcel of the duties and powers of appropriate ministries by proclamation No. 127/77.

(iv) Farmers Training Institute at Agarfa, Forestry Training Institute at Wendo-Genet, Ethiopian Geological Studies Institute at Addis Ababa, Institute of Water Technology Development at Arbaminch, National Health Research Institute at Addis Ababa, Jimma Health Institute at Jimma, Plant Genetic Resources Center at Addis Ababa,etc are some of the few examples of S&T research and training institutes that were established in recent years.

(b) Action at the Regional Level

(i) In the African Region, Ethiopia continues to collaborate in undertakings for the appropriate enhancement of S&T capabilities of African States and application of such capabilities in action programs tackling common problems of development through existing organizations and new ones to be established through bilateral, multi-lateral and regional agreements. Some of the existing organizations in which Ethiopia already collaborates are Desert Locust Control in East Africa (DLCOEA), All Africa Leprosy Eradication Research and Training (ALERT), East Africa Mineral Research and Development Centre (EAMRDC), International Livestock Centre for Africa (ILCA), Africa Regional Centre for Technology (ARCT), etc.

(ii) Ethiopia also continues to collaborate in existing and new sub-regional and regional networks and association of education and R&D institutions and production and service organizations such as the Association of African Universities, the Committee of Engineering Education in Central Africa, the African Airlines Association, etc.

(c) At the International Level

(i) Ethiopia collaborates in programs of action in the appropriate application of S&T to enhance human and social development and engages actively in Technical Cooperation among Developing Countries (TCDC). It supports the attainment of the

New International Economic Order and its correlate S&T order.

(ii) Ethiopia is also an active participant in various UN and other S&T bodies such as the Intergovernmental Committee on S&T for Development of UNFSTD, IAEA, FAO, UNESCO, WHO, SAREC, EEC, U.S.S.R, FRG, World Bank, IDRC, SIDA, etc.

18. Thus, Ethiopia has made efforts from time to time both at national, regional and international levels to deal with one or more of its S&T deficiencies, However, in the absence of a comprehensive and well coordinated effort to tackle the entire spectrum of these problems, the desired impact could not be realized.

B. THE SCIENTIFIC AND TECHNOLOGICAL SYSTEM: GENERAL OVERVIEW

19. Before attempting to identify some of the major constraints faced by the S&T system of Ethiopia, it may be useful to look at what is meant by a national system and a S&T system and the major tasks of such systems.

20. Experts on scientific and technological development have defined a system as a collection of inter related entities each of which affects, at least potentially, the behavior of the others. According to this definition, a nation system can be seen as encompassing several subsystems(systems for short) the most important ones being the regulating systems (which are made up of the cultural system and the political system), the S&T system, the educational system, the economic system, the demographic system and the physico-ecological system.

21 The regulator of the nation-system contains both the political system and the cultural system. The political system has the functions of generating goals ,evaluating alternatives, and setting priorities. It also has power in the form of political influence; it exercises authority and mediates the interests of individuals, groups and institutions of the nation system. One of the main functions of this system is the setting of priorities and goals which are expressed in terms of policies.

22. It follows that one of the most important interactions between the political and S&T systems takes place through the definition of a scientific and technical policy which would guide the activities of the S&T system and its relations to other systems in the nation. A second line of interactions is provided by the scientific and technological system's role as a provider of knowledge in the form of advice to the political system. In summary, it can be stated that the relation between the S&T system and the political system takes place through the flow of policies and resources from the political to the scientific and technical fiscal system, and through the flow of advice and influence from the S&T to the political system.

23. The cultural system on the other hand, has the function of maintaining the stability of the nation system and legitimizing activities and flows within it. Cultural norms and values are the forms through which the cultural system expresses itself and acts on the other systems. This system is also concerned with the restoration of balance once the forces of change have modified the stability of the nation-system.

24. The cultural system is related to the scientific and technological system in two ways. First, cultural values and norms limit the extent to which scientific and technological advances are introduced and diffused through the nation-system. This is particularly true for societies like Ethiopia where there has not been a scientific tradition at the grass - roots level. Second, the S&T system affects the society's cultural norms and values; it is not just passively conditioned by them.

25. The educational system comprises all the organizations, institutions, and individuals engaged in the preparation and training of human resources for the nation-system.

26. The educational system is related to the scientific and technological system in two ways.First, it supplies human resources to the S&T in the form of trained manpower and second the educational system plays an important role as a vehicle for diffusing knowledge through the nation system. In short, the interaction between the S&T and the educational system takes place through the exchange of human resources and the exchange of knowledge. On the one hand, the scientific and technological system receives trained manpower from the educational system, while on the other it generates and provides knowledge which is diffused through the educational system.

27. All the activities , organizations, individuals and institutions dedicated to the production and distribution of goods and services belong to the economic system. The general function of this system is to provide the members of the nation system, whether individuals, organizations, or institutions,with the instruments they require for the pursuit of their objectives.

28. The relation between the economic and the scientific and technological systems is extensive and far-reaching. The basic pattern of interaction between these two system considers the S&T system as providing inputs to the economic system in the form of technological knowledge, which allows it to produce goods and services in a more efficient way. This is to say that the S&T system provides the economic system with the capability to generate more instruments more efficiently. The economic system, in return, provides the S&T system with material resources which ultimately can be referred to some monetary unit. In brief, the exchange between these two systems takes place in the

form of technical know-how transferred from the S&T system to the economic system, and in the form of a flow of funds in the opposite direction.

29. The demographic system has the function of providing a base of human resources to the nation- system. It is constituted by all the individuals in the nation-system who participate in its activities in one capacity or another. Of particular importance is their participation as consumers, for in this capacity they act as recipients for the activities generated by all the other systems.

30. The links between this system and the S&T system are of two kinds: direct and indirect. The direct link is established through the influence that the knowledge generated by the scientific and technological system has on the demographic system, which can be very important particularly in the area of medical and health care.

31. The indirect link is established through the educational system. The demographic system provides the human resources which are trained by the educational system and become inputs to the scientific and technological system. Another kind of link is represented by the flow of information in the form of problem areas that are suggested by the demographic system to the S&T system.

32. The physio-ecological system is constituted by the physical and ecological environment of the nation- system and has the basic function of providing natural resources to the economic system, which uses them as inputs in the production of goods and services.

33. The physico-ecological system is also related to the S&T system through direct and indirect link. The direct link is provided by those activities of the scientific and technological system which affect the availability of natural resources and their rates of exploitation and replenishment. Those activities aimed at prospecting the physical environment and preparing an inventory of natural resources are included here, as well as those oriented toward determining the best rate of exploitation and replenishment of perishable natural resources such as forests, wildlife and marine life.

34. The indirect link is established through the economic system which takes natural resources and transforms them into goods and services. These are in turn used by the scientific and technological system in order to produce its output of knowledge.

35. It is also important to note that the nation system is not a closed system, for it clearly stands in interaction with other nation-systems. In particular, as long as science and

technology are truly international in their nature, there is bound to be interrelations between the external world and the S&T system of a nation.

36. In summary, the scientific and technological system takes goods and services from the economic system, trained human resources from the educational system and knowledge from itself as inputs in order to produce its output in the form of more knowledge. The educational system takes its inputs from the economic, the S&T and the demographic systems in the form of goods and services, knowledge, and human resources respectively, combining them to produce trained human resources.

37. The economic system takes natural resources from the physico-ecological system together with knowledge from the scientific and technological system and human resources from the educational system, in order to produce its output of goods and services. The physico ecological system provides the natural resources which are used by the economic system. Finally, the demographic system provides human resources which are input to the educational system, and it also generates the consumer force in the nation-system, to which the outputs of the economic, scientific and technological, and the educational systems are ultimately directed.

38. In each of these systems there are crucial choices to be made. This is particularly true of the three central systems, the economic, the S&T and the educational systems. The proportion of goods and services to be directed from the economic system to the other systems and the proportion devoted to final consumption has, in some way or other, to be established. Similarly, the proportion of knowledge produced by the scientific and technological system which can be considered as oriented to final consumption and the proportion designated to serve as input to the other systems have to be determined. Even in the physico-ecological and the demographic systems we find complex choices referring to the rate of exploitation and replenishment of natural resources and to the rate of growth of population.

39. In addition to these choices, the matters are complicated even further by the fact that the nation system is not a closed system. It exports and imports,not only goods and services, but also knowledge in all its forms, trained manpower, and natural resources. The regulation of these flows within the system (and in and out of it) is a task which is usually accomplished, implicitly or explicitly, by the political and the cultural systems, which act as regulators.

40. Thus the regulating systems may be considered as being interconnected with all the other systems in the nation;they receive information flows and generate a flow of policies, plans and norms. When regulation is achieved through explicit action,

it generally can be considered as emanating from the political system; while the cultural system acts in the general case as an implicit regulator, cultural norms and values can either inhibit or foster certain types of flows and activities in the nation system.

41. So far an attempt has been made to convey a picture of the interrelationship among the various systems. Following this a similar type of exercise for the 'science system'is made. The science system may be defined interms of those institutional and social structures whose activities consist mainly of the discovery, articulation and propagation of scientific and technological knowledge.

42. Thus the scientific and technological system can be considered as a collection of interrelated operations and activities which generate and transform the intangeable good 'knowledge'.

43. According to this definition a scientific and technological system can be seen also as encompassing several systems the most important ones being government agencies dealing with regulation, control and administration of other public functions; universities, testing, standardization,and general purpose data collection institutions; science and engineering education, science and information; R&D institutions; enterprises involved in production and innovation;non profit organization engaged in philantropy,popular education in science, art, etc.

44. At the heartland of the science system, research and experimental development(R&D)is placed where creative work is undertaken on a systematic basis to increase the stock of scientific and technical knowledge and to use the stock of knowledge to devise new applications. These applications may then be utilized in a variety of contexts, from the purely productive, or economic system right through the educational and the cultural systems.

45. In the first place, it is emphasized that the S&T system is not a closed system, for it clearly stands in interaction with other nation - systems and its sub-systems. The out put of knowledge generated within the scientific and technological system is in turn influenced by the inputs it receives from the nation-system and its subsystems.

46. The scientific and technological system does not stand in isolation. It is closely related to other systems in the nation,the rough exchange of knowledge, goods and services, human resources, plan and policies and norms . This is to say that the plan for the development of the S&T system should contain an evaluation of its impact on the economic system; the educational system; the political and cultural systems; as well as the impact

on the scientific and technological system itself.

47. The above explanations of the systems and their interactions with each other enable one to see the role of each system and how the behavior of one affects the behavior of the other(s). This is also significant to appreciate the fact that one cannot talk about the scientific and technological system in isolation. This is particularly important to a developing country like Ethiopia where S&T capability building is a matter of urgent priority. Sustained development in the scientific and technological capacity of the country requires a more vigorous growth and development on the other systems as well. System acts in the general case, as an implicit regulator; cultural norms and values can either inhibit or foster certain types of flows and activities in the nation-system.

C. THE MAJOR CONSTRAINTS OF THE S&T SYSTEM IN ETHIOPIA

48. The scientific and technological system of the country is faced with a variety of serious problems, such as:-

(a) Absence of well elaborated and detailed S&T policy and plan for national S&T capability building as well as lack of well-defined priorities for scientific research and imbalances in the S&T effort.

(b) Insufficient allocation of resources in terms of scientific manpower, funds and facilities for research and development.

(c) Isolation of the S&T system from the national economic planning process as well as from the users of technology i.e. the productive sectors.

(d) i. Poor quality of S&T education given at primary, secondary and tertiary levels and inadequate availability of vocational training institutes in various technical fields; a system of education which does not inculcate curiousity for research and spirit of enquiry.

ii. Inadequacy of university programs and facilities for post-graduate research work.

iii. Insufficient S&T manpower at all levels of activities.

iv. Lack of adequate support for the participation of Ethiopian scientists and technologists in the active centers of learning in the world.

(e) i. Lack of effective S&T popularization resulting in inadequate promotion of science and technology in society.

ii. Absence and /or underdevelopment of scientific and technological terms in the national languages.

(f) Absence of conducive conditions to promote scientific & technological culture in society and non-existence of reward and effective system to enhance S&T activities.

(g) Lack of strong professional associations and poor financial resources of non-governmental scientific societies/learned bodies and their consequent ineffectiveness in creating science awareness in the nation and involving the people at large in the process of technology development.

(h) Absence of close linkages between education, research and production.

(i) Lack of accountability and systematic reward system for institutions and individuals engaged in S&T activities resulting from the absence of a satisfactory mechanism for regular assessment and evaluation of research performance.

(j) Inadequate career structure for scientific personnel, specifically for technicians.

(k) Insufficient allocations from the national budget to building and expanding S&T capabilities in the various sectors.

(l) Undue reliance on foreign sources of technology instead of conscious utilization and promotion of indegenous technology, lack of capability to identify, transfer and adapt technologies that are appropriate to the country's need.

(m) Lack of effective coordination between scientific establishments leading to fragmentation of national research effort.

(n) Lack of effective S&T institutions at the grass root level (e.g. field experiment stations) for creating site specific technologies.

(o) Low priority given to R&D activities.

(p) Lack of well coordinated and strong S&T information system.

(q) Weak engineering and consultancy service capabilities.

(r) i. Low productivity of traditional technologies as well as the inadequate attention given to their improvement and development.

ii. Lack of complementarity between the modern and traditional sectors.

(s) Non-existence of a strategy for the S&T managerial and administrative capability building.

(t) Lack of appreciation of the importance of building S&T capabilities by the various production and service sectors and hence non-existence of S&T institutions and infrastructures in the majority of the production and service sectors.

49. In general , the low level of the material base of the society, the underdeveloped nature of the economy, the traditional orientation of agriculture, the undeveloped nature of industry and the low level of development of S&T institutions have contributed significantly to the major problems of the S&T system of the country and vice versa.

CHAPTER II

BRIEF ASSESSMENT OF SECTORAL SCIENCE AND TECHNOLOGY SITUATION

50. In any country, political, cultural, socio-economic and envionmental conditions, set the stage for, as well as greatly influence the application of science and technology for subsistence and for development. These conditions contain the problems for which country-specific, location specific and resource specific solutions to socio-economic and environmental problems are required from the scientific and technological capability of the particular country.

51. Furthermore, analysis of S&T requirements and priority setting follow the political, economic and cultural objectives and organization of the country. The assessment of the S&T situation and identification of problems of S&T are treated on sectoral basis. In the case of environment, however, although it belongs to the food and agriculture sector, due to the worsening situation of the environment in Ethiopia and the pressing attention it deserves it is treated separatley. Though energy, mineral and water resources are normally classified under natural resources, they are managed by two different state organs. Hence , it is found legical to assess their S&T situations and priorities separately. Some aspects of these conditions, in Ethiopia are therefore, briefly described under sectoral headings as follows.

A. FOOD AND AGRICULTURE

52. Ethiopia has a total area of 1.22 million square kilometers. Its boundary areas are arid receiving less than 700mm minimum rainfall per year essential for reliable rainfed crop cultivation. The only exception is tha short stretch of boundry area in the Baro Akobo and Blue Nile valleys in Western Ethiopia. These arid zones cover 580,000 square kilometers or 46 percent of its total area.

53. A further one third of the country's total area, although it receives more than 700 mm rainfall, consists of terrain at too high an altitutde or having too steep slopes or too badly eroded for crop cultivation or comprises river course or lake body.

54. The area of Ethiopia suitable for rainfed cultivation is thus less than one quarter of the total. The irrigable total is estimated not to be greater than 3 million hectares. This low figure results from lack of relatively flat terrain suitable for irrigation in river basins where water flow is abundant and due to lack of sufficient water flow in river basins where there is plenty of terrain suitable for irrigation. At present less than

5 percent of the potentially irrigable land is under irrigation.

55. Erosion is an acute problem in Ethiopia. Much of the land cultivated especially in long settled populous areas in the northern and central highlands is steeply sloping terrain. Heavy rain drops, during the rainy season, falling on the bare farm soil surface losen top soil particles, which are then easily washed away down the slope. A recent estimate puts the top soil thus washed to be carried as the silt-laden of muddy Ethiopian rivers at one thousand million tons per year. The fertilizer that would replace the nutrients of this lost soil would cost US$1280 million.

56. More and more land is being brought under cultivation to feed the rapidly growing population, and to produce cash crops to earn investible funds for development. But the expansion of erosion with cultivation constitutes loss of agricultural production potential and therewith loss of the future life support capacity of Ethiopian farm land. The process of erosion has been accelerated by the indiscreminate cutting of forest trees for cultivation of crops, firewood, charcoal, construction etc.

57. Much of the agricultural practices in Ethiopia are age-old. Food and fiber production with these traditional and archaic technologies is no longer adequate for subsistence and development needs of the Ethiopian population which is currently estimated at 47 million and is growing at almost 3 percent per year. On the other hand, improvement of agricultural productivity through widespread substitituion of imported inputs such as fertilizers, chemicals and equipment in place of traditional practices and implements, is likely however, to be very costly in light of the scarce foreign exchange and will undoubtedly induce dependence unless the country rapidly builds up its S&T capabilities in the effective transfer and utilization of these modern technologies.

58. The application of modern technologies and inputs, in state farms, has yet to attain a level of efficiency that would enable output to make a cost effective contribution to annual harvests. The exercise is also marred by high demand for scarce foreign exchange and by the danger of deepening dependence on imports.

59. Livestock herding in a nomadic pattern now prevails over much of the 46 percent of the country's area which falls in the arid category. Animal husbandry is also a major feature of agriculture in cultivated zones where oxen provide traction power for tillage, pack animals serve rural transport and various domestic animals supply meat and milk as well as wool, hides and skins. Scarcity of fodder and water supply in the long dry season in all parts of the country is a major constraint for livestock production and use for processing livestock production. The country is considered to possess vast fishery potential

along its Red Sea Coast and in its numerous lakes and rivers. This wealth is practically untouched and is awaiting for exploitation as a major source of food.

60. The pre and post-harvest losses of crops due to diseases, insects, weeds, birds, rodents, inefficient processing practices, defective storages, etc. are considered to be excessive estimated at about 30 to 40 percent of the potential total yield. Ethiopia can neither afford nor sustain such a loss. A saving of only about 50 percent of this loss could make a difference between adequacy in food supply and starvation in many parts of the country. Animal diseases also contribute significantly to the high mortality rate and low productivity level of the livestock husbandry practices of the country.

61. In general the productivity of both land, labour, crops and livestock is drastically low even by standards of many developing countries. Some research results indicate that crop and livestock yield can be increased to two or even three fold of its present level by using improved materials and management practices. If the country is to attain self-sufficiency in agricultural production it simply has to improve its agricultural practices and provide farmers with effective incentives to induce them to use their existing resources to the fullest extent for maximum production.

62. The loss of valuable genetic materials as a result of adverse climatic changes, expansion of development efforts into new and previously undisturbed eco-systems, and replacement of indigenous land races with " improved" materials etc., is becoming serious. The collection, conservation and utilization efforts of the diverse genetic materials of the country will have to progress at a much faster rate than in the past before some of these priceless assests are lost.

63. The total number of formally trained manpower in the agricultural sector is extremely low . Of the approximately 3000 students graduated from the Alemaya University of Agriculture since it was established in 1957, only about 30 percent are now working in the agricultural sector in the country. To meet pressing needs, several organizations in the sector have had to engage foreign agricultural experts. The drastically low trained manpower has adversly affected the country's research, extension and training programs in the agricultural sector.

64. The fruitful results of agricultural research formally pursued with government, bilateral and international funding since the begining of the sixties, have disseminated little into peasant agriculture even after the thoroughgoing rural land reform and the formation of farmers into cooperatives.

65. The various farm implements which the peasants are using for performing their various farming operations such as plowing, cultivation, harvesting, transporting, etc., are inefficient, time-consuming and tiresome and in short incapable of meeting the new demands for more agricultural products.

66. The socio-economic set-up and characteristics of the peasant sector has not been adequately studied. The peasant and his existing production system have not been adequatelystudied to enable to identify his real bottlenecks and to determine possible openings for improvement. In most cases the peasant is not involved in the identification of his own problems nor is he invited to participate in generating their solutions. Thus he is left aside as a passive observer on matters of vital interest to him. In short, the principle that research must be done for the benefit of someone and with the involvement, in this case the peasant, has been disregarded by most of the researchers for a long time in the past. Under this situation the appropriateness of the research results would be highly questionable and their acceptability by the peasant is very unlikely. Although the situation has improved in the past few years there is still a long way to go before the research activities of the country can be meaningful to the peasant and bring about effective solutions to his immediate problems.

67 With all its problems and short-comings the agricultural sector still remains as the foundation of Ethiopia's national economy. It is expected to remain the largest sector of the economy in the foreseeable future. About 85 percent of the the working age population is engaged in it and contributes some 50 percent of the GDP annually. About 90 percent of foreign exchange earnings accrue from the export of agricultural commodities and the manufacturing industries are also agricultural products.

68. However the agricultural sector has been increasingly unable to meet the country's rising demand for more agricultural products. The stagnation of the agricultural sector, in comparison with the growing national demand for agricultural products, is one of the critical factors which is retarding Ethiopia'socio-economic development. Thus, the need for improved production practices and the creation of conducive conditions for rational and maximum utilization of agricultural resources cannot be overemphasized. For these and other related reasons the Party and the Government have given the topmost priority to the agricultural sector in the country's Ten Year Perspective Plan.

Major problems of the Sector

69. It is not difficult to see that the food and agricultural sector of Ethiopia is beset with a number of complex problems which have contributed to its over-all low productivity and

inefficiency. Some of these major problems include, among others the following;

a. A sizeable portion of the country (about 46 percent) is arid, receiving less than the 700mm minimum rainfall per year for reliable rain-fed crop production. Even the highland areas which normally get adequate rainfall are experiencing insufficient and erratic precipitations in recent years.

b. The agricultural practices of farmers are less productive and the technologies they use are archaic resulting in not only wastage of scarce resources but also in exteremely low productivity.

c. The potential yield of both plant and animal materials is very low.

d. Livestock husbandry is found at a very low level. Diseases, scarcity of fodder and water supply and uncontrolled breeding practices are creating serious problems. Lack of appropriate technology is hindering the expansion and exploitation of the fishery resources of the country.

e. Valuable genetic materials are being lost at a much faster rate now as compared to what it used to be in the past.

f. Pre-and post-harvest food losses are alarmingly high, some 30 to 40 percent of the total yield, is lost due to diseases, insects, weeds, birds, rodents, defective food processing techniques, inadequate storage practices, shortage of transportation infrastractures and high cost etc.

g. There is inadequate and in most cases total lack of dissemination and introduction of improved technologies and practices to the peasant sector in which more than 90 percent of the total agricultural land is farmed and more than 90 percent of the total yield is obtained.

h. The implements the farmers are using are inefficient and ineffective to meet the new and rising demands for higher quantity and better quality of agricultural products.

i. The nature and characteristics of the socio-economic conditions of the peasant and his specific traditions and social values are less well understood by researchers and development workers. He is neither encouraged to identify his own immediate and hence burning problems nor given the opportunity in seeking solutions to these problems.

j. The shortage of trained manpower in the sector is a serious problem, adversely affecting the training, extension, development and research programs of the sector.

k. Soil erosion has reached a colossal magnitude and the rate at which the fertile surface soil being eroded each year has become extremely alarming. The productive capactiy of the land is declining from year to year as a result of the unchecked soil erosion.

B. Environmental Rehabilitation and Protection

70. To talk about development problems while the very foundation of survival of the nation is being destroyed is rather senseless and meaningless. The country is experiencing recurrent droughts which have resulted in the loss of hundreds of thousands of human and animal lives. The economy of the country has been drastically affected by the droughts and a large segment of the population was subjected to untold suffereing and tragedy. The root causes for the devastating famine was and is the deterioration of the environment as a result of massive ecological disruption and the unabated growth of the population.

71. The accelerated population growth and its uneven distribution in the country have placed considerable pressure on the natural resources such as the soil, water, animals, plants, grasslands and forests. Hungry and malnourished people must devote what little energy they have to immediate survival, growing what food they can at whatever cost to the environment. This state of affair has resulted in the deterioration and degradation of the productive capacity of the land.

72. Even though the drought problem which affected the country was somewhat related to the changed conditions in the world climatic situations, its effect was greately aggravated by the improper agricultural practices and low-level of technological development. The land, forced to produce as much as possible without fallow periods or proper rotation and fertility enhancing practies, finally loses its productive capability. Deforested and overfarmed hillsides are eroded and their topsoil is washed down and wasted. One observes muddy rivers after each torrential downpour. This soil is carried away beyond the boundaries of the country never to be reclaimed again and with it the country's opportunity to survive is gradually diminished. According to some historical records, at least about 40 prcent of the country was covered by fine forest in the last century. Now only about 3 prcent is so covered. Centuries of cutting and burning and ovrgrazing by livestock have brought desolation to the hillsides. Any or all of these practices expose the topsoil, so that it can be blown away by winds or washed away by rainstorms. In the more

arid areas dustladen windstorm, darkening the horizon indicate that once-fertile areas have become a desolate dust bowl. This catastrophe is the result of overgrazing by too large herds of cattle, sheep and goats and of plowing for crops grasslands that should never have been converted to this use.

73. The country's forests are still being depleted at a rate far in excess of their annual growth (200,000 hectares a year) and as a result water resources, wildlife and the other interrelated elements of nature's economy are still being dangerously affected. Ethiopia is still riding tne downward spiral that has carried other nations in the past to eclipse and even to oblivion. It does not have to wait for another catastrophic warning from nature to stir it to further action. It has to accept now the many evidences of approaching crises and take steps to ward it off. It must recognize the necessity of cooperating with nature.

74. Another area of great concern is the alarming rate at which the genetic resources of the country is eroding. As a result of drought, development activities of areas hitherto undisturbed by man and the replacement of landrace crop varieties by improvd high yielding seeds are all contributing to the fast disappearance of the valuable genetic materials of the country. This is an incalculable loss to the nation, which is depriving the country one of its priceless assets. The velocity of loss, if continued, will bring upon it a national catastrophe.

75. Realizing the critical importance of protecting and rehabilitating the forestry, soil and water resources of th country, the governmnt has launched an extensive conservation and development program. According to a report of the Ministry of Agriculture th main goals of the conservation program include: -

a) Rehabilitating by natural and man-made means, the land that is degraded by improper utilization.

b) Producing basic forest products, that are needed by the people for different purposes.

c) Making all efforts to increase food production by employing proper erosion control measures in the traditional farming system and encouraging the use of manures and crop residues as natural fertilizers.

d) Protecting the soil from the adverse effects of wind and water erosion.

e) Carrying out scientific research in regard to the major natural resources in order to be able to develop appropriate technoloiges for sustainable use of the available natural

resources.

f) Training diferent levels of personnel in order to meet the requirements for trained manpower in the conservation field.

76. Conservation measures are being carried out on croplands, grazing areas and forest lands which include:-

a) Physical conservation structural masures on farmlands

These inlude tied-ridges, soil or stone bunds, various types of terraces, cut-off drains and others. These structures are in general simple and can easily be understood by farmers. Furthermore they are believed to be effective in slowing down surface water movement, encourage infiltration and water are retained to make it available for plant use.

b) Soil and water conservation on grazing land

The main activities carried out include closure of hill sides from human and livestock intervntions, revegetation with fodder trees or shrubs.

c) Soil and water conservation on forest land

These include hillside terracing, planting of multi-purpose tree species, fruit tree planting, etc.

d) Water development

Activities included in this area are spring development for human and small scale irrigation, construction of earth dams and weirs, ponds, etc.

77. According to the report of the Ministry of Agriculture (1988) the total achievements of the last year in soil in and water conservation work include:-

a) Farmland Terrace constructed on about 444,784 hectares of land.

b) Hillside Terraces constructed on about 175,347 hectares of land.

c) Series of check dams to plug numerous gullies have been constructed. The total lengths are estimated at about 13,579 kilometer.

d) Afforestation mainly on highly denuded areas have been

executed on about 180,465 hectares of land.

e) Area closure for natural regeneration of vegetation have been performed on about 134,380 hectares of land.

f) Earth dams constructed mainly for irrigation are over 65 in number.

g) Ponds dug mainly for drinking and livestock use are 1408 in number.

h) Springs have been developed. These are temporary in nature in many cases and are used for drinking and partly for small scale irrigation. Over 5000 springs have been improved.

78. The conservation activities indicated above were carried out in nine regions, out of the fourteen regions of the country. The nine regions are identified as areas where the impact of degradation is severe, the rainfall irregularities are high and hence shortage of moisture acute and food deficit prominent.

Major Problems of the sector

79. The conservation program is beset with a number of critical problems, which inlude among others the following:-

a) Farmers are reluctant to carry out conservation program without incentives especially in areas where it is launched with incentives.

b) Some of the physical structures are not liked by the farmers because they create problems previously unknown by them such as loss of cultivable land, interference with the traditional cultivation system, introduction of weeds and pests and other problems.

c) Ecological diversity of the country requires deep investigation and analysis of problems.

d) The high cost of conservation in relation to return particularly in the highlands.

e) Inadequate maintenance of conservation physical structures once they are built.

f) Very low survival rate of forestry seedlings due to inadequate care and protection.

g) Low infrastructural distribution over the country or inaccessability of most of the hinterlands.

h) Inadequate trained manpower to give the necessary technical support and advice to the peasants.

i) Lack of resources to expand the program.

B. Environmental Rehabilitation and Protection

80. The major problems facing the Environmental Rehabilitation and Protection field include, among others the following:-

a) Lack of understanding and awareness by the general public of the need for protecting the environment for survival.

b) Lack of knowledge of the different measures that can be taken to protect and rehabilitate the environment.

c) Indiscriminate cutting of trees for cultivation, firewood, charcoal, construction, etc, purposes.

d) Overgrazing of the land by too many animals.

e) Mismanagement of the land leading to loss of soil and production capacity of the land.

f) Lack of effective measures for the conservation, development and wise use of water resources.

g) No effective R&D work on environmental conservation and development.

h) Very limited forestry research work.

i) Accelerated rate of loss of the valuable genetic resources of the country.

C. INDUSTRY

81. Manufacturing industry is little developed in Ethiopia as its current contribution is about 11% to GDP, 0.3% to employment and 11% to the country's export earnings.

82. About half of the manufacturing contribution to GDP originates from handicraft and small-scale industries and almost 50% of the industrial employment is also provided by the same. Nearly all manufacturing industries were set up in Ethiopia in the past fifty years by the state or by private entrepreneurs most often foreigners, or having foreign majority share holders. The ownership of all such major industries is now transferred to the

state.
83. Most of the industries produce consumer goods such as textiles, leather goods, food and beverages. But the volume of output covers only a tiny fraction of what could be required if supply were available. Chemical and metallurgical industries which are the bases for heavy industry are at their infancy. These subsectors don't produce fertilizers & chemicals as well as machinery and equipment highly demanded by the agricultural sector. However, there are, among others a few metal fabrication workshops, a small scrap and ingot steel smelter, four cement plants and vehicle and tractor assembly plants.

84. Nearly all components of these industrial plants are imported with the exeption of the non-metal bulk building materials,.The proportion ofindustrial spare-parts imported is 93 per cent by value. Equipment, facilities and tools in most of these industries are aged and production suffers frequent interruption due to breakdown. The proportion of raw materials imported for industries in Ethiopia is close to 50 per cent of overall value of material inputs.

85. Currently, modest measures are being undertaken to reduce the dependency of the industrial sector on imports and to enhance its capability in capital goods production. Such measures include implementation of a spare parts manufacturing project, an engineering design and tool center, and a pilot foundry.

86. The industrial enterprises are located mainly in three concentrations in and around Addis Ababa, Asmara and Dire Dawa. An estimated 80,000 workers or about 0.7 percent of the labour force was employed in these industries in 1983/85. The cost per work place in some factories established recently reaches as high as 70,000 birr per head; thus indicating a high capital intensity.

87. Before the popular revolution foreign managed enterprises dominated the industrial sector and all responsible posts down to foreman or supervisor level were kept and reserved most frequently for expatriate personnel. The domination of the industrial sector by foreign interests was done away with by the nationalization law in 1975. Industrial organization, management as well as technical operation capacity have been built up as rapidly as possible since then. The inherited intrinsic defects have, however, yet to be substantially corrected. The reform of the existing pattern and the launching of new industries better inter-linked with national human and natural resource endowments awaits the further build-up of national industrial technological capacity.

88. Handicrafts and cottage industries based on traditional technologies and using local raw materials, provide most of the consumer goods, household furniture and utensils, farm and other

implements and tools, for the rural 85 per cent of the Ethiopian population. It also provides many of these items for much of the population in towns and cities. The labour force it engages is believed to be not fully employed. The extent of the under employment needs to be studied.

89. The traditional handicrafts and cottage industry enclave has lost market in many directions to cheap imports and/or domestically manufactured articles, often based on imported materials and intermediates. In such cases the traditional practices and products have receded to outlying areas where the industrial substitutes had poor access. This was the case for example with iron or smelting for the black-smithing which fashioned iorn hand tools.

90 The artisans who with their precious skills sustained the traditional societies in Ethiopian environment were however specifically oppressed and kept sociallysegregated in the feudal structure. This might have been a significant factor for extended dormancy and lack of dynamism and development in their technical skills in all directions without exception.

91. The Revolutionary Government established the Handicraft and Small-scale Industries Development Agency, HASIDA in 1977 to guide, promote, support, supervise development of handicrafts and small-scale industry as well as to assist artisans in organizing producers cooperatives. HASIDA has currently launched training centers that enhance artisan skills and is also disseminating improved artisanal production methods and processes. Broadened and strengthened,these efforts are expected to contribute to the revitalization of technological capacity in this important subsector. There is no, however, institutional infrastructure to engage in technological developments to up-grade traditional technologies.

92. The Ministry of Industry is one of the early few initiators of setting-up S&T policey-making and planning department with focused concern with the acquisition, adaptation and development of technology. The departmentis responsible for industry-wide planning, supervision, co-ordination, encouragement and implementation of S&T activities. The department, however, needs to be further strengthened by relevant S&T high-level manpower and also by extending its reach at corporation and/or enterprise levels through establishing S&T units with more or less comparable functions.

93. Organized industrial research within the industry system is non-existent. However, isolated efforts at corporation/enterprise level in the areas of mainly using local raw materials are being attempted. Industrial corporations of chemical, food and textiles are in the early formative stage of initiating building research capabilities with, mainly, the aim of substituting imported

materials with local ones. Furthermore, the Ministry of Industry has, as of recently, opened-up a research co-operative programme with the Addis Ababa University with an over-all programme objective of providing a forum for technological trouble-shooting and for scientific investigation into industrial raw materials. Inorder to facilitate and accelerate the emergency of an organized and effective industrial research activity, constraints of institutional budgetary, highl-level manpower and facilities must be over-come.

94. The industry sector's design and engineering capabilities are negligible. The local development of the capital goods sector through mainly adaptation and reverse engineering is a basic objective that needs to be persued so as to minimize the impact of dependence on imports. As almost all industrial products have an engineering design input incorporated in the building of national capability in engineering design is necessary in the national effort to promote the development of the capital goods sector.

Major problems of the Sector

The above broad assessment of the industrial sector indicates a number of crucial problems which require immediate attention if this sector is to play its vital role in the national economy of the country. Some of these problems include the following:-

a. The consumer goods industries are incapable of meeting the domestic demand for consumer goods.

b. The industrial sector contributes very little, if at all to the manufacture of improved inputs required by the agricultural sector. Fertilizers, Pesticides, improved tools etc., are all imported at present.

c. The critical shortage and in some cases complete lack of spare parts for industrial machines and equipment is hampering the performance of the sector.

d. Excessive dependence on imported industrial technological hardwares with very little effort devoted to the choice, selection, adaptation,transfer and assimilation of the technologies.

e. Inadequate attention given to improving traditional technologies which are suitable for small-scale industries.

f. Inadequate and in some areas complete lack of workshops, engineering design, machine tools building, spare-parts and components manufacturing facilities, etc.

g. Lack of capability in many vital areas of industrial processes and manufacturing capacity of essential products.

h. Weak S&T activities in general and R&D undertakings in particular.

i. Inadequate program and facilities for periodic upgrading the skills of industrial workers. In general, lack of trained professional industrial workers.

j. Inadequate situation in the manufacture and development of export oriented products.

D. ENERGY

96. Of the total non-muscular energy utilized for household, production and service purposes, 93.4 percent is drawn from traditional biomass fuels such as firewood, charcoal, crop residues and cattle dung. The remaining 6.6 percent is commercialized and is mainly made up of petroleum which is imported and hydro-electric energy which is not. 95.5 percent of this non-muscular energy is used in Ethiopian households mainly for food preparation, while 4.5 percent is utilized in modern transport, industry, agriculture and the services. Petroleum and hydro-electric energy cover 94 percent and 6 percent, respectively, of this modern energy usage.

97. Traditional practice in household fuel use in most parts of Ethiopia is esxtremely wasteful. As supply continues to slip further behind demand, firewood that is less than optimally dry is increasingly being used especially in the larger urban areas, on the traditional open fire for deily cooking and baking. Charcoal which is made by a most inefficient traditional process is the fuel of choice in urban areas. These highly wasteful practices and usages are inflating inordinately, fuel demand and there-with fuel prices in urban areas. Woodstands are therefore disappearing in over-widening circles around urban areas,the population of which has been doubling every ten years. Brought in from ever increasing distances by truck, the supply of firewood to cities and towns is contributing to the nations petroleum import bill.

98. A study made recently had indicated that the woody biomass resources in Ethiopia amount to about 13.8 million tcal in forms of standing stock and 930 thousand tcal in terms of annual yield. This includes all types of woody biomass in both small and large stands existing in all environments including shrubland and bushland as well as woodland and forest areas. Three regions,

Keffa, Illubabor and Bale, occupying less than one fifth of the land area, account for over half of the woody biomass resources. One of the major problems is the strong mismatch between the location of forest resources and the concentration of the population, largely occupying currently deforested land or areas which are being rapidly deforested. It is estimated that trees are now cut on the equivalent of 200,000 hectares yearly, whereas the replanting rate barely covers 15 percent of this area. As the tree cover is removed precious top soil is exposed to erosion by wind and rain. Eroded soil carried by muddy rivers settles behind dams to silt up reserviors thereby rapidly decreasing the water impounded for generating hydro-electric energy. Some of this electrical energy would have substituted for firewood the excessive demand for which triggered the erosion conditions.

99. According to a recent study agricultural wastes currently contribute about 76 thousand tcal/yr. to Ethiopia's biomass resources or less than one fifth of the annual forest yield. About 97 thousand tcal, slightly over one half of these resources, is accounted for by animal dung. The increasing use of crop residues and cattle dung as household fuels increasingly denies precious green manure and mulch to crop land on which food (i.e. energy) is grown for human consumption. The curbing of the exceesive demand of traditional household fuels, through the rapid and effective dissemination of inexpensive fuel efficient firewood stoves offers multiple benefits. This solution has to be given an institutional base with the mandate and responsibility to produce the apparatus on a larger scale.

100. Substitution of modern energy supplies such as, electricity, kerosene, refinery gas, biogas and solar energy in place of firewood used now in house-holds is often advocated as a solution to the firewood crisis. Effective and widespread adoption of these substitutes however, requires reliable systems for the transport and distribution of the alternative energy forms to be inplace nation -wide. Households in urban and/or easily accessible rural areas would also have to be equipped with appropriate stoves. All components of such systems and equipment would have to be developed locally as fast as possible. Encouragement to producers and the necssary capital investment has to be allocated to promote this.

101. The yearly import of about 800,000 tons of crude oil and petroleum products is now absorbing more than one third of Ethiopia's annual export earnings. Two thirds of the nations petroleum imports goes to fuel heavy goods and public passenger transport by road and rail. This is indispensable as it involves the movement of imports and exports, distribution of food, fuel and raw materials and other inputs, of products and services to rural and urban areas etc. The distribution of petroleum products throguhout the country alone consumes ten percent of the products

distributed.
102. The price of petroleum which had rapidly escalated during 1970s and early 1980s is confidently predicted by many that it will continue to rise in the long term . There are prospects of discovering crude oil deposits in Ethiopia in the near future. The damming of rivers to impound water for the production, transmission, distribution as well as utilization of electrical energy in households, production and technological services require technologies and technological services. These will be improrted unit capabilities are created to reverse the situation. Capabilities in this regard that have been initiated by ELPA to design and build hydroelectric stations should be encouraged.

103. A study in 1986 indicates that the gross hydro-potential of the whole Ethiopian territory is of the order of 650 TWh/year. Between one third and one half of the total potential is due to the Blue Nile basin (280 TWh/yr.). The Blue Nile and Omo basins taken together contribute close to 400 Twh/yr to gross potential. If exploited at 15-25% of potential this could provide 70-120 TWh/yr.

104. The construction of hydrelectric plants at Melka Wakena, Sorø , Yadof and others are encaraging good examples of the efforts of building capability in construction, appraisal, design, and engineering although there is much that remains to be done in order to strengthen the sectors capability for the construction of hydroelectric plants using local materials and skills.

105. Recent explorations indicate that Ethiopia is richly endowed with geothermal energy resources. To benefit appreciably from this energy resource directly as heat or converted to electricity requires overcoming the obstacle of heavy requirements of foreign exchange intensive technologies throughout from source harnessing to end use.

106. Solar energy is being brought very rapidly as a low temperature heat source into widespread use even in industrialized countries in the upper northern latitudes such as Japan and Sweden. This is helping cut the cost of fuels for the provision of low temperature heat in households, hotels, hospitals and schools, in industry etc., and helping limit investment in costly supply transport, distribution and utilization arrangements in both fuel and electricity supply system in these countries. In Ethiopia the foreign exchange cost of imported flat plate solar collectors would restrict their application. On the other hand although the components of the fabrication and technological capability required for fabrication and assembly of such collectors exist domestically, there is no enterprise producing and marketing them.

107. In many petroleum importing countries, bio-solar technologies are being actively developed to help curtail demand for petroleum products, through fueling internal combustion engines primarily in transport, by partial substitution of fuel alcohols and/or oils of plant origin. Biomass conversion to biogas and to producer gas to fuel diesel engine operation are both gaining ground. Follow-up of these and related developments and local adaptation trials have yet to be organized and to involve the sectors that could benefit.

Major Problems of the Sector

108. Energy plays a vital role in the socio-economic development of society. A brief assessment of the energy sector in Ethiopia indicate that it is beset with a number of crucial problems. The following main problems can be identified in the energy sector:-

a) Close to 94 percent of the total energy utilized for household comes from traditional biomass fuels such as firewood, charcoal, crop residue and cattle dung. This has led to the deterioration and degradation of the environment from unabated deforestation practices and deprivation of the soil of the essential organic matter which could come from the use of crop residues and cattle dung.

b) The remaining of about 6 percent of energy usage is commercialized and is mainly made up of petroleum which is imported and hydro-electric energy which is not. Petroleum and hydroelectric energy cover 94 percent and 6 percent, respectively of this modern energy usage. Petroleum and crude oil import is now absorbing more than one third of Ethiopia's annual export earnings. On the other hand less than 5 percent of the estimated 56 billion kwh per year of hydro-electric potential has been harnessed so far.

c) The traditional household fuel use for cooking and baking on open fires is extremely wasteful.

d) The inexpensive but highly fuel efficient firewood stoves (closed stoves) are not yet disseminated to users in any appreciable scale.

e) Shortage of foreign exchange and lack of technological capability have hampered the wide use of modern energy supplies such as electricity, kerosens, refinery gas, biogas and solar energy in place of firewood used now in households.

f) The harnessing of the huge geothermal energy resources has been difficult because of lack of investible funds and inadequate domestic technological knowhow.

g) Eventhough the country is abundantly supplied with solar energy, there has been no domestic enterprise so far to fabricate the necessary components and market them to users at reasonable prices.

h) No appreciable technological capability has been built which would enable biomass, conversion to biogas and to producer gas to fuel diesel engine operation even in areas where conditions are favorable.

i) R&D activities in the energy sector are weak and lack effective coordination and the necessary infrastructures.

j) There is extreme shortage of trained manpower in the energy sector.

E. Mineral Resources

Institutional Infrastracture

109. Mineral resources represent the foundation required for building an independent and strong national economy in general and for the rapid growth of the industrial,construction and export sectors of the economy in particular. It is, therefore, of immense significance to accord high priority to the development of mineral resources. The possession of national S&T capacities to undertake mineral exploration works through geological surveys as well as of techniques for exploiting mineral deposits of commercial significance is of crucial importance in the developmental effort of mineral resources.

110. Aware of the importance of the development of the country's mineral resources as a basis for the construction of a modern economy, a geological survey unit within the Ministry of Mines and Energy was set-up in 1968. It was initiated and established by assistance obtained from UNDP and other organizations. After the elapse of some time, the unit was transformed in 1982 into the Ethiopian Institute of Geological Surveys with a status of an autonomous government organization accountable to the Ministry of Mines and Energy. Two other organizations namely, the Department of Geology and Geophysical Observatory which are an integral part of the Addis Ababa University, are engaged in related scientific activities.

Ethiopian Institute of Geological Survey

111. The principal objectives of the Ethiopian Institute of Geological Survey (EIGS) is to under take scientific studies and surveys of the earth's crust and to explore for mineral deposits of all types. The Institutes specific activities include geological mapping, remote sensing studies, mineral surveys, hydrogeological surveys, geothermal surveys, exploration for petroleum and natural gas, geophysical surveys, training of personnel, etc.

112. Nowadays EIGS is engaged in mapping the whole country at the 1:250,000 scale; there is no earlier map coverage or the country at this or larger scales. Mapping was initiated in those areas thought to be of greatest economic mineral potential, that is in the precambrian of northern, western and sourthern Ethiopia Later on mapping will be extended to mesozoic sedimentary areas and then to cenozoic volcanic qareas. The Ethiopian offshore zone will also be surveyed geologically when EIGS acquires the necessary expertise and equipment.

113. At present two geological mapping projects are being executed, one of Agere Marian in Sidamo, the other of Nekemte mapsheet in Wollega.

114. Exploration is carried out for both metallic and industrial minerals. Exploration for metallic minerals is carried out comprehensively, that is, mineral deposits of all types are explored for. Exploration for industrial minerals is usually carried out specifically on demand by customers, usually government agencies.

115. Important exploration projects being carried out at present are:-

a) the Guba metallic minerals exploration project(Gojam and Wollega)

b) the Kurmuk metalic minerals exploration project, mainly for primary and placer gold (Wollega)

c) six industrial minerals projects for bentonite, diatomite, phosphate, construction materials, ceramics and sheet glass raw materials.(wollega)

d) the iron exploration project (Wollega)

e) the Bulbul and Hageremariam mineral exploration project (Sidamo)

116. Hydrological surveying has been carried out by EIGS. The objective is to produce hydrological maps, depth to water level

maps, ground water level profiles and ground water hydrographs. Studies are also made of phenomena such as the occurrence and movement of ground water, ground water and water well hydraulics and natural and artificial recharges.

117. In the past, EIGS has been engaged in surveying the geothermal resources of the country. The basic objective of this survey is to evaluate the geothermal potential of the country with an eye to defining exploitable geothermal energy reservoirs primarily for electricity generation.

118. The Ethiopian rift valley system is volcanically the most active part of the country; thus geothermal surveys have been concentrated there. A reconnaissance survey of 150,000 sq. km was carried out in this region in the early 1970's. The three most promising areas thus established were Dallol in the Danakil Depression, Tendaho Garben in The Afar and Aluta Volcanic Centre in the Lakes District Rift. Since then a large number of potential areas have been identified.

119. EIGS is also engaged in the search for lignite (coal) and petroleum. The objectives of the search are to check all reported occurrences of lignite in the country in order to establish their exploitability, which is on-going at present, and to search systematically for coal deposit which will be carried out in the future. This work will be facilitated when the future program of geological mapping of the sedimentary basins of Ethiopia gets underway.

120. Present activities involve the evaluation of lignite occurrences near Jimma and Central Wollo.

121. At present the hydrocarbon department of EIGS does not itself carry out petroleum exploration work. Instead a major project was set up with a US$ 7 million loan from the World Bank, the aim being to promote exploration for petroleum in Ethiopia by international oil companies.

122. Geophysical surveying is a valuable and powerful technique used in geological mapping and more particularly in resource surveying. Geophysics is also a unique tool for basic research into the structure and composition of the earth's interior. Ground, airborne and marine geophysical surveys can be carried out.

123. EIGS, However, has concentrated initially on building up a competent ground geophysics capability. The present capability is used mostly in specific mineral and groundwater exploration projects. Aside from this a regional gravity survey for producing a standardized gravity map of Ethiopia is at present in progress.

124. In order to accomplish those tasks that are stated so far more efficiently, the manpower requirement of the institute should be fulfilled. When the institute started its work, it had only 8 workers who had been engaged in their activities under the supervision of foreign experts. But nowadays, the institute has got approximately 1200 workers of which 300 are contract employees. Out of the total employees, the number of Ethiopian professionals and semi-professionals engaged in the institute is 329 and 78 respectively.

Geophysical Observatory and Department of Geology

125. These are integral parts of the Addis Ababa University and are mainly engaged in training. The Department of Geology has got six expatriate teachers, 15 Ethiopian teachers and 11 technicians. Among the 15 Ethiopian teachers, nine of them are engaged in teaching in the department and the remaining six are workers of the Geophysical observatory.

126. The Geophysical Observatory was founded in 1957 at Arat Kilo Science Faculty Campus. After its establishment, the Observatory has contributed a lot in areas of geomagnetic studies.

127. The first progress of this Observatory is that in 1962 it organized seismology and geodynamics unit which helps in collection of information and data on earthquake in Ethiopia and around the world. This Observatory has helped different government and international organizations by making available vital information on earthquakes in different areas. This information would in turn help these organizations to take the necessary precautions before implementing tyheir projects in different areas. In addition to this, it also renders services for researchers whenever they need such information. Numerous departments can find research topics related to earthquakes and geodynamics from the unit of this observatory.

128. In addition to the seismology and geodynamics unit, the Observatory has three other units. These are: the Applied Geophysics Unit, the Meteorology Unit and the Ionospheric and Geomagnetism Unit.

129. The activities in the Applied Geophysics Unit which were defined after consulting the Ethiopian Institute of Geological Surveys, among others, are carrying out geophysical mapping. The consultation helped in clearly defining the research area of the Applied Geophysics Unit by avoiding duplication of work in applied geophysics in the country as a whole. The Unit deals with research project which are largely of academic nature.

130. The Meteorology Unit was developed after consultation with the Ethiopian Meteorological Services Agency. Accordingly a training programme for meteorologists has been introduced in the Physics Department. This programme is planned to lead, after some time, to M.Sc and Ph.D. degrees. The Ethiopian Meteorological Services Agency is willing to provide staff and laboratory facilities for training and research in meteorology.

131. In the Ionospheric and Geomagnetism Unit, it is planned to conduct research in inospheric physics and geomagnetism which directly affects communication. The Telecomunications Authority cooperates in this programme.

132. As indicated above, due to the nature of its work, the Observatory shares a similar working area with institutions such as Departments of Physics and Geology of AAU, National Meteorolotical Services and Institute of Geological Survey. Hence, there should be some type of coordination within these organizations and the Observatory in their common area so as to avoid duplication of work.

133. Absence of core staff in geophysical observatory division of the Science Faculty and apparent apathy on the part of the University are some of the major problems faced by most of the units of the Observatory.

134. Since there were expatriates working in the Observatory, until 1976, it had sufficient manpower, to conduct its activities properly. However, after their departure it faced problem in areas of trained manpower. Nowadays, it has only nine workers of which one is with PhD degree, three with MSc degree, one with BSc.degree and the remaining four are diploma holders. There is no budget allocated for the Observatory. It meets its financial requirements by requesting the Science Faculty of Addis Ababa University.

Finance

135. In the Ten Year Indicative Plan it is estimated that an investment of Birr 1.71 billion is required for the mining sector as a whole, of which Birr 709 million will be spent on prospecting and exploration and Birr 997.7 million on production of minerals.

136. The distribution of the estimated investment requirement for geological survey (709 million in 1980/81 prices) is shown in decending order.

a. Petroleum prospecting and exploration 46.7%
b. Mineral prospecting and exploration 18.1%
c. Geotherimal studies 15.6%

d. Infrastructure and for strengthening of institutes..... 11.5%
e. Hydrology and engineering geology 4.6%
f. Large scale mapping 3.5%

Total 100%

137. On the other hand, an investment worth Birr 997.7 million in 1980/81 prices, is estimated to be required for the mineral development sub-sector. The distribution of the sub-sector's investment by type of mineral is as follows:

a. potash production 55.0%
b. precious minerals production 25.7%
c. metalic minerals production 10.4%
d. industrial minerals production 8.4%
e. mineral dressing technology 0.5%

Total 100%

138. It is expected that this investment programme will be accomplished mostly in cooperation with foreign companies and countries through joint-venture projects, as well as through aid/loans and technical assistance to be obtained from international organizations and friendly nations.

139 The investment requirement for S&T capacity building in the mineral resources sector during the Ten Year Plan period is estimated at 110.364 million Birr out of which birr 18.054 million is allocated for the first phase, Birr 57.375 for the second phase and Birr 34.935 million for the third phase of the development programme. The following table shows how the total investment will be distributed to the various S&T activities.

Capital Investment for S&T Capacity Building in the Mineral Resources Sector in the 10 Year Perspective Plan

S & T Elements	Resources in '000 Birr			
	Infra structure	Equipment	Manpower	Total
1. Development of Science and Technology	6897.75	13795.5	6897.75	27591
2. Transfer of Techno.	4138.65	8277.3	4138.65	16554.6
3. Utilization of Techno.	4138.65	8277.3	4138.65	16554.6
4. Technology Adaptation	2759.1	5518.2	2759.1	11036.4
6. Technology Consult.	1379.55	2759.1	1379.55	5518.2
7. Manpower Development	3348.875	6897.75	3448.875	13795.5
8. Development of Traditional Technology	1379.55	2759.1	1379.55	5518.2
9. Formulation and Instruments of Implementation for S&T Policy and plan	689.78	1379.55	689.78	2759.1
Total	27591.005	55182	27591.005	110364.0

Source: The Ten year S&T Perspective Plan for Mineral Resources, Water and Energy Sector (S&T task force;June, 1976 E.C. A.A.)

140. The actual capital and recurrent budget allocated from the government for different sections in the mining sector for the last 5-10 years is presented in the folloing tables.

Capital Budget for the Mining Sector
in million Birr

Sections	Y E A R (E.C.)								
	1971	1972	1973	1974	1975	1976	1977	1978	1979*
1. Head Office	-	-	-	-	-	-	-	-	-
2. Mineral prospecting & exploration	-	-	-	4.7	1.2	2.2	5.1	9.4	9.9
3. Mineral Exploitation & development	-	-	-	7.8	5.1	8.9	13.3	36.5	26.5

* for nine months only

Source: Evaluation of Plan implementation from the year 1971 upto 1978 E.C.
(ONCCP, Dec, 1978, A.A)

Recurrent Budget for the Mining Sector

(in Million Birr)

Sections	Y E A R (E.C)								
	1971	1972	1973	1974	1975	1976	1977	1978	1979*
1. Head Off.	0.6	0.8	0.7	0.6	1.1	0.7	0.7	0.8	0.9
2. Mineral prospecting and exploration	0.9	1.0	1.4	1.2	1.6	9.4	2.9	3.1	2.5
3. Mineral Exploration and Development	1.7	3.1	3.4	1.3	4.0	6.7	3.1	2.3	7.5

* for nine months only
Source: Evaluation of plan implementation from the year 1971 upto 1978 E.C (ONCCP, Dec, 1978. A.A)

Manpower

141. For the activities that are envisaged to be covered in this economic sector there is a need for trained manpower in areas of geological survey, exploration, research and development.

142. The number of skilled manpower which is engaged in this sector from 1941 up to 1974 E.C. is shown in the following table.

Mining Professionals Employed in the Mining Sector (1941-1974 E.C)

Qualification	Y E A r (E.C)			
	1941-1950	1951-1960	1961-1970	1971-1974
Geologists	-	8	44	41
Mining Engineers	2	4	4	3
Chemists	-	-	-	3
Mechanical Engineers	-	-	1	2
Drillers	3	2	1	-
Assistant Geologists	4	50	17	3
Physicists	-	-	2	1
Surveyers	-	6	5	14
Assistant Chemists	-	3	10	4
Assistant Drillers	1	-	3	9
Drafts men	-	5	13	9
Electrical Engineers	-	1	1	-
Total	10	82	107	91

Source: The Ten Year Perspective Plan for the Mining Sector part 1 (Evaluation of the Sector, Objectives and Strategies) Mining task force, Sept., 1975

143. As shown in the above table, prior to 1950 E.C.,there was no single Ethiopian geologist engaged in mineral resources. Inactual fact most of the geologists presently working in the sector were employed after 1961 E.C. The total number of staff, in 1971 E.C., was 165 of which 98 were professionals, 27 sub-professionals and 45 technicians. Compared with the planned activities, the number of professionals is too small to accomplish the task. At the same time, recognizing the fact that there must be three to five assistants (sub- professionals and technicians) for every professional, the present situation of 72 assistants to 98 professionals is not satisfactory atll. Furthermore when the professionals are grouped by areas of specialization they are much fewer compared to what is expected of them in the specalized activities of the sector. Another serious problem is an internal brain drain. Some of the professionals have left

the sector for more gainful employment in other fields.

144. Eventhough it is difficult to show the development statistically (due to lack of the necessary information), the general situation after 1974 E.C. seems much better compared with the previous years i.e the manpower engaged in different sections of the mining sector is increasing from year to year as shown in the following table.

The Total Number of Manpower Engaged in Different Sections of the Mining Sector at Different Years (in Number)

Sections	Year 1975	1976	1977	1978	1979*
1. Head Office	373	192	225	498	258
2. Mineral Prospecting and exploration	192	454	519	580	739
3. Mineral Exploitation and development	196	664	760	1031	-

Source: Evaluation of plan Implementation from the Year 1971 upto 1978 E.C.(ONCCP, Dec., 1978 A.A)

* for nine months only

145. The Geology Department of Addis Ababa University contributes in training of professionals for the sector. In the past three years, by enlarging its effort, the Department has produced a large number of Geologists. As regards the training of technicians, efforts made so far are not that much sufficient, previously though the Ministy of Mines had its own training department for prospectors.

146. EIGS is making and will continue to make every effort to send its professionals abroad for post-graduate training in fields which the Institute needs to acquire advanced skills. A manpower development and training service has recently been set up, part of its duties being to assist in reationalizing the post-graduate training programme and to carry out the necessary forward planning.

147. An Institute of Geology and Mining is being set up at Mekele by EIGS, where a post-secondary three year training course leading to a diploma will be given in the following five disciplines:

a. Geology/Geochemistry
b. Geophysics
c. Drilling technology
d. Mining engineering

e. Mineral dressing

Thirty trainees will be accepted annually in each of these disciplines that are mentioned above.

Infromation and Documentation Capability

148. The Ministry of Mines and Energy has got well-organized small library in its head office. In this library there are different S&T books, magazines, technical reports and news papers that deal particularly about different mining and energy aspects.

149. After collecting and evaluating those S&T information from these different articles, the sector uses them in its different technical activities. In addition to this, the different sections of the mining sector produce technical reports about the results of their activities. This sector also prepares geological maps. These technical reports and geological maps have been distributed to different organizations in tne country and abroad.

150. Among those libraries found in different sections of the mining sector, the one which is somehow well-organized is the library of Ethiopian Institute of Geological Surveys. This library holds 6150 books, 1600 unpublished technical reports, 275 company reports, 560 maps and 280 microfiched technical reports. Eighteen scientific journals are subscribed at present.

151. To enable computerization of the library, a Hewlet Packard 3000/series 37 computer with six terminals and printer has recently been acquired.

152. Measures are presently being taken to strengthen EIGS' publishing facilities. A desk top off set printing machine and complementary equipment has very recently been acquired and additional equipment is being ordered. This library has also a publication exchange agreements with the geological surveys of Canada, U.S.A. Jpan, Austrialia, France and the Internatinal Development Research Centre.

153. The Ethiopian mineral Development Corporation has also a small library. But as it can be seen from the condition of this library much has to be done in the future.

154. In the area of publication, a serious problem facing the sector at present is the lack of an offset printing machine for producing multi-colour maps. The printing of completed geological maps is delayed for years due to technical problems at the Ethiopian Mapping Agency. Thus an important portion of the scientific output of EIGS is not readily available to users.

155. The low quality of reports is also the other problem which has been frequently mentioned. This is a matter of exceptional

importance. Unless reports are written to an acceptable standard and then made available quickly for circulation, the value of much of the work of this sector especially that of the EIGS will be lost. There are hardly any incentives or funds available for research leading to the production of scientific publications outside routine work.

Technology Transfer Capability

156. Most of the technologies that are used in the mining sector for mineral exploration and development purposes are imported from abroad. These technologies are obtained either in the form of aid or credit from organizations like UNDP and different friendly countries. In this process, the sector is not usually in a position to evaluate and select the quality of the technologies in relation to the conditions of the nation. In this regard the sector's participation is limited in the sense that it only suggests the name and number of the equipment which it needs at the time. Besides this, those S&T equipment that are needed for the same type of activity are imported from different countries. As a result of this it is not possible to use spare parts for equipments that are imported from one country for equipments that are imported from the other. In general, the sector faces problems in areas of technology selection, spare part acquisition and in limiting the origin from where technologies are imported.

Link between R&D and Production

157. In general, there is a division of work among the two units that are found in the mining sector. While EIGS is directly responsible for all the activities in the area of geological surveys and exploration, almost all the mineral development and exploitation activities are conducted by Mineral Resources Development Corporation itself or by joint agreement of international bodies with this corporation. Hence, after mineral exploration and surveys are conducted by Ethiopian Institute of Geological Surveys, the mineral development and exploitation activities are undertaken by Ethiopian Mineral Resources Development Corporation, since it is this organization that is involved in the explitation of mineral deposits found by EIGS.

Technology Utilization and Maintenance Capabability

158. The capacity for repair and maintenance of sophisticated scientific and other equipment is very limited. This problem has a direct bearing on the technical activities of the sector. One of the main impediments to developing this capability is the sector's inability to attract highly qualified engineers as well as competent technicians due to the very low salary scale imposed by the Civil Service Commission.

159. Since there is no well-organized repair and maintenance workshop in this sector, the scientific equipments used in different activities of the mining sector, get maintenance services from workshops that are organized elsewhere. When Some of the laboratory equipment face this kind of problem they would be sent abroad in order to get maintenance services. In such a situation, in addition to the time needed to get a proper service, the foreign exchange cost incurred is enormous.

160. A possible solution for this problem is to organize a workshop in the short-run. In the long term, it will also be necessary to develop the capability of modifying, designing and making mechanical, electrical, and electronics instrumentation to be used in the sector's activities.

Major Problems of the Sector

161. It is not difficult to see from the above short assessment that the mineral resources sector of the country is faced with some fundamental problems which are seeking effective solutions. These problems, among others, include the following:-

a) Tne mineral resources of the country have remained largely unexplored. The prospects for many base metal resources are unknown. Given this situation, tne existing national capacity for geological survey is highly inadequate.

b) Detailed geological mapping of most parts of the country has yet to be under taken.

c) Para-scientific facilities such as libraries, laboratories workshops, etc. are not well organized and adequately strengtnened .

d) Information and documentation activity of the sector need to be adequately organized and strengthened inorder to adapt data processing methods in earth scientces. This would help in systematising and integrating the data inputs available and presently collected in a largely uncoordinated manner.

e) The sector faces financial and material resources constraints for ensuring effective implementation of its programmes .

f) Participation of foreign/private investment in the form of joint ventures so as to exploit the mineral resource potential of the country for the best interest of the nation is inadequate.

g) For the type and amount of work that needs to be done in mineral resources the number of trained Ethiopian professsionals is cretically short.

F. Irrigation and Water Resources

162. Water and atmospheric resources in general are not adequately exploited and efficently utilized in Ethiopia. Traditionally the most important use of water in most parts of Ethiopia has been principally for domestic food and beverage preparation in the household. It is thought that other uses may nave had to remain small because clean water by custom is fetched by the women folk from far off spring at least once a day, except in the three month monsoon season. Urban and rural settlements in Ethiopia have been sited traditionally at appreciable distance from river and stream banks, most often on flat hill tops or gently sloping mountain sides or high plateaus. Water power harnessing and irrigation uses were little known in past ages in Ethiopia.

163. Only 4 percent of rural innabitants have access to safe drinking water. Safe and reliable drinking water supplies have yet to be established for most of over 300 townships with 2000 inhabitants or more to cope with the needs of the rapidly growing populations. For the larger 20 towns and cities supply systems have been established or expanded with loan financed projects. But even in such urban areas the women-folk in the majority of the lower income households have to fetch water one or more times per day some distances from tne home.

164. Barely 3 percent of the 2-3 million hectares of potentially irrigable land in the nation's 14 river basins has been put under irrigation. On the other hand it is estimated that 100 billion cubic meters of heavily siltladen water are carried annually into neighbouring countries by rivers flowing out of Ethiopia.

165. In two major river basins, (Blue Nile and Wabi-Shebelle) comprehensive studies accomplished by 1975, were carried out by foreign experts under technical assistance agreements. Hydrological and hydrometreological data collection outside these basins was not systematized and regularized.

166. The concentration of rainfall in the three month rainy season- June, July and August in most parts of the country, gives rise to torrential and muddy flow in the rivers. The volume of flow rapidly subsides to a mere trickle in subsequent months. This very uneven river flow pattern requires that dams be built to establish reservoirs large enough to maintain adequate supplies thoughout the dry months for whatever purpose be it

drinking water, or hydroelectric energy or irrigation. The construction of large dams is however expensive, and national capacity to design and construct them has yet to be built.

167. Loss of water by evaporation from the extensive surface of the reservoir during the hot dry, windy months can deplete the stored water quantity appreciably. The loss by evaporation from the Koka reservoir is estimated to be up to 25 percent.

168. The capacity of reservoirs to retain water is rapidly depleted by the haevy silt-load carried into the reservoir by the muddy river flow during the rainy season. A drinking water reservoir for Addis Ababa which came into services at Gafarsa in 1939 has now barely ten percent of its original capacity. The Aba Samuel hydro-electric power station reservoir at Geja near Addis Ababa is estimated to have lost 80 percent of its storage capacity to silt in about 40 years. Koka reservoir is estimated to have similarly lost 30 percent ot its storage capacity to silt in 26 years since 1960.

169. With the exception of the local fabrication of pipes up to 6 inch diameter out of imported sheet steel, all equipment and spares and most materials used in water treatment, distribution and utilization in irrigation and in data collection are imported. Staffing of the Ethiopian Water Resources Authority, fully Ethiopianized over a decade ago has been subjected to continious attrition estimated recently at 60 percent. The establishment of the Water Technology Institute at Arba Minch is a landmark which would go a long way toward meeting the trained manpower requirement in water resources development field.

170. Weather data collection was established some thirty two years ago to furnish aeronautical/aviation meteorology as part of the Civil Aviation Adiministration. Support to non-aviation meteorology remained therefore minimal and other activities such as water resources were constrained. To attempt to make up the deficiency the Meteorological Services Agency has been recently estblished under the National Water Resources Commission to provide integrated metereological Services.

171. Weather observation data have been made at about 700 locations in the past. But since the observations were so frequently interrupted, most locations now have few years of complete records. For a country with a large weather variability and size characteristics of Ethiopia, a minimum of 4000 rainfall stations are required. The data transmission and processing system in use, leaves much to be desired. The shortages of metereologists has been a major impediment to the establishment of a multifaceted nation-wide service.

172. The existing metereological service has until very recently, been largely dependent on technical assistance for procurement of

supplies of instruments and consumable materials, all of which must still be imported. Meterological education and training at intermediate and higher levels are dependent on scholarship and fellowship grants by international organizations and friendly nations.

173. A few large-scale irrigation works have been in operation in certain parts of the country, mostly along the Awash river course for the production of sugarcane, cotton, fruits and vegetables, etc. These have contributed greatly to expanding agricultural products mostly for domestic consumption. As noted earlier out of the potential irrigable land the country is using only about 3 percent. There is thus vast potential which is not yet tapped. Small-scale irrigation works by the peasants are minimal. Conservation of water in artificial ponds and utilizing this water along with the water of rivers and small streams for irrigation purposes could contribute siginficantly to the food self-sufficiency effort of the country.

174. As in the other sectors, the irrigation and water resources sector is critically short of trained manpower and the S & T activities in general, and R & D undertakings in particular leave much to be desired.

175. Some efforts are being made in recent years to develop small-scale irrigation facilities by the Ministry of Agriculture, the Relief and Rehabilitation Commission and the Peasant Associations. It has not been possible to obtain reliable data on the amount of work accomplished so far in this field. The few data obtained indicates, however, that considering the potential in this area what is achieved so far is only minimal. Neither the experience nor the necessary facilities are peresent to adequately exploit the potential.

176. Available data indicate that a great deal of educational program on the usefulness of irrigation development would have to be undertaken at a national level. Moreover, the local availability of some essential materials and equipment for the development of small-scale irrigation facilities is essential. The availability of trained manpower in irrigation work is very helpful.

177. There is now strong political will to promote irrigation and water resources development. The Ministries of Agriculture and State Farms, as well as the Relief and Rehabilitation Commission, the Water Resources Development Commission, Valleys Development Authority, and the Peasants Associations are all trying to expand and strengthen their capacities in irrigation and water resources development works. The need for launching a strong promotional work especially among the peasants is very high indeed. It has not been possible to get reliable data on the amount of work accomplished in this area.

Major Problems of the Sector

178. The above brief assessments of the Irrigation and Water Resources Sector reveal a number of crucial problems which require urgent attention for their solutions. These fundamental problems would, among others, include the following:

a) Although some parts of the country receive heavy rainfall during the three months of June, July, and August, water shortage is experienced almost immediately after the rainy season due to lack of dams to establish water reservoirs.

b) Irrigation practices especially among the peasant farmers are underdeveloped and inadequate i.e., only about 3% of the potentially irrigable land of the country is now under-irrigation. The awareness of the importance of irrigation is very low among most farmers.

c) Water conservation, management and rational utilization techniques are inadequately practised. These have led to the wastage of this essential resources which have aggravated its scarcity.

d) It is estimated that 100 billion cubic meters of heavily silt-laden water are carried away annually by rivers flowing out of the country as a result of which the soil erosion has reached a clossal magnitude and the rate at which the fertile surface soil being eroded each year has become extremely alarming. Thus the productive capacity of the land is declining from year to year.

e) Only a tiny percentage of rural inhabitantshave access to safe drinking water. Only very few of the urban areas have safe and reliable drinking water supplies.

f) Fetching water is a laborious and time consuming activity.

g) Hydrological and hydrometereological studies have not been carried out for most of the major river basins of the country.

h) Practically all the equipment, spares and materials used in water treatment, distribution and utilization in irrigation and in data collection are imported.

i) Weather observation data is incomplete and the number of rainfall stations inadequate.

j) R & D activities in the irrigation sector are weak and inadequate.

k) Loss of water by evaporation from reservoirs is considered to be quite excessive.

l) The heavy silt load carried by the muddy river flow rapidly deplete the capacity of reservoirs to retain water.

m) Trained manpower in irrigation field is extermely low.

G. Transport_and_Communications

179. Transport and communications is an important economic sector which enables the movements of passengers, freights and messages from the point of origin to the point of destination. This sector in any country is a truly integrating system of different sectors of the economy. The advance achieved in this sector is an indicator of the level of the development of a country's economy, among other things. The fulfilments of development objectives and targets of various econmic sectors depends on the availability of reliable transport and communication services. It was from this ground that the Ten-Year Socio-economic Development Plan accorded priority to the sector. The transport and communication sector in Ethiopia organized under the Ministry of Trnasport and Communication, embrace four subsectors; namely, inland transport which includes Road and Rail Transport, Marine Transport, Air Transport and Communications which consists of telephone, telegram and postal services.

180. Inland_Transport: In respect of inland transport, under the direct supervision of Road Transport Authority are organized as Freight Transport Corporation, Public Transport Corporation, and Ethio-Djibouti Railway Company. Road transport accounts for 94% of the national passanger and goods traffic. Yet, when compared to the intensity of the need, it's development is very low. For example, in 1966 E.C. all types of roads in use were only 6,638 km; when this is compared with total area of the country, it is only 5.4 km. of road for every 100 sq. km of land area. Howevere, due to developmental measures taken over subsequent years the ratio has grown to 13.6 km of road to 100 sq.km. of area in 1979 E.C.

181.Freight_Transport: Trucking is the most accustomed method of transport. Presently, there are 6,818 trucks; of these, 1,015 are state-owned and the balance 5,803 are privately owned. Inaddition, there are 988 fuel trucks, of which 162 belong to the public sector. The performance of freight transport during the first five years of the Ten-Year Perspective Plan was slightly lower than planned. During the period a total of 27.8 million ton freight was transported 10.1 million ton K/meter. This was 91% and 94%, respectively, of the plan. The factors for the

below-target performance are reported to be mainly very high down times and poor management and coordination facilities.

182. With the object of promoting the efficient use of existing fleet and other transport equipments, Freight Transport Corporation has established a Central Repair and Maintenance Garage in Addis Ababa. This central workshop is being installed with machineries, tools and equipment, with investment worth in the order of 4 million. The planned total work-force is around 500; of which, 50-60% are technicians and 8-10% senior engineers. Furthermore the establishment of 5 regional workshops in 5 major towns is in progress. The realization of these workshops and their full utilization would contribute a great deal towards reducing down time.

183. Public_Transport: In 1979 E.C., the number of buses, both public and private, providing public services in and between towns and cities were 3,137 as per the following break-down.

Big buses with seats over 44	536
Mini busese with seats ranging Between 21 and 44	1,306
Small buses with seats ranging between 7-20	1,295
Total	3,137

Furthermore, taxi service especially in Addis Ababa city is important. In 1979 E.C., the number of registered taxis were 4,323, of which some 90% are 25 years old and hence with low service efficiency. The shortage of transport facilities is severe. For example, in 1978 E.C. for Addis Ababa one bus is for 10,000 people. Comparison of this ratio with other cities reveals that for every 10,000 people the number of buses for Abijan is 14.1, for Acra 5 and for Nairobi 8.6. A certain study made in 1984 further reveals that most buses were absolete and there was one failure in every 120 km. This is a very high rate when compared to one failure to 48,000 km in London. To decrease the problem of frequent failure of buses, the public transport sector has established a very big garage in Addis Ababa. This may, however, reduce the failure rate but it does not overcome the shortage. As per a recently completed road transport feasibility study, the everincreasing shortage of transport in Addis Ababa is envisaged to be met through the introduction of trolley buses in few directions connecting different zones.

184. Railway Transport:- The Ethio-Djibouti Railway linking Addis Ababa with Djibouti is the main railway line through which 40-60 percent of the country's import/export are channeled. Between the years 1978/79-1982/83, G.C., there was significant decline in the freight traffic and this is mainly due to poor locomotive conditions, and lack of adequate supply of spare parts

plus poor maintenance facilities. To overcome the acute problem of shortage of spare parts, there is an ongoing project of strengthening a cast iron foundry to undertake the domestic prodution of currently imported cast iron spare parts. Furthermore, the project has as its objectives to upgrade the skills of Ethiopian workers and technical staff, implement appropriate foundry technologies in melting, moulding, heat treatment, etc., as well as to expand production capacity of casting to enable replacement of old railway lines.

185.Air_Transport: The air transport sub-sector is controlled and directed by Ethiopian Air Trnansport Authority which manages and facilittes air infrastructure, Ethiopian Airlines Corporation coordinates both domestic and international flights; and Admas Air provides air taxi and agricultural chemical spray services. Air transportation is facilitated by 32 air ports, four of which are international, and many more air fields.

186. Ethiopian_Airlines_Corporation:- Ethiopian Airlines, with its 28 airplanes, covers an extensive network of airports and air fields. The Corporation has developed a very high technological capability mainly in respect of repair and maintenance, management choice of technology and training. Presently, the corporation is in pace with advanced airliners in daily maintenance, air plane scheduled checks, includinng structural inspection and heavy overhaul. JT3D and JT8D engines are completely stripped down, repaired and tested. All airplane componenets, excluding pneumatics, are disassembled, overhauled and reassembled. The expansion project of the corporation in power plant shops small air-craft manufacturing facility, engine test cell, wide-body hanger with supporting shops as well as the modification of the existing hanger, cargo handling facilities and flight catering facility will give the corporation self-sufficiency in maintaining engines from 500-3000 SHP turboshaft engines to 55,000 lbs thrust high bypass ratio jet engines, assembling agricultural sparying airplanes, testing engines from 15,000 to 100,000 lbs thrust, training up to 500 students, etc. Sound managerial structures to facilitate smooth functioning are in place. Administration systems are well synchronized with both transportation and commercial portion and technical department of the airlines. Capabilities to choose the type of aircraft that meets both local and international needs, the types of engines and components to be fitted on aircraft, and the appropriate type of workshop equipments are well developed.

187. The Ethiopian Airlines Aviation Training Center offers a two-year training programme in three specializtion areas; namely, aircraft frame and power plan, structural repair techniques and avionics which includes electricity, electronics, and instrumentation. The training programme of each specialization lasts for two years. The training center, at present, has 22 teachers that are Ethiopians. The training center renders training services

for Ethiopians and foreigners. There are three criteria to join the center for Ethiopian trainees. The first is the Ethiopian School Leaving Certificate Examination, ESLCE, with minimum grades of C, B and B for mathematics, english and physics or general science, respectively. This is required for registration. The second is entrance exam which contains interview to understand aplicants's ability of mechanical comprehension and a written exam in english, mathematics and physics or general science. The third is medical fitness. Those who fulfill all these criteria join the Center. Currently, the Center is a multinational training center for English speaking African countries. There are 35 countries that benefit from its services. Those that are outside of Africa include the Peoples Democratic Republic of Yemen, Greece, India and Srilanka. Since its establishment the center has trained 1,135 technicians upto July 1987 G.C., of which 713 are Ethiopians and 422 are foreigners. The breakdown by field of specialization and by Ethiopian-foreign classification is presented as follows:

Field_of_Specialization	Ethiopian	Foreigners	Total
Aircraft frame & power plant	337	255	628
Avionics	261	149	410
Structural repair technique	79	18	97
Total	713	422	1 135

Source: Interview with an administrative workers of the Center

The Training Center has a capacity to train 192 students with the now existing facilities. The constriant of the center to train more is shortage of dormitories for students. If additional dormitories are built, the Center will have the capacity to train 240 students. The center gets its annual budget from the Ethiopian Airlines. It also enjoy external assistance made by the International Civil Aviation Organization and the United Nations Development Programme, UNDP.

188.Marine_Transport: Marine transport is handled by three organizations; namely, Marine Transport Authority which is established with the objective of providing quick services at reasonable cost, expanding port services, ensuring safety of marine transport and of controlling sea polution; Ethiopian Shipping Lines Corporation; and Maritime and Transit Services Corporation which renders transit services to all in-coming and outgoing goods that are transported by air, sea and land as well as offers agency services to all ships calling at Asseb, Massawa and Djibout Ports.

189. About 90% of the country's trade is served by the three ports; namely, Massawa, Asseb and Djibouti. The cargo handling capacity of the two national ports of Asseb and Massawa is about

one million eight hundred fifty thousand tons of dry freight per year and can give services for 12 large ships at a time.

190. Until very recently, the country was almost completely dependent on foreign ships for import and export of goods to and from the ports. Since 1976 E.C, this situation has improved and today about 15% of the freight is transported by national ships. Inview of the minimum requirement of 40% which is set by UNCTAD for national ships to handle own cargo, the country has still a long way in expanding the national shipping capacity.

191. A number of developmental projects with an estimated total cost of birr 438,546,000 are envisaged for implementation during the ongoing Ten-year Perspective Plan. One such project, which results in new national capability, is a small boat assembly, and rapair and maintenance project at Haleb. This poject, with an estimated total cost of birr 69,003,000, is planned to be completed in 1982 E.C.

192. The Ethiopian Marine Transport Authority has two on-the-job-trianing units at Asseb and Massawa established in 1972 E.C. However, the units are not well organized. They are not equipped with the necessary training facilities and there are no permanent professional teachers. The objective of establishing the units in question is to offer orientation and on the job training to fresh technical workers who are graduates from technical schools. Traininig is offered in electrical enegineering, mechanical engineering and port opperation for one to three months by experienced workers of the two ports. The Ethiopian Marine Transport Authority has planned to establish a Marine Transport Training Institute.

193. Communication: The communication sub-sector comprises telecommunications and postal services. The former services are managed and directed by Telecommunication Authority and the later by the Postal Services Organization.

194. In its long history of services, the expansion of telecommunications is not significant. As of end of 1979 E.C., there were only 18 P.A.B.X. and 469 P.M.B.X., as well as 106,151 customers, using 135,281 telephone apparatus. As per the findings of a certain study conducted in 1984 G.C. there were 0.7 telephone lines for every one hundred people in Africa while for Ethiopia it was only 0.23 telephone lines for every one hundred persons, which was slightly below one-third of that of the African Continent's average. This situations revels the extremely low diffusion level of telecommunication services throughout the country's socio-economic activitites.

195. The developmental aspect of telephone could be viewed from replacement of exchangers and from expansion of telephone lines. This include replacing old manual telephone exchangers of 27 towns by automatic exchangers and introducing digital tele-

phones, new telephone lines and radio telephone services in 100 urban villages.

196. The Ethiopian Telecomunication Authority has a trianing institute whose objectives are to train required technical man-power, and acquaint workers with modern telelcomunication technologies and to upgrade the quantity and quality of services. The Institute offers in-service and pre-service training. The in-service training is designed to upgrade the quality of the already employed workers of the Authority. In this type of training, job upgrading courses are offered to administrative workers and telephone operators apart from technicians. The duration of in-service training stretches from one to four weeks. In the case of pre-service training the Institute trains technicians by enrolling graduates from comprehensive high school majoring in electricity and who passed the entrance examination of the institute. Pre-service training lasts for 18 months. In the first 8 months, common courses are offered for those who joinde the institute. After the elapse of these 8 months, those that passed the examination pertaining to common courses are allocated to four different areas engineering, telegraph and telex, radio and transformation, and switching (exchange). Those who properly complete the 18 months course of training are awarded certificate. Currently, the training capacity of the institute is 60 students in its pre-service training programme. The institute has 11 permanent teachers. Since its inception, the institute has no significant problem except lack of foreign exchange to import required facilities. Proposal has been made to the government to upgrade the institute to college level.

197. Concerning postal services, not less than 888 post offices are in operation throughout the country to-date. Nevertheless, in light of the on-going literacy campaigns and of the expansion of the education system which places increased demand on such services, the existing capacity can not be considered adequate enough.

Major_Problems_of_the_Sector

198. The above brief assessment of the sector indicates a number of crucial problems some of which are given below.

a) Apart from the highly limited diffusion of modern transport and communication technologies into the Ethiopian Socio-economic system, the basic institutional infrastructure for a national self-sustained development of such technological capability are either little developed or totaly lacking.

b) There is no S & T department within the Ministry of Transport and Communication that could co-ordinate, plan and

excute and/or supervise scientific and technological activities of the sector. However, the existence of such a department is crucial to synchronize and materialize S & T capability building efforts in the area of transport and communication.

c) There is no unit, let alone, an institution that undertake R&D activities on the problems of transport and communications. The national effort to generate indigenous transport and communication technologies, to adopt and modify imported technologies as well as to upgrade traditional ones is very minimal. The sector is almost totaly dependent upon imports for its requirement of modern technologies.

d) An institution, with capabilities to assess, identify, select, negotiate and transfer economically, socially, ecologically sound technologies as well as to unpackage technology into its components, specifically charged with the task of importing transport and communication technologies is lacking.

e) The sector is relatively better off in technology repair and maintenance capability. The workshops of Ethiopian Airlines, Anbessa Transport, Ethiopian Shipping Lines and Ethiopian Telecommunications Authority are well equipped with necessary repair and mantenance facilities and staffed with required manpower. These workshops need further strengthening and new ones established to ensure self-reliance in this field.

f) The sector has no S & T information and documentaion center for the importation of knowledge, generation of local knowledge and dissemination of foreign and local transport and communication knowledge to potential users. In order to build the necessary capacity to know that technologies exist, where and how to get and use them, that is, to collect document and disseminate information technologies with regard to transportaion and communication it is imperative to establish S & T Information and Documentation Center at the sector level. Besides strengthening the currently available small libraries in different sub-sectors of transport and communication, the establishment of such a center is called for.

H. CONSTRUCTION

199. The construction sector of the economy plays a key role in satisfying a wide range of physical, economic and social needs including the construction of shelter, the development of infrastructure in the form of housing, schools, health centers, roads, streets, bridges, dams and canals, airports and harbors,

factories, water works construction and other important civil works including the task of maintaining them.

200. Construction contributes to the economic development of the country by satisfying some of the development objectives of the country. According to the Ten Year Indicative Plan the estimated investment during 1979-81 E.C. plan period amounts to 522.6 million Birr out of which Birr 152.8 million is allocated for the first phase, Birr 175.1 million for the second phase and Birr 194.7 million for the third phase of the development programme. What is intersting to note is that out of the total investment 53% comes from local sources while the remaining 47% in foreign exchange is expected to be obtained through aid/loans and technical assistance. Most of the investment in foreign exchange is allocated for the purchase of machineries and equipment. However, given the volume of the investment and actitvites of the sector, much has not been done to develop the capability to select, negotiate and transfer of technology. In order to reduce the foreign exchange requirements of imported construction technologies and utilize local materials in the long-run efforts should be exerted to transfer appropriate technologies and adopt locally and produce parts or whole of some of the equipment used for construction works.

201. The sector contributes about 8-12% of the nations's GNP, and it is said that the sector is second to agriculture interms of employment generation in the country. While the direct contribution of the construction sector to the development of the country is significant, it also contributes to the country through backward and forward linkages in which other ancillary industries are established.

202. The construction industry also plays a key role in satisfying a wide range of physical, economic and social needs including the construction of shelter, infrastructure and others. It provides services to differnt economic sectors through the provision of building, transport, water, works constructions and important civil works including the task of maintaining them. Building construction is an important part of the construction sector. Until recently building construction works were in the hands of foreigners and few private nationals. Hence, its activities were scattered and unorganized. It is after the revolution that the building construction sub-sctor is getting importance and its activities are centralized. To this end, the Ethiopian Building Construction Authority was established to coordinate, manage, guide and help building construction works. Presently the Authority has a total regular workforce of nearly 3,800 and deploys an annual wage-labour force of not less than 30,000.

203. The other part of the construction sector is the transport construction and maintenance of rural and interurban roads of

various categories, bridges, the consturction of airports, ports and railway lines. After the revolution, the length of the road network has increased and reached 15,000 kilometers indicating that it has more than doubled the status of pre-revolutionary period. Nevertheless, the average length of all weather roads being only 12.3 kilometers per 100 sq. kms, the level of road development in the country is very low.

204. The third part of the constuction sub-sector is the construction materials sector. Construction materials production plays significant role in the national economic development. This sub-sector is engaged in the production of materials that are useful for building works, transport construction and maintenance. According to a report of the Authority's Planning and Programming Department that of the total Birr. 935.9 million allocated for various construction projects during the last six fisical years (1973-1978) Birr. 734.2 million has been utilized.

205. The Ethiopian Building Construction Authority is not the only entity engaged in building constuction works. However, the available data shows that almost half of the building construction works are done by EBCA.

206. What is striking is that, both local and imported construction materials, goods and tools are now scarce and expensive. Given the large volumes involved transportaion of significant quantities of construction materials for appreciable distances overland would make costs prohibitive and constrain severly construction activity. Decentralized, no.-capital intensive and non-energy intensive domestic supplies of major construction inputs therfore appear to be essential.

207. Eventhough there is a promising tendency in the production of construction materials, it is presently deterioration, because of shortage of material inputs and the usage of out-dated machinery. Thus one of the greatest impediments for the development of the construction machinery and equipment, building and construction materials in the right quantity and quality.

208. According to a report of the Authority's Planning and Programming Department construction materials manufactured by twenty factories have a share of 11% out of the total industrial output at the end of the 1976 E.C. fisical year about 5,960 manpower is engaged in these factories. Besides this, birr 36,659,324 worth of construction materials has been produced by the Ministry of Construction organization in 1976 E.C.

209. The production of construction machinery and building materials require competent trained and skilled manpower. The construction sector in Ethiopia is lacking adequately trained human resource which is the formost leading factor required for

the development of the sector.

210. At present R & D in the sector is conducted only in the area of building materials. The effort to conduct R & D in construction materials started in 1954 with the establishment of the Ethio-Swedish Techmology Institute, the new Building College under the Technology Faculty of Addis Ababa University. The College presently uses this laboratory as a teaching-aid, and it does not conduct any research.

211. The other effort made to strengthen R & D woeks was the establishment of the Highway Road Transport Building Materials Laboratory in 1955. This laboratory concentrated mainly on testing rather than on conducting research on building materials. The laboratory is presently used by the Ethiopian Transport Consturction Authority (ETCA) for testing materials.

212. The only entity that deals with R&D in the sector in general and in building materials in particular is PKG. At present R&D in the sector is conducted only in the production of walling materials, roofing materials, etc. However, the R&D activities of the sector on the production of building materials based on domestic raw materials to reduce dependence on imported materials is far from desired.

213. The successful application of S & T to the development of the sector depends among other things, on the qualitative and quantitative strength of the human resorce available. A complete numerical data regarding S & T manpower in the construction sector is not available in desired form. It seems that thee is a shortage of qulified and trained personnel in the sector. For example the only R & D service department of the sector has a total of 70 workers out of which only 3 are professionals, 2 are laboratory technicians, 11 are machne operators, 8 are administrative workers while the remaining are daily labourers.

214. From this one can infer that the emphasis given to S & T training in the sector is very weak. ETCA is the only organization which offers technical training in the sector. ETCA's training unit at Alemgena, gives some training for transport construction foremen, super intendents, mechanics, roller, loader and grader operators.

215. This suggests that measures have to be taken to devlop the required S & T manpower in the sector to intensively conduct R&D in the sector at the national level.

216. In the rural areas construction offers the opportunity to absorb labour conveniently in the slack agricultural season. Construction capacity in both the formal and informal sectors is at present very limited. There is an obvious need for very rapid expansion of component construction capacity in order to meet the

vastly expanded needs of planned development at affordable costs.

Major problems of the sector

217. The Problems of the construction sector are many in number and complex in nature. The following are some of the main problems:-

a. Both local & imported construction materials are now scarce and expensive.

b. Its employment creating opportunity appear to be limited when compared to its size of investments.

c. There is lack of adequate domestic production of good quality hand-tools, materials as well as absence of managerial and administrative tradition in labour intensive and construction methods.

d. Construction capacity in both the formal and informal sectors is at present very limited.

e. S & T activities in general and R & D in particular are very weak and limited.

f. Trained manpower in the construction sector is extremely limited.

g. Inadequate attention given to the improvement and development of traditional construction technology.

h. Contribution of the sector in the dissemination of improved construction technology, standards and materials used is low.

I. HOUSING_AND_URBAN_DEVELOPMENT

218. The housing and urban development sector of the economy plays an important role in social, economic and political fields and has important inputs on productivity, social welfare, justice and peace.

219. In Ethiopia urbanization is a recent phenomenon and it is at a very low level compared to many devloping countries. Despite the fact that the level of urbanization in the country has been very low, the urban population has been growing rapidly. Inspite of the low level of urbanization in tge country, the urban growth rate of almost 4% per annum is considered to be among the highest in the world. If the current growth rate continues for the

coming one or two decades, the urban population of the country will double in about 13-15 years. The task of accomodating this unprecedented increase in the number of urban population and providing the necessary services poses a mojar challenge for national development.

220. What is striking is that most of the urban areas in the country are established without any sort of plans. According to the Ministry of Urban Development and Housing (MUDH) at present there are 325 towns in Ethiopia with 2,000 or more inhabitants. Of these towns 168 have topographic plans, 155 have detailed plans. The total population of these towns is estimated to be 4.3 million. In pre-revolution Ethiopia, there were only 97 towns with plans. From this one can easly see that the MUDH is making a head way as far as twon planning is concerned. The absence of twon planning has made the development of most towns handicapped whereby the residential areas, industrial sites, institutional office sites, etc., are established spontaneously. This calls for building the capability of town planning, preparation of topogranic, master and detailed plans of towns inorder to guide the development of these towns in a planned way.

221. At present, few towns provide the necessary services for their dwellers. For instance according to MUDH study only 6% of the urban areas have an adequate pipe water supply, and 60% have no access to reliable and protected water supply. Hence, the population in the latter towns get water from wells and springs which would create health problems. In Addis Ababa, 92.3% of the population gets water form pipies, 3.1% form protected wells and springs, 2.3% from unprotected wells and springs, and less than 1% from rivers and lakes. Of the 92.3% of the population who gets water from pipes, 52% have their own pipe borne water in their compounds while the remaining get from public taps (bono) or from private pipes.

222. Another important part of the sector is housing both in the urban and rural areas which is the most crucial and glaring problm in the country. Housing is important to development in both economic and welfare terms. Housing has substantial social benefits, including the welfare effects of shelter form the elements, sanitation facilities and access to health and education services. The importance of housing needs, however, stands in contrast to the immense housing needs in the urban areas.

223. During 1975/76-1980/81 about 30,275 dwellings with an average annual rate of about 6,055 dwellings were constructed in the major urban areas of the country. Otut of this about 54% was constructed in Addis Abab and its surrounding towns with an annual rate of about 3,300. However, the annual estimated demand for housing in urban areas is about 77,600 and this is by far greater than the current actual capacity which is about 5,046 houses per annum. Therefore, it seems very difficult to meetn

the housing demands of urban aeas with the present construction capacity in the country.

224. Despite this wide gap between the country, many efforts have been done to ease the housing problem in the urban areas of the country. Among the efforts made are the establishment, promotion in strengthening of housing cooperatives and setting up new organizations and enterprises under the auspices ot the MUDH to ease the supply of housing construction materials whcih are at present in short supply and rapidly escalating costs, and the process and procedure of construction itself.

225. In order to tackle the housing problem through the formation of cooperatives, the MUDH have organized 321 cooperatives with a membership of 9,854 at different levels of cooperatives during 1977 to 1986. The MUDH has also distributed a total of 93,068,514 sq. meters of urban land to individuals, cooperatives and organizations in the same period; of which 58.1% has been in Addis Ababa.

226. Another important attempt made by the MUDH is the setting up of new organizations and enterprises to tackle the housing problem in urban areas. These are the Urban Housing Construction Enterprise (HUCE) whose responsibility is to construct dwelling units for housing cooperatives and individuals. The other is the Construction Materials Supply Enterprise (CMSE) whose main duty is to produce or buy as the case may be construction materials for dwelling houses particularly housing cooperatives. Recently the National Urban Planning Institute (UNPI) is also established as an autonomous entity. The main objectives of te institue are to prepare and implement town plans such as topographic, master and detailed plans, to conduct socio-economic research in urban areas and to train the required manpower in the field of town planning. At present the institute is in the process of establishing and organizing itself.

227. Despite the above efforts made by the MUDH and related organizations including the private sector to ease and alleviate the housing problem in the country, the problem has been further aggravated by the fact that the cost of consturction housing units in most of the urban areas of the country has been doubled. Housing development programme without a sound basis of building materials is difficult to realize. Building materials in the country are hardly adequate to meet the presnt requiremens, especially in the supply of cement, timber, glass plate and steel bar all of which account a larger share in the construction of a housing unit. This shortage of construction materials coupled with the rise in price is reponsible for the increase in the cost of housing construction. For example, the cost of housing construction has increased from Birr 250 to Birr 460 for a hollow block house and Birr 250 to Birr 500 for brick house.

228. Both indigenous and imported components of housing and other building construction as well as of all infrastructure of urban areas have rapidly escalated recently. The escalation of costs is also affecting maintenance and repair of building and facilities already in place, on the other hand the number of urban dwellers is rising very rapidly. The choice of the technology mix that would serve for meeting the needs at affordable costs will play crucial role in urbanization development in Ethiopia.

229. The problem of the rural housing situation is not as bad as that of the urban areas. The major objectives of the country is to increase as rapidly as possible the stock of housing units in both urban and rural areas of the country to keep pace with the satisfaction of the minimum basic needs for shelter. The effort in the rural areas is, therefore, to upgrade the existing structures with improving the standard of living of the rural population by providing basic services such as roads, water and sewarage, communication facilities, education, health, transport, etc. The major issue related with rural housing is a fast depletion of forest resources for construction of rural housing units and for firewood and charcoal production. This extensive use of traditional construction material, wood, has led to environmental, ecological and deforestation problems. Therefore, efforts have to be made to undertake community afforestation programmes and substitute this scarce resource with new and appropriate construction materials which can easily be handled and is abailable to the rural population.

230. Although there are no adequate information on R & D works underatken in the sector, there are limited efforts made on building materials, the design of foundation and roofing of housing units, and relatively cheap form of disposal have been carried out by the Faculty of Technology of AAU, the Ministry of Construction and Water Resources Development Commission. There are also minor R & D activities carried out here and there by different institutions without sufficient and complete results. Among these the effort made by the Building College is important. The other effort made by the MUDH is the creation of an institution to conduct R & D activities by establishing Housing Research Service Department in the head office. As experience shows, research in the MUDH is quite a new venture. Although a considerable amount of preliminary work in the area of quantity survey and the like has already been done, proper R & D activities have been perfomed in a scattered and in uncoordinated manner by different institutions, deparments and units. As indicated earlier little progress is made to generate efficient and effective indigenous technologies that fit the available material and human resoruces in recent years, especially in low cost housing construction. There is no centrally organized, effective and comprehensive institution responsible to support,

carry out and excute R & D activities in the sector.

231. It is surprising to note that finance allocated for S & T activities in the urban development and housing sector is low. For example in 1977-78 out of the total investment of 293,309,000 birr for the sector only birr 125,000 has been allocated for undertaking an R & D project entitled MUDH/REX COOP, which is a joint project undertaken with the Government of France. Even if one looks at the amount of finance allocated for housing construction, it is clear that the allocation is low. For example, the UN recommends that member countries should spend at least 6% of their GNP for housing constuction. In Ethiopia however, up to recent years only 2.6% of the GNP was allocated for housing construction.

232. The successful application of S & T to the development of the sector depends among other things on the qualitative and quantitative strength of the human resource available. It seems that there is a shortage of qualified and trained personnel in the sector. For example out of the 277 professional manpower available in the head office of MUDH 7 have second degrees and 107 have first degrees while the remaining are sub-professionals. This indicates that most of the works are performed by sub-professionals. In order to overcome this shortage of qualified manpower the sector should make efforts to develop the human resources both in quantity and quality.

233. As in the other sectors the housing and urban development S&T activities in general leave much to be desired.

Major problems of the sector.

234. From the bref assessment of the overall housing urban devlopment sector a number of crucial problems can be identified. These problems, among others include the following:-

a) Shortage of cheap and durable building materials for constructing low-cost housing.

b) Appropriate building technologies for mass construction of housing are not available.

c) Most urban centers do not have adequate and safe water supply.

d) The supply of energy is unreliable and/or expensive.

e) Transport and communication facilities between and within urban centers are inadequate and inefficient.

f) Lack of careful study of the socio-economic and cultural aspects of urban development.

g) Inadequate R & D activities in housing and urban development problems and lack of trained manpower in town planning and urbanization.

h) Underdevelopment of essential urban institutional resources commensurate with the urbanization rate.

i) Impact of the under developed socio-economic structure on urbanization.

J. Health and Population Planning

235. Health is one of the central components that determines the level of socio-economic development. Good health results in higher productivity and therefore, higher level of development.

236. A key factor in the mass health problems is the demographic profile of Ethiopia where 25 percent are under five years and 45 per cent are under 15 years of age. In this profile obviously dominated by growing children and women in the reproductive age group, rapid bodily growth, pregnancy and lactation impose high nutritional requirements. But marginal food production and high post harvest food losses as well as poor knowledge of specific nutritional needs result in under-nutrition and malnutrition. These reduce the body's defence capability against infections leading to high marbiditry and mortality. Also repeated infections lead to mal-nutrition.

237. The leading causes of outpatients morbidity in childern under 5 years are upper respiratory infections, diarrhea, eye infections including trachoma, skin infections, and fevers of unknown origin.

238. Dysenteries/gastro intenstional infections, malaria, helminthiasis, eye disease, including trachoma, venereal diseases, rheumatic pain, malnutrition, upper respiratory tract infection and tuberculosis are leading causes of adult morbidity. Communicable diseases are still a major concern. The high prevalence of worm and other intestinal infections reflects poor sanitary facilities, and education and the fact that protected water supplies are available to only 4% of the population. Vector born diseases such as malaria and schistosomiasis are likely to become of increasing importance as irrigation and resettlement schemes expand.

239. As there is no effective registration system, mortality data are unreliable. Therefore only very approximate estimates of mortality rates are possible. According to 1984 census, an infant mortality rate of 142/1000, with regional variation ranging 117-171 has been estimated. Life expectancy at birth is estimated to about 47 years.

240. A crude birth rate of 46.0 and a crude death rate of 18.1/1000 have been estimated resulting in a population growth rate of 2.8% per year. If such rate of growth is sustained for the future, it will take only 25 years for the population to double or to reach about 84 million. Such exponential increase in population growth will have wide-ranging implications on the demand for food, energy, and social services.

241. In order to check the population explosion, strengthening and expanding of family planning services is essential. Family planning services were first provided in Ethiopia in 1963 in Addis Ababa by a few private physicians. In 1966 the Family Guidance Associations of Ethiopia, which is largely supported by International Planned Parented Federation was established. Provision of family planning services in health institutions run by Ministry of Health and other agencies began in 1979. By the end of 1984 family planning services were available to 365 health facilities. In total only 18% of health facilities offer family planning services. This limited coverage especially in rural areas is attributed to shortage of contraceptives, shortage of training facilities, (less than 60 paramedical/nursing staff are currently trained in family planning each year), weakness of mother and child health services into which family planning activities are integrated, and insufficient awareness on the part of users especially rural communities.

242. Recent data on the magnitude and distribution of malnutrition among population groups in Ethiopia are scare and except for a number of quick nutrition assessments undertaken by NGOS in areas for relief during the 1984/85 drought. Available data for urban areas are limited to preschool children. No comprehensive information is available on the nutritional status of the other high-risk population, pregnant and lactating women, although low birth weight, which indicated poor nutrition of pregnant women, appears to be a serious problem.

243. Estimates of the degree of malnutrition among preschool children by a region and for different year indicate that the weight of around one-third of the children fail below 80% of standard weights for the particular ages (ENI, 1985). Thus it appears that at least 30% of the preschool children in urban and semiurban areas are affected by serious growth retardation. What ever scraps of data there are on the rural sector, suggest a worse situation than in urban areas (MOH, 1985). Infant and child mortality offers another indicator of malnutrition and poor

health. The infant mortality rate was estimated to be 142 live births in Ethiopia for 1984 while the mortality rate for preschool children (below 5 years of age) was estimated 236 (ENI, 1987). Given those high mortality rates, 50% of all deaths in Ethiopia occur in children below the age of 5 years. The infant mortality rate is considerable higher in rural than urban areas.

244. Before the Revolution, the distribution of health services favoured three privileged cities which absorbed most of the country's health manpower and 47% of the health budget. Total coverage was no more than 15-20% of the population. Since the Revolution, the Government has supported primary health care as a strategy for health for all by 2,000 year. Health policy gives priority to the development of rural health services to the prevention and control of the most common cause of mortality and morbidity.

245. Despite the priority accorded to rural health services development, the coverage of modern health services remains extremely low and the urban and teritary (specialist) care bias of health facilities continues, reflecting the pattern of health infrastructure inherited from the former regime and severe financial resource contraints since then.

246. As of 1983/84, the total number of hospitals in Ethiopia was 86, health centers 139 and health stations 2149. During the same period the population per hospital bed was 3735 a very unfavourable ratio compared to other African countries (Kenya, 620, Tanzania 500 per bed in 1982).

247. The key health care providers in Ethiopia are doctors, nurses and health assistants. Existing facilities are severly understaffed in all categories. With a total of 547 doctors of all types in Ethiopia in January 1985, the population per doctor ratio was 76,700. Of 857 posts for general practitioners in the government health service, in May 1984, only 230 were filled, 80% of these doctors were expatriates. The shortfall is greatest at regional hospitals, where only 50 out of 338 doctor posts were filled (1984). The output of doctors has risen from 50 in 1983 to about 120 per annum now from two medical schools at Addis Ababa and Gonder and 100-120 students from Jimma Health Institute which was opened in 1984. However, the increase in the number of doctors do not parallel with other auxillary medical staffs.

248. Four nursing schools are currently in operation, two new schools are proposed under the Ten Year Perspective Plan. Of nearly 4,000 posts for nurses in existing facilities, about 2,000 remained unfilled as of Janurary 1985. The shortages are fairly evenly distributed across the tiers of health services. As with doctors, training staff and equipment are in short supply, and attrition rates high among graduates.

249. Ethiopia had its own traditional methods for combating diseases. Though traditional medicine is extremely important in Ethiopia and more than 80% of the people depend solely on it for their health care, many of the medical herbes are virtually unknown and much work awaits taxonomists, chemists, phermacologi-sts and medical doctors. Traditional Ethiopian medicine is not

scientifically modernized and integrated into the general network of modern health services. The possible reasons may be:

- The majority of the traditional medicine practioners do not share their knowledge;

- The attitude of health professionals to modernize traditional medicine scientifically is poor.

250. There are about 5000 traditional medicine practitioners which have been registered with Ministry of Health (1985). The Co-ordinating Office for Traditional Medicine, which is an outcome of the struggle of traditional healers for the establish-ment of their own nation-wide association, is now trying to establish criteria for registering and organizing the genuine traditional healers under a national association, collecting samples of traditional remedies and beginning research on their medicinal properties. There is one mass organization of traditi-onal healers known as 'The National Ethiopian Traditional Medicine Practitioners'. The organization is not under the Ministry of Health and does not carry out research activities. The Government recognizes the need to integrate the traditional system of care with modern services provided at the village level, but little progress has so far been made.

251. The need for drugs in a typically developing country like Ethiopia is great because of inadequate preventive health measures and insanitary living conditions. Therefore, drugs provide the main prophylactic and curative support against diseases. As a consequence, a large share of the meagre health budget is committed to durgs.

252. In Ethiopia the demand for human pharmaceuticals and medical supplies is met by three sectors i.e Government, Private and NGOS (RRC, Red Cross, Missioneries). Although there is no reliable data, the total annual supply of pharmaceuticals and medical supplies is estimated to be about 90 million birr. Out of this approximately 80% is supplied by government sector, 15% by the private sector and 5% by NGOS. Of the total value supplies by the government sector (72 million) about 45 million birr (62.5%) is imported from abroad the remaining 27 million birr (37.5%) is produced locally (MOH, 1987).

253. Pharmaceutical production started in Ethiopia in 1965. At present the only pharmaceutical formulation plant in the country

is the Ethiopian Pharmaceuticals Manufacturing (EPHARM). The plant has two units operating in two locations about two kilometers apart. The main unit is involved in the formulation of tablets, injectables, syrups and ointments. The second unit produce oral rehydration salt (ORS) and capsules. EPHARM has a total work force of 430 out of which 40 are technical staff. The production range of the plant is quite diverse, the factory has the know-how to formulate 130 items, but the current production range comprises of 85 items. The output of the plant represents about 30% in value of the total volume of drug supplies in the country (MOH, 1987).

254. EPHARM is heavily dependent on imported products and technologies. It uses imported raw and packaging materials. It is only with research and development backing that the pharmaceutical industry can grow properly, imported technology can be assimilated and new technology developed. However, there is no research and development unit in EPHARM. Regarding quality control of pharmaceuticals, EPHARM has a small quality control laboratory equipped for chemical assay and sterility testing which serve to control the quality of raw materials, intermediate and finished products. Assistance is also provided by the National Research Institute of Health.

255. In 1976 the Government established the Ethiopian Pharmaceutical and Medical Supplies Corporation (EPHARMECOR) with the ultimate objective that it would take over the import, manufacture and distribution of human pharmaceuticals and medical supplies for both the public and private sectors. However, at present both the private and public sectors independently import and distribute pharmaceuticals. Therefore significant economics of scale yet not be realize by fully utilizing EPHARMECOR's capacity i.e a system of centralized procurement. All public sector needs are met through the distribution channels of EPHARMECOR, which has a central store in Addis Ababa and five regional distribution centers. Weak procurement management frequently leads to stock shortages and adhoc procurement at higher cost. Budget are so limited that most rural facilities have inadequate supplies. Many facilities order expensive drugs which are not priority items from an epidemiological stand point, this also contributes to supply shortages.

256. Preventive medicine requires vaccines. Research into the production of vaccines that are more appropriate for the country and for their saftey testing and distribution is essential. Morevoer, regular potency control of vaccines at arrival and after storage in various child immunization centers throughout the country is required. Presently human vaccine production is carried out in Ethiopia only by NHRI. The Institute produces only one type of vaccine, that is antirabies vaccine. Recently vaccine quality control laboratory is opened in NHRI which carry out potency control of vaccines that are imported and locally

produced.

257. Occupational diseases are severe and disabling and affect a considerable number of people. Thus early detection of occupational diseases, chemical and environmental hazards have great importance in taking preventable measures.

258. At present, there are 144 factories in Ethiopia, which are under the supervision of the Ministry of Industry. These factories employ about 80,000 permanent employees. The type of medical care provided to the workers when they become sick varies based on the collective agreement made between the employees in each corporation and enterprise. Out of the 144 factories 92 of them have first aid clinic of their own, which at present run by 41 part time doctors, 4 permanent doctors, 12 health officers, 61 nurses, and 241 health assistants. Out of these, 28 part time doctors, 3 health officers, 16 nurses and 80 health assistants are working in the clinics found in Addis Ababa.

259. The health service provided by the factory clinics is yet very poor, in that the service focuses only on examination and treatment of cases. It doesnot include health education, family planning, immunization, preplacement medical examination and periodical medical checkup.

260. However, there are no activities or measure taken yet and no researches are done on chemical and environmental pollutants in Ethiopia in order to determine the exposure limit and nature of occupational hazards. The Occupational Health and Safety Unit of the Ministry of Industry now submits a project titled as "Organization of an Occupational Health and Safety for the Industrial Workers of Ethiopia". The development objective of the project being to promote and maintain the highest level of health among the industrial workers of Ethiopia by establishing regional occupational health and safety units in the country. Generally promoting, expanding and strengthening of occupational health and safety activities together with the scheme of the general health services, through the primary health care approach which is designed for the attainment of "Health for All by the Year 2000", is not worked out.

261. Although health research activities have been carried on in the establishments such as Ethiopian Nutrition Institute, the National Health Research Institute, the Institute of Pathobiology, the Medical Faculties and School of Pharmacy as major and part of their major activities, health research activities has been actively promoted with the establishment of the Ethiopian Science and Technology Commission in 1975. As the result of such promotional activities there is increased number of health problems addressed, greater number of national involved and wider international collaboration and cooperation. Major sources of technical and material support has come from the Swedish Agenc-

ies, SAREC and SIDA and the WHO. However, the achievements in terms of published information has been limited. Likewise, the utilization of published research information in health system development has remained limited. There are several projects in various stages of development and implementation. In the area of tropical diseases research project in the six diseases are in progress. An exciting series of studies offer unique design options in health and health systems research.

262. Major areas of nutritional research have been the establishment of the prevalence vitamin A and iodine deficiencies. But nutritional research activities have been overshadowed by the occurance of recurrent drought and famine. Considerable experience in public health nutrition and nutrition extension work has been attained during emergency feeding and nutrition rehabilitation activities which may serve as useful starting points for future research and development activities in health and nutrition.

263. Maternal and child health has continued as a topic for several research projects. A community based maternal mortality survey using a retrospective design was completed and published. In the area of health service research the geography of disease in Ethiopia and the study of the mechanism for drug distribution at community level have been completed and await processing and publication. The utilization of ORS (oral rehydration salt) and the mechanism for its distribution at community level have been studied and await analysis. The prevalence of infections with various types of hepatities viruses have been studied and the results published.

264. Traditionally, research has been undertaken in institutions of higher learning where academicians have regularily recieved recognition in terms of promotion and the renumeration whereas the work of scientists in research institutions remains generally unrecognized. This lack of incentive for scientists in research institutions is responsible for the low output of research and relatively high turnover of personnel.

265. All health research and development activities require adequate financing. In Ethiopia the volume of financial resources devoted generally to the health research and development is estimated about 2.5% of the national health budget, most of which has come as foreign and international contribution. For example, from the ENI's 1985/86 budget the contribution of Ethiopian government was Birr 1,049,333.33 while the contribution of international organizations such as SIDA and UNICEF was Birr 1,292,107.19. In the case of NHRI, apart from the subsidy given by the government and other donor agencies, diagnostic laboratory service is the main source of income to support the various activities of the Institute. Funds and R&D activities do not always match and their continuity is not promising. Research

projects in some instances are discontinued for lack of funds and unutilized research funds are returned to the government.

266. Research, training and service are not integrated. The results of R&D activities are not often reflected in the objectives, strategies and contents of instructions of health professionals. The research institutions seldom participate in the formal and informal training activities of health professions. Besides there is no clear coordination among the health research institutions. This makes a duplication of effort at the expense of the available meagre resources.

267. The research information gathered so far is sketchy and is not sufficient to generate R&D. Capacity for data acquisition and information retrieval systems are in their infancy. There is only one medical library with 400 periodicals, a significant proportion of the volumes are incomplete from loss in transit. There is only one journal with four issues annually. The low level of information exchange hampers the development of R&D.

268. Medical equipment are important in the delivery of health services and in the promotion of health research activities. Thus proper maintenance and repair service of medical tools is essential. In Ethiopia, the maintenance and repairing capability of medical and hospital equipment is at its infancy stage, and the only responsible body for this purpose is the Techno-Centre (also named The Medical and Hospital Equipment Engineering Service of the Ministry of Health).

269. The Medical and Hospital Equipment Engineering Service (MHEES) is operating under the Ministry of Health, and was established in 1960 at Menelik II Hospital. The Centre has the following objectives:

- To install medical equipment, such as x-ray machines, operation theatre equipment, etc.
- To give training to the technicians who operate the installed medical equipment.
- To provide repair service for medical tools and instruments.
- To provide preventive maintenance service for medical tools and laboratory equipment.
- To prepare general inventory of medical tools available in the hospitals all over Ethiopia.

270. Before 1969 all equipment were installed and maintained by expatriates. But presently 80% of the medical equipment are installed and maintained by the nationals.

271. The maintenance philosophy of the Centre follows has got dual trend. The first trend is to maintain all equipment in the hospitals, while preventive maintenance and short term training are carried through on programmed activity level. Besides the maintenance service the selection of medical technological product and demarcation of specifications along with discrimination of standards for medical and hospital equipment on hospital level is also carried by the Centre.

272. Inorder to fulfill its objectives at present the Centre has 75 electronic, electrical and mechanical equipment, 27 technicians, 30 administrative staffs and a budget of 25,000 per annum.

Major Problem of the Sector

273. The brief assessment of the health and population sector indicates that this sector is beset with a variety of S&T problems. Among the major problems the following can be identified.

a. Inadequate R&D infrastructure due to lack of defined health research policy which determines the nature, area and coordination of health research effort.

b. Lack of proper regulation and guidelines in the transfer of technologies.

c. Lack of qualified and experienced S&T manpower.

d. Lack of proper attention given to develop and improve traditional medicine and technologies to get the best out of them.

e. Limited access to scientific and technological information.

f. High dependency on import regarding pharmaceuticals, medical supplies and equipment.

g. High population growth rate with excessive demand on limited health services.

h. Insufficient and inappropriate funding for health research activities.

i. Lack of capacity to improve, maintain and handle the existing health technologies and to use them more productively.

j. Lack of proper attention given to Occupational Health and Safety activities.

k. Widespread problems associated with communicable parasitic and nutritional deficiency diseases.

l. Inadequate and in most cases absolute lack of modern health services to the vast majority of the population.

m. Inadequate attention to the survey and evaluation of most common communicable diseases and lack of sufficient R&D effort to control them.

n. Absence of S&T policy of the sector and priorities of research.

o. Lack of emphasis on primary health care related R&D activities.

K. Social Sciences

274. The social and human sciences are here taken to mean all disciplines concerned with what is specifically human, in its social and cultural aspects, including economics, law, demography, sociology, linguistics, ethno-anthropology, psychology, education, administration, management, political sciences, history, human geography and philosophy. The importance of social sciences in understanding the functions of human societies, their traditions, cultural values, aspirations, etc has never been given its due recognition in Ethiopia. Social scientists were not given the encouragement, opportunity and the support they need to identify land marks in the country's history, civilization, collective identity, education and philosophy. They were not duly consulted in the past on matters of national ideologies.

275. The assistance of social sciences concerning social engineering was not sought in the past by policy makers and development planners. Demography, psychology, economics, anthropology, geography and the education sciences were not called upon as frequently as needed to guide development decisions and provide impact studies. The need for policies to be socially and economically profitable and administratively feasible was not that much appreciated. Nobody bothered to ask questions such as in what way and to what extent can the social sciences affect choices regarding research to be undertaken in the life sciences, the physical sciences and technology and optimize its results? What are the chances of certain technolog-

ies being accepted and assimilated by the people for which they are intended? What are the probable economic and social impacts of these technologies? Such vital questions which should have been carefully studied and evaluated by the social scientists are simply ignored and not given due attention. The idea of steering technology in a direction that is compatible with the current social, economic, and technical imperatives of the local people rather than with the internal logic of the technology concerned has not yet received due recognition and appreciation.

276. In short the contribution of the social sciences in understanding the dynamics of socio-economic development hasyet to be realized by all concerned. Relevant questions such as, how could the social sciences contribute to the understanding of a social environment conducive to creativity in the field of science and technology? How could the social sciences help to guide the choice of research options and to rationalize that choice for development purposes? What are the social implications of the choice of certain technological options? What impact might social science research have on programs of technological research in, for example, animal husbandary, agronomy, small--scale agricultural engineering, food processing or housing? Have reforms ever been thought along the line of incorporating the social dimension of development into science and technology education? Are social science specialists involved in science and technology programs from the outset should be asked and adequately dealt with.

277. However, inspite of the general malaise described above, limited activities have been going on in the sector. Some research projects, mostly initiated by and based on the interests of individuals, have been supported and as a consquence results produced. The Addis Ababa University, the Ministry of Labour and Social Affairs and the Ministry of Culture and Sports were and are among the various government organizations involved in carrying out essential social science research. Examples of what has been performed by these organizations is given below.

278. The Institute of Development Research established in 1971 under the Addis Ababa University, is responsible for:-

- undertaking, promoting and coordinating research on Ethiopia's development problems,

- preparing social science teaching materials utilizing research results,

- providing consultancy services, in its areas of specialization, to governmental and other organizations, and

- preparing research projects and securing funds from local and foreign sources.

Its functional organizational structure consists of

- Demography Training and Research Unit,
- Food and Famine Research Unit, and
- Development Research Unit.

279. Since its inception, the Institute has been actively engaged in various research undertakings. In 1973, for example a total of three studies were completed: Wonji Socio Economic Survey, Food for Work Reforestation Program in Tigre and Wello provinces and Analysis and Evaluation of Faked Trade Declaration. Three more studies were carried out in 1975. The Agaro-Chiva Feeder Road Survey was a baseline socio-economic survey which was intended to provide a comprehensive background information against which future impact of the new road could be measured. The Social-Behavioural Survey of Entoto, Addis Alem and Lemamie was carried out to obtain baseline characterstics or urban, semi-urban and rural households in the three areas with respect to literacy, health, demography and nutrition. The Ada Baseline Survey was conducted to establish a data base on conditions of current agricultural practices and production, demographic characterstics, levels of living (in terms of housing, health, education etc...), land use intensity and efficiency, agrarian structure, the diversity and use of area infrastructures and spatial aspects of both cultural and physical phenomena. During the 1976-1983 the research work of the Institute concentrated on important national problems: diffusion of agricultural innovations, nomads in transition, economic effects of Ethiopia's exchange rate policy, rural health and health education, famine in rural Ethiopia and rural vulnerability to famine, functional role of periodic markets in economic development, agrarian reform, planning and management of education with evolving pattern in rural development and socio-economic factors related to rural water use. A total of four research works were completed in 1984, and these were:-

- Agricultural marketing and pricing policies in Ethiopia
- Factors which affect peasant motivation in Ethiopian Agricultural Producers, Cooperatives,
- Cooperatives and national development, and
- Sociological considerations in preparing a development strategy for the Ethiopian highlands.

280. The Institute of Development Research has a total of twenty seven employees of which sixteen (5 Ph.D's and 11 M.A's) work in research and teaching. Some of its personnel who were sent abroad for further education and training have not returned, as a result of which the Institute was unable to fulfil its objectives. Others have left the Institute due to unimpressive salary scales and lack of conducive working conditions, per diem for example.

281. The Institute of Ethiopian Studies establihsed in 1963 by the Addis Ababa University, has the functions of conducting and coordinating research in the areas of Ethiopian history, languages and culture. It carries its duties and responsibilities through three bodies: the Ethiopian Studies Library, the Ethiopian Ethnography Museum and the Research Unit. The total number of manpower of the Institute is twenty two: 3 Ph.D's and 6 Ph.D candidates, 3 M.A's and 2 M.A candidates, 2 B.A's, and 6 Diploma holders. Of these, eleven are fully involved in research work. Both professional and sub-professional staff are scheduled for education and training within and outside of the country. The fields of training at present being anthropology, ethnology and musiology.

282. The Ethiopian Studies Library, its collections being one of the best and extensive, renders services to both researchers and students interested in Ethiopian studies. The Research Unit, however, has continued to assume a low profile because the number of Ethiopian researchers was too small to come up with variety and number of research projects expected of it. On the other hand, the Unit was able to participate in international conferences, symposia and workshops and to the Ethiopian Studies Center transferred to Ethiopia.

283. The Institute of Educational Research was established in 1967 with the following objectives:-

- to undertake and coordinate research about Ethiopian education,
- to collect research publications on education,
- to publish educational journals, and
- to organize educational workshops symposia, conference, etc., concerning Ethiopian educational problems.

Despite its wideranging and important objectives the Institute was almost non-functional for some time, due to lack of trained manpower, finance and other material requirements. Moreover its organizational structure and its functions were not clearly defined, and as a consquence it had to stop its activities for

some time. It was only in 1982 that the Institute was revitalized and given a new mandate for a new and active participation.

284. The present manpower situation of the Institute is not good. Of a total of nine employees, only three are directly involved in research, while its present minimum requirement is five (3 with Ph.D and/or M.A and 2 with first degree qualifications). Even if it were to get additional manpower the salaries are not attractive to get the highly qualitative persons.

285. The Institute's research performance are not yet available. However, it is involved in the preparation of series of lectures in the provision of guidance and counselling services to individuals and organizations and in supporting researchers. This in no way is a right profile for research institute and so fast and positive actions have to be taken to make the Institute really functional.

286. Since the eruption of the Revolution, the Ministry of Education, through innovation, adaptation and/or adaption, has produced new curricula, new textbooks and other additional teaching-learning materials new educational infrastructures and new strategies and methods of training and educating students. Through its empirical research efforts it has attempted to define the characterstics of the Ethiopian learner, to develop monitoring and evaluation mechanisms, to initiate methods for teaching adult participants in literacy programs, and to devise a system of production and distribution of educational materials and equipment. Furthermore it had made a thorough study to determine the parameters against which existing quality of education must be compared.

287. It cannot be said that the Ministry of Education has constraints in the provision of manpower and finances for S&T development in general and for R&D activities in particular. The Curriculum Department, in which most R&D activities are carried out, has notbe inhibited to undertake innovative projects by lack of finance, manpower, equipment or other materials. The same can be said for Mass Media, Adult Education and Technical and Vocational-Education programs.

288. The training of manpower inside and outside of the country is adequately cared for. There are regular training programs, developed by the German Democratic Republic, in which Ethiopian educators participate and gain new knowledge and new experience for solving educational problems. The British Council has a number of slots reserved for experts from the Ministry. The Italian Government has initiated training programs for technical - vocational personnel. International organizations such as UNESCO provide of a variety of training opportunities in different fields such as planning, monitoring and evaluation and

research methods. Indeed the training of manpower in the Ministry of Education is well planned and well-implemented.

289. The Academy of Ethiopian Languages under the Ministry of Culture and Sports has carried out various linguistic and socio-linguistic research. Most projects have been completed, while some others are still underway. A project on orthography and contrastive analysis of two Ethiopian languages (Gedio and Amharic) has been completed, and as a result alphabets for many Ethiopian languages (Silti, Sidama, Afar, Saho, Kefa-Mocha, Arsi, Gumz and Anwak) have been developed. An on-going project - socio - linguistic survey - is expected to help assess the nature of bilingualism, the language use and attitude of the people as well as the degree of intelligibility (mutual understanding) within the related languages.

290. With respect to oral tradition, the Ministry of Culture and Sport is at present carrying out a study on oral literature of eight Ethiopian languages-Amharic, Oromigna, Tigrigna, Wolaitigna, Sidamagna, Haderigna, Gedeogna and Kembatigna. It has also taken steps to preserve the rich cultural heritage contained in oral traditions through documentation and dissemination of such elements.

291. Monolingual dictionaries are in the process of praparation for five languages - Amharic, Oromigna, Tigrigna, Wolaitigna and Sidamigna. The Ministry in cooperation with the Workers Party of Ethiopia has produced a Marxist-Leninist terms dictionary.

292. The Academy of Ethiopian Languages in collaboration with the Addis Ababa University and the Ethiopian Science and Technology Commission has taken the responsibility of translating scientific and technical terms into Amharic. So far more than 15,000 foreign terms have found their equivalents in Amharic. The diciplines included in the project are biology, chemistry, physics, mathematics, statistics, geology, technology, medicine and pharmacy, nutrition and agriculture.

293. Various geological, paleontological and paleo-anthropological studies were initiated in cooperation with foreign researchers. Some of these are:

- the geological, paleontological and paleo-anthropological studies in Gamo Gofa and Lower Omo Basin,
- human origins and paleo environments in the Afar inhibited areas of Harar and Wollo,
- archeological survey in the Adna - Yeha area,
- paleontological research in Wollo, Shoa and Harrarge,

- a tudy of human origins and paleo-environments in Awash Valley, and
- excavation of artifacts in Melka Kunture.

294. Information on the manpower and financial situations was not available. However, the variety of research activities and their work progress indicate that they must be well staffed and well funded.

295. Since the Ethiopian Revolution the Ministry of Social Affairs, specially it's Employment and Manpower Research Division is actively conducting studies dealing with employment and manpower, examples of which are:-

- Ethiopian Classification of Occupations:- is a dictionary whose purpose is to define regular classification of fields of work in order to facilitate professional training and manpower studies. It was completed in 1978.

- Registration of the unemployed population:- only 35 towns selected with respect to the economic activity. The number of unemployed people in these towns and the kind of work they were looking for was studied and compiled in 1979. The same study was again carried out, encompassing this time a wider area - 45 towns in the year 1980.

- Employment Survey in Ethiopia:- which was launched in 1981 classifies according to sex and fields of employment, the manpower engaged in private firms which accomodiate fifty or above workers, and governmental organizations.

- The Manpower Implication of Current Development Strategies:- was carried out by the International Development Agency (IDA), and it deals with evaluating the demand and supply of manpower is a special emphasis to the agricultural sector of the Ethiopian economy. The study was completed in 1984.

- The Development of Manpower and Employment Capability in Ethiopia:- this research, which was undertaken by the UNDP in 1984, is intended to enable to predict the demand and supply of manpower in all the economic sectors including an evaluation of Universities as well as employment and manpower in concerned institutes.

296. The Ministry produces two important publications:- The Annual bulletin entitled Labour Statistics Bulletin is a sort of annual report on employment, manpower study and an overall evaluation of workers conditions. The bulletin came into existence in 1978. The Training of Manpower in Ethiopia is another annual publication which has been in print since 1969.

This analyses the manpower trained in various training and technical institutes of the country.

297. The activities described above are quite significant and must have required substantial financial input. However, no definite financial allocation was reported.

298. As a result of lack of recognition and appreciation of the contribution of the social sciences, the financial support and facilities made available to research in this field have never been adequate and quite often irregular which have adversely affected and inhibited the continuity of R&D efforts of the sector.

299. Major Problems of the Sector:- The overall assessment of the social sciences sector reveal certain fundamental problems which require due recognition and appropriate actions for their solutions. Some of these problems include:-

a. Lack of understanding and hence realization of the contribution of the social sciences to national socio-economic development efforts in general and to S&T development in particular.

b. Lack of consideration of the social aspects of technology generation and importation due to not involving social science specialists in science and technology programs form the outset.

c. Lack of adequate support to R&D efforts in social sciences field.

d. Inadequate S&T facilities, research units, finance, and trained manpower in the various fields of social sciences.

e. Unattractive salary scales and working conditions.

L. Natural Sciences

300 The major fields in the natural or basic sciences are biological sciences, earth and space sciences, chemical sciences, physical sciences and mathematics/computer sciences.

301 Natural Sciences research and training is essential for the strengthening of the overall scientific and technological activities of the nation. Development and service activities in the agricultural, medical, industrial, environmental, mineral resources, energy and educational sectors are greatly influenced and enhanced by the outcome of research work and the quality of

training in the natural or basic sciences. The absence of such research or training hinders scientific development and essential service activities in these sectors. Research in natural or basic sciences also helps maintain the vitality of the scientific community which is greatly stimulated by the discovery of new scientific knowledge and understanding through research. The vitality of such a scientific community is essential to the formation of the teams of competent researchers who are able to be engaged in applied research in response to national developmental needs.

MANPOWER

302 The two major local sources of trained natural scientists are:

- Higher education establishments
- Overseas training through scholarships/fellowships

303 The country is far behind fulfilling the number and quality of natural scientists it needs for a steady socio-economic growth and development due to the lack of attention given to the field.

304 The faculty of science of Addis Ababa University was established in 1950. It began offering BSc degree in Biology in 1957. Similar degrees in the remaining major areas of natural science were first offered almost ten years later in 1966. Post-graduate programs were launched in 1978 and all the natural science departments presently offer post-graduate programmes. Since its establishment, Addis Ababa University has graduated 2914 students with a BSc, and 162 students with MSc degree (Table 1).

305 The post-graduate program in some departments needs strengthening in both trained manpower and research facilities. The shortage of adequate teaching laboratories and experienced senior natural scientists are the two major problems faced by most of the departments. The later may be partially solved upon the return of Ethiopians who are currently pursuing PhD programmes in foreign universities.

Table 1. Number of graduates from Addis Ababa University since its establishment.

	BSc	MSc
Biology	807	48
Geology	409	12
Mathematics	614	40
Chemistry	656	36
Physics	428	26

306 The departments of biology and chemistry have launched PhD programmes. Even though there are shortages of staff in most areas of zoology, the department of biology has made considerable progress in acquiring trained staff members in genetics, physiology, medical entomology, medical parasitology, microbiology, fresh water biology and systematic and ecological botany. PhD candidates of the department enroll in Addis Ababa University and a well established foreign University.

307 The Department of Chemistry has acquired the necessary equipment and a few Ethiopian PhD staff to offer a PhD program in four areas of specialization, analytical, inorganic, organic and physical chemistry. PhD candidates of the department spend part of the time in a foreign university to gain different research experiences.

308 Asmara University, which was established as a private catholic institution in 1958, was chartered by the Ethiopian government in 1968 and it came under the Commission for Higher Education in 1979, the year it began offering BSc degree in Biology and Chemistry. The first BSc degree in Physics and Mathematics were awarded five years later in 1985. Since its establishment, the University has trained and graduated 124 biologists, 115 chemists, 68 physicists and 78 mathematicians with a BSc degree. However, the University is in the process of commencing post-graduate studies leading to MSc degree in areas currently offered at under graduate level.

309 Ethiopian natural scientists have also been trained in foreign universities. The number of graduates from foreign universities since 1974 reached 196 at the end of 1987 (Table 2). The record prior to 1974 is largely lacking.

Table 2. Number of graduates from foreign universities since 1974.

	BSc	MSc	PhD	
Biology	-	21	3	- 24
Biochemistry	-	35	-	- 35
Geology	3	44	1	- 48
Mathematics	2	19	2	- 23
Chemistry	-	34	3	- 37
Physics	-	17	2	- 19
Computer science	-	10	-	- 10
	5	140	11	= 196

RESEARCH

310 Besides teaching, the Science Faculty of Addis Ababa University and the Natural Science departments of Asmara University, have developed research capabilities. Research activities in the natural sciences in Ethiopia are by and large carried out only in these two universities.

311 Research work in Natural sciences includes original investigation undertaken in order to gain new scientific knowledge and understanding. It may be "pure basic research" or "oriented basic research", directed towards a field of present or potential scientific economic or social interest.

I. Research In Academic Institutions

312 The research undertakings at Addis Ababa and Asmara University have had two basic aims: to investigate natural phenomenon which are unique to Ethiopia and to solve problems which are barriers to national economic and social development. However, due to the very little attention given to natural science research the capabilities built are very limited. Since natural science activities of the two universities are mainly focused on teaching students the basic principles and fundamental knowledge in these fields, the number and quality of research work is very limited. The teaching and natural science research activity in both universities is also less than 40 years old.

1. Research at Addis Ababa University

313 Until about 1970, the various natural science departments in the faculty of science, Addis Ababa university, were essentially staffed by expatriates on contractual basis. With few exceptions, most academic staff members did not stay more than one or two contractual periods and this did not permit the initiation of long term research projects. Efforts to do so by those who stayed in the country for longer periods were frustrated by the absence of research facilities.

314 During the early seventies a number of Ethiopians returned from abroad with Msc and PhD degrees and made attempts to start research programs. The university had also established an office for Associate Vice President for Research and Publications. Even thus, Ethiopian scientists were faced with the most difficult task of developing research programs in a country which did not have any culture or tradition in modern scientific research.

315 The launching of post-graduate studies in 1978 provided an opportunity to undertake research projects which are addressed to local problems. At present, two major catagories of research activities are carried out in Universities. This includes post-graduate research, carried out by graduate students as a partial

fulfillment of their post-graduate degree requirement, and departmental research, short or long term research carried out by academic employees of the Universities. Due to the absence of post-graduate program in natural science, post-graduate research has not been conducted at Asmara University in this field. The natural science post-graduate research program at Addis Ababa University has resulted in 122 thesis.

316 Post-graduate research in biology, is mainly focused on biomedical science, aquatic biology and systematic and ecological botany. Research activity in higher vertebrate zoology is largely lacking. The Department of Chemistry focuses its post-graduate research on analytical, organic, inorganic and physical chemistry. Mineralogy and petrology, geomorphology and quaternary geology and applied geology are the main areas of post-graduate research in the Department of Geology. The Departments of Physics and Mathematics are relatively weak in trained manpower and research facility. The few post-graduate research activities in physics are focused on theoretical physics, (particle, plasma and solid state) and experimental physics (characterization of solar cells for energy conversion). The Msc program in mathematics has not yet resulted in a thesis.

317 In addition to post-graduate research academic employees of the different natural science departments of the Science Faculty also conduct long and short term research. They are expected to use 25% of their time for research projects. Currently the following major projects are being carried out in the different natural science departments.

1.1 Department of Biology:

1.1.1 Ethiopian Flora Project:

318 It was started in 1980 in collaboration with the University of Uppsala (Sweden) and with support of the Swedish Agency for Research Cooperation with Developing Countries (SAREC). It is a long term project that will be continued for about 10 years. The objective of the project is to write up a flora (totality of Plants) of Ethiopia, to build a national Herbarium with a Herbarium Library and to promote scientific activities in forestry, taxonomy, ecology and economic botany.

319 It is expected that the write up of the flora will appear in eight volumes and a total of 32 research, review and popular article have already been published in connection with and as a result of the flora work. The project has also made substantial contribution to the growth of the plant collection of the National Herbarium, establishment and growth of a Herbarium Library, and the development of a research capability in plant taxonomy and ecology. So far, three staff members of the Biology Department have completed PhD programs and an additional three

are pursuing a similar program in botany as a result of the training carried out within the project. The plant collections and the library will provide the reference material and scientific information on Ethiopian Flora needed for teaching, research and public education.

1.1.2 Fresh water Fisheries development in Ethiopia.

320 It is a joint project between Addis Ababa University and the University of Waterloo (Canada). The project work began in 1981 with CIDA support and is expected to continue at least until March 31, 1989. The project is expected to:

- provide Msc and PhD level training in limnology and fisheries biology to graduates of AAU, so that they would acquire the necessary theoretical and practical knowledge that would enable them to design, initiate and carry out research and development programs concerning the proper and optimal utilization of the countries fresh water fish resources.
- establish a self sufficient and self propagating school of hydrobiology, limnology and fisheries biology at Addis Ababa University.
- carry out basic and fundamental research and research training on fresh water fisheries biology simultaneously with the academic training program. The row data, and results of the data analysis from the research program would be used in development planning.

1.1.3 Biotechnology project:

321 The research work began in 1984 with SAREC funding. The project aims to:

- produce simple sugars and oligosaccharides from waste cellulosic materials using cellulase obtained from cellulose degrading microorganisms.
- explore ways by which the simple sugars such as glucose produced through enzymatic saccharification of cellulosics could be used as starting material for pharmaceutical purposes.
- use the simple sugars and oligosaccharides for the production of biomass which can serve as protein supplement in feeds and foods.
- use the products of cellulase action as starting material for the production of industrial solvents such as acetone, butanol, isopropanol etc.
- produce ethanol which will serve as fuel supplement or starting material for PVC.

322 The Department of Biology is also planning to launch the Ethiopian Fauna Project. The project will write up a Fauna (totality of animals) of Ethiopia, help build a national zoological collection with zoological library, and promote scienti-

fic activities in wild animal management, taxonomy, ecology and economic-zoology. It will also help train the highly needed man-power to build a research capability in most areas of lower vertebrate and all areas of higher vertebrate zoology. The Flora and Fauna projects will allow effective utilization of the nation's plant and animal resources.

323 A quality collection of Ethiopian Fauna, that is vital to teaching and taxonomic, ecological, and other biological research is currently lacking. The Department of Biology has a small zoological Natural History Museum which houses a small collection (a little more than 3,500 specimens) representing about 1,100 species. Some of the specimens in the collection are unidentified.

324 The museum does not have environmental control and the space is inadequate to even house the currently available small collection. It is also faced with other major problems such as the lack of functional specialists and the shortage of funds to carry out active specimen as well as data collection and research.

325 There is considerable international interest to study both recent and prehistoric Ethiopian Fauna. Well planned and co-ordinated research activity with foreign based researchers would greatly benefit the country interms of research material man-power training and the overall national capability building in biological research. However, some foreign researchers conduct their field work in Ethiopia with non academic government organizations. The participation of local academic or research institutions in such activities is minimal. This is specially true for Palaeontological and Palaeoanthropological researches.

326 Most foreign-led or initiated natural science researches are not well planned or co-ordinated with the activities of Ethiopian academic or research institutions and their merits are not assessed, prior to their initiation, for their usefulness to Ethiopia. In some cases, relevant scientific informations and materials collected by foreign researchers are not passed to Ethiopian academic or research institutions.

1.2 Department of Chemistry:

327 Attempts to initiate research activities were made soon after the initiation of the Bsc training program in the early sixties. These however, were not very successful as it was quite difficult to set up the required infrastructure in a short time. some activities were initiated in the area of analytical chemistry, specially in analysing and documenting the inorganic constituents of Ethiopian rivers and some of the Rift Valley lakes.

328 Research in chemical sciences obtained significant stimuli with the establishment of the Science Center, purchase of major items of capital equipment in the mid seventy's, and the launching of graduate studies in 1977. By this time the Department had acquired a few Ethiopian Ph.D. staff. Major long and short term research activities carried out by the academic staff of the department fall in the following areas:

1.2.1 Organic and Natural Products Chemistry:

329 This is a fairly broad area of research activity and one in which there are presently four Ph.D. level staff and two Ph.D. students. About 20 MSc students. have been or are being trained in this area. The research activities may be broadly described in terms of the following research areas:

1.2.1.1 Investigation of plants of economic and cultural importance. There are a number of plants, which have not been investigated previously, but which are already or potentially of commercial interest. These include several plant species such as the essential oil yielding plants, gum and resin producing plants and medicinal plants that are commonly sold in local markets. Research activity on such plants is of major economic value and helps develop the scientific basis for culturally important plants. Over 150 plants have been screened and a number of plants subjected to detailed phytochemical investigations. Among the essential oil yielding plants Cymbopogon citatus (Tedj sar), Artemisia rehan (Ariti), Trachyspermum copticum (Nech azmud), and a few Ocimum species have been investigated thoroughly. Research on gum and resin producing plants has been started recently and only preliminary data have been generated so far. The recent completion of the manuscripts of the Ethiopian Flora dealing with the important families of Burseraceae (which consists of some of the most important gum and incense producing plant species) and Leguminosae has made it possible to launch investigations on these commercially important plant resources. A number of plants which occupy important positions in traditional herbal medicine have either been investigated or are currently under study. Some of these plants include Taverniera abyssinica (dingetegna), Glinus lotoides (Mettere), Rhamnus prinoides (Gesho), Rumex abyssinicus (Mekmeko), several Kniphofia species, some Erythrina species, several Echinops species.

1.2.1.2 Marine Chemistry. The department has recently initiated a chemical investigation of some sponges from the Red Sea. The project is launched in conjunction with the training of a student from the department of chemistry of Asmara University and is expected to make a contribution to the manpower needs of the recently established marine Research Station in Massawa. Such a study of natural products from marine sources has, during the last 15 years, become the focus of research activity through out the world.

1.2.1.3 Multidisciplinary research. Members of the Department are also involved in a network of international groups of scientists working on the eradication of lathyrism which is a neurotoxicity manifestation caused by a toxin found in the legume Lathyrus sativus (locally known as Guaya). Chromatographic, electrochemical and spectrophotometric methods are being developed for the detection and quantitative determination of the lathyrogenic constituent of this important food legume.

1.2.1.4 Synthetic Organic Chemistry. Research in this area has not been a continuous activity, although results have been obtained in heterocyclic syntheses. The department needs to develop more activities in synthetic organic chemistry in the future.

1.2.2 Electrochemical and Electroanalytical chemistry:

330 The electrochemical field has also been the subject of research by some of the few scientists of the department. The department is regarded as one of the few world centers from which significant contributions have been made in the field of Electrochemistry of Liquid-liquid Interfaces. Research activities in ion-selective electrodes have led to the development of methods for the construction of saccharin sensitive electrodes. Some contributions have also been made to the understanding of detergent sensitive electrodes. Analytical methods have also been developed for the determination of such substances or amino acids, anti-helminthic drugs, gossypol (a toxic substance found in cotton seed).

1.2.3 Analytical Chemistry:

331 Research activities in analytical chemistry have mostly been dealing with the development of spectrophotometric methods for the determination of the commercially important metals such as iron, zinc, nickel and tungsten. These activities have, in some cases, led to the development of analytical methods which are superior to existing methods in the literature. The Department has also been able to conduct analytical work and generate data on the fluoride composition of a variety of environmental and food samples from around thee agro-industrial sites of Wonji and Metahara in the Rift valley.

1.2.4 Other Areas of Research:

332 These include: the application of polymers as pesticide support to promote controlled release of pesticides, the characterization of reforming catalyst and platinum recovery from exhausted catalyst, and hydrochemical investigations of geothermal waters from the Ethiopian Rift Valley.

333 The following organizations have provided funds or other forms of support for the research activities of the department. The Research and Publications Office of the University, SAREC, the International Foundation for Science (IFS, Sweden), UNESCO, DAAD, the Italo-African Institute, WHO, and others.

334 Faculty members of the department have also been involved in the preparation of monographs, text and reference books for teaching materials. Some of these materials are prepared by incorporating indigenous data and with particular attention to make chemistry relevant and understandable to students of the University. These efforts have resulted in the preparation of at least four text books and one laboratory manuals.

335 The department also operates an Analytical Services and Research Unit (ASRU). This unit was established four years ago. Its objective is to provide analytical services to organizations for a modest fee. This unit has so far carried out the analyses of such substances as soap, water and other biological as well as environmental samples.

1.3 Department of Geology

336 The department conducts several research projects that are mainly concerned with economic applications of geology. This includes metalic deposit exploration, oil and gas exploration, building material exploration and studies on soil origin and analysis. The four major on-going projects of the department are:

1.3.1 Study and Evaluation of the Mineral Resources of Sidamo:

337 All staff members of the department participate in this project. It is funded by the Ministry of Foreign Affairs of the Republic of Italy. The project will assess the mineral resources potential of Sidamo and also enhance the research and technical capability of the Geology department.

1.3.2 Geodynamic and Volcanologic Studies Within the Mugherr-Mojo Geotraverse area:

338 The project adresses problems of wide economic and social importance. This includes the research for low-cost building materials, water supplies, soils, and raw materials for ceramics. It also looks into the geodynamic and volcanologic evolution of the NW margin of the Ethiopian Rift Valley. All members of the Geology department participate in this project. The financial support comes from the Ministry of Foreign Affair of the Republic of Italy.

1.3.3 Recent and Active Britle Tectonics in the Ethiopian Rift System:

339 This project analyses the structure of the Rift System. It is expected to produce a detailed structural geologic map of the study area. Three Ethiopian and three Italian geologists from Addis Ababa, Florence, Cosenza, and Cagliari Universities participate in this project The Ministry of Public Education of the Republic of Italy provides the fund.

1.3.4 The Stratigraphy and Sedimentology of the Middle Awash Basin, Ethiopia:

340 This project attempts to undertake detailed work on bio, litho, and chronostratigraphy of the basin and define and model the palaeoenvironmental as well as the palaeogeographical set-up of the study area. Two Japanese and two Ethiopian geologists from Nagoya, Kyoto and Addis Ababa Universities participate in the project. The fund for this project comes from Nagoya and Kyoto Universities, Japan.

341 Two additional projects are under preparation. The first project looks into the geology of the sedimentary basins of Ethiopia with special reference to the generation and accumulation of oil and gas. All staff members of the geology department, Addis Ababa University, and three staff members of the Geology department, University of Windsor, Canada, are expected to participate in this project. The participants aim to:

- determine the stratigraphic and tectonic set-up of the major sedimentary basins of Ethiopia and the relationship between sedimentation and tectonics.
- Elucidate the manner of generation, accumulation and distribution of oil and natural gas in various sediments of the basins. Funding for this project is expected to come from CIDA, and University of Windsor and Addis Ababa University.

The second project under preparation aims to study the relationships between geology and factors of soil formation in selected River Valleys. Four staff members of the department of geology , Addis Ababa University, and three staff members of the geology department, University of Gotebary, Sweden are also expected to participate in this project. Funding is expected to be acquired from SAREC, Gotbarg and Addis Ababa University.

342 In addition to departmental research and training, the geology department also collaborates with government organizations such as the Ethiopian Institute of Geological surveys in applied research and the training of geotechnicians .

1.4 Department Of Physics:

343. Research activity is currently limited to theoretical work in particle, plasma and solid state physics; experimental work in search of materials for energy conversion; and the determination of high temperature super conductors.

344 Funding for these activities is acquired from the International Center for theoretical Physics, Trist (Italy) and the Uppsala University (Sweden) International Grogram for Physical Sciences.

345 Radiation physics, solid state physics and laser physics are future priority research areas of the department.

346 In addition to the teaching and research activities, the department also works with the National Meteorological services Agency, Ethiopian Standard Institute and the Ministry of Mines and Energy in a number of development and service activities.

1.5 Department of Mathematics

347 Due to the excessive teaching work load, shortage of senior Ethiopian researchers, books and journals, departmental research activity has been minimal. However, individual staff members conduct some research work in differential equation. This is specially true for foreign staff members of the department.

348 In addition to the post-graduate and departmental research Addis Ababa university has two autonomous research institutions, the Geophysical Observatory and the Institute of Pathobiology, in order to enhance the gradual expansion of research activities both in scope and intensity. Researchers of these institutions are expected to use 75% of their time for research activities.

1.6 The Geophysical Observatory

349 It was founded as a research unit of the Faculty of Science of University College of Addis Ababa in 1957. In 1961, it became a full-fledged standard seismic station unit of the University and in 1979 two new branch seismic stations were launched at Alemaya and Awasa. At present, research work in Geomagnetic and Ionospheric physics, seismology exploration geophysics and Meteorology are carried out.

350 The observatory's work in natural disasters has enabled to generate useful data on seismic risk. It has given consultancy services to a number of development projects such as, the Melka Wokena Hydroelectric Project, Assab- Addis Ababa Railway Project Gelgele Gebe Project. The capability of the observatory in this

regard need to be developed in the future in order to effectively investigate the effects of natural disasters.

1.7 The Institute of Pathobiology

351 It was founded as a medical research unit with the Biology Department of Addis Ababa University in 1964. In 1972 it was reorganized as an autonomous biomedical research institution. The Institute is currently involved in research activities that deal with human and other animal diseases that need further investigations and have particular relevance to Ethiopia and other developing countries. Current activities of the institute are focused on research work on Leishmaniasis, Epidimiology of Shistosomiasis, parasitological studies on vetrinary medicine and radiation protection.

2. Research at Asmara University

352 Asmara University is a very young academic institution with very limited resources. It faces major problems such as the shortage of manpower, funds, research equipment, supplies and transportation facilities. The university has no budget specially allocated for research. Ethiopian academic employees of the university are very young and thus lack the necessary research experience. The majority of the experienced academic employees are expatriates who come for a short period of time and who are mostly unable to stay and finish projects that require long time. To upgrade their skill, the university sends its academic employees to Addis Ababa and foreign universities for further training.

353 Although Asmara University currently lacks graduate research work in natural sciences, academic employees of the biology department have a few ongoing projects. The university tries to identify research programs and projects that are compatible with its geographic location so that it becomes responsive both to local (northern ethiopia) and national needs, that are best answered from northern ethiopia. The university has established different research stations in order to facilitate its research activities. One of these stations is the Marine Biology and Fisheries Research Station at Asmara. The station is established to:

- carry out basic research useful for the better understanding of the Red Sea marine environment and better utilization of its fisheries resources.
- establish back-up research and teaching programs in disciplines which support marine biology such as marine chemistry, physics and geology, and eventually extend teaching and research in these fields sc that they can be developed into full-fledged programs that are capable of providing the necessary trained manpower and research out

put for the effective utilization of marine chemical, geological and energy resources for economic development.

354 Recently completed research projects of the marine biology and Fisheries research station include:

2.1 Ecological and taxonomical studies on the marine and mangroove fungal ecosystem.

2.2 Diversity and productivity study of the macrobenethnic fauna of the Red Sea Coast around Tewalet, Massawa.

2.3 Studies on the benthic Macrofaunal productivity and diversity of the Red Sea Coast around Tewalet.

355 A few research projects are also currently under progress in the station. These include:

- The monitoring program of the Red Sea.
- The faunastic ecological investigation on meiozobenthos of the shallow water areas near Massawa.
- The macrozoobenethos investigations in the area near the Red Sea Laboratory of Asmara University and
- The identification of the fish fauna of Massawa.

II Research at Non-Academic Institutions

356 Applied and basic research in the natural sciences is also conducted in the National Health Research Institute, the Armher Hansen Research Institute, Ethiopian Nutrition Research Institute, the Institute of Agricultural Research, Wild life Conservation Organization, Department of Forestry, Ethiopian Valleys Development and Study Authority, Ministry of Culture, Ministry of Mines and Energy and the Plant Genetics Resource Center. However, the research activities in these institutions are uncoordinated and little collaborative work is observed. Efforts must be made to coordinate and guide their research activities. They must be encouraged to undertake collaborative research to solve the development problems of the country in a multidisciplinary approach.

357 The growth of the academic and other institutions that are directly or indirectly involved in basic or natural science research will undoubtedly contribute to accelerate the implementation of the National Science Center. It is envisaged that this center will create the highly needed research manpower and develop research in the natural sciences especially in areas that are not covered by the existing institutions.

III Research Fund

358 According to the Research and Publications Office of Addis Ababa University, the amount of funds allocated from 1971 - 79 for projects in the natural sciences was only Birr 122,137 and

Birr 35,683 from local and foreign sources respectively. This amount has increased to Birr 2,363,132 for the period 1979 - 84. However, more than 90 percent of this amount was obtained from foreign assistance. The foreign funds have enabled to acquire equipment and supplies which needed a lot of foreign currency.

359 The allocation of the Government should be significantly increased in order to develop our capability in the natural sciences as desired. It is generally suggested that least developed countries spend 1% of their GNP on RAD with 10 - 20% of that amount spent on fundamental research. It is also important to include an adequate amount of foreign exchange to pay for importation of equipment not locally available, subscription to scientific journals, international travel etc. The international assistance can be effective to supplement the expense that require foreign currently.

PUBLICATIONS IN THE NATURAL SCIENCES

360 Publications are generally accepted as good indicators of scientific activities. Until about 1970 very little natural science research work was conducted and as a result there were insignificant number of publications. With the return of a number of Ethiopians from abroad in the early seventy's with MSc and PhD degrees and the attempt made since then to start research programs it is now noted that more publications are appearing in the field. In a recent survey by ESTC, about 600 research publications in the natural sciences are registered. These publications include those from the Faculty of Science, Institute of Pathobiology, National Health Research Institute and Armher Hanson Research Institute. It is observed that a lot more publications have appeared in the fields of biological, bio-medical and chemical sciences compared to physics mathematics and earth sciences.

361 The Faculty of Science publishes a journal entitled SINET, An Ethiopian Journal of Science, "which is produced twice a year. In addition to this, Bulletin of the Chemical Society of Ethiopia, Hissab, and Bulletin of the Geophysical Observatory are produced by the Chemical Society of Ethiopia, the Mathematical Association of Ethiopia and the Geophysical Observatory respectively. These journals have enabled the dissemination of research results and information in these areas of natural science. However lack of funds and printing facilities have slowed the development of scientific journals. More funds should therefore be allocated to increase the number of publications and improve the quality of the journals.

MAJOR PROBLEM AREAS OF THE SECTOR

362. The major problems of the sector spring from lack of attention given to it and consequently only limited capabilities in the field. Among the major problems the following figure very importantly:

a) Lack of direction and hence prioritization of S&T activities: National policy and planing on natural science activities is non existent. Research, development and service activities are not given the necessary attention as a matter of policy and how they can be used so that they can, by their application in a continuous, predictable and understandable way, be more effective in helping the nation achieve its develomental needs.

b) Inadequate R&D facilities and support staff for research: The few university science laboratories and other facilities are mainly used for teaching. Some are not even adequate for this purpose. The researcher in most natural science departments has to teach, work on his/her research project, provide research training, clean his/her lab and perform minor maintenance work on laboratory instruments.

c) Shortage of trained manpower and senior Ethiopian researchers: The major component of the natural or basic science research in the national scientific system is that of the universities. The shortage of senior Ethiopian researchers and the teaching and other work load on the few that are available has greatly hindered the growth and development of natural science research activities of the nation.

d) Limited job opportunities for graduates in the natural or basic sciences and narrow prospects: Natural scientists can be engaged in various research, development or service activities. However, most government organizations that are not fully aware of this do not make any effort to attract and higher natural scientists.

e) Fragmentation and lack of coordination of research activities; dispersion and duplication of research efforts: Research activities of the different academic as well as nonacademic institutions are not well co-ordinated. This has resulted in the dispersion and duplication of efforts, and hence the inefficient utilization of scares resources.

f) Lack of guide lines and regulations regarding natural science activity carried out by foreign based researchers: The various research activities carried out by foreign based researchers in collaboration with different Ethiopian organizations, in the absence of co-ordination, guide lines and regulations, have made it very difficult to assess the merits of the research projects for their usefulness to Ethiopia, make sure that their results find their way to Ethiopian academic or research institutions and avoid duplication of efforts by the collaborating Ethiopian institutions in the training of manpower and the development of research facilities.

g) Lack of sufficient data on the current status of scientific manpower and expenditure of various natural science research, experimental development and service activities: The absence of such data has made it difficult to formulate a comprehensive and systematic plan for the nation.

h) Weak link between the natural science research activities of academic institutions and the development and service activities of government organizations: The universities and the world around them have tended to remain separate. Government organizations are not exploiting the creative potentialities of universities and universities do not have access to organizations, their problems and resources. This situation needs to be remedied so that natural scientists can be used to help solve problems facing society and the nation.

M. Emerging Technologies (Biotechnology, Electronics & Others)

363. Emerging technologies have already become an important force of development in developed countries. Among such technologies electronics and biotechnology deserve special consideration in Ethiopia.

364. Electronics:- Electronic systems have become an essential part of all major industrial, transportation, communication, and defence systems. Electronic equipment costs constitute a major element of the over all systems costs. Micro-electronics has immediate scope and application in management, materials handling and marketing functions. New developments in electronics are expected to revolutionize the socio-economic life of a nation. In the light of these considerations, the acquisition and development of electronic technology is becoming increasingly more sophisticated and most of it is now in the domain of high technology.

365. Current techniques of micro-miniaturization have brought about major changes in the concept of electronic equipment design. The know-how in electronics and institutionalization of R&D in this field, which is of vital importance to the future well-being of the country is currently lacking.

366. A key to the full exploitation of the potential of electronic high technologies is the software application. Even if we cannot develop electronic hardware in the immediate future, considerable degree of self-reliance can be achieved in the field of software application with a large number of design engineers, computer programmers and a well organized standard institution in this area. At present however, there are only a few Ethiopian design engineers and computer programmers and there is no national institution of electronics that would perform this task speedly and effectively.

367. However, the ESTC has taken prompt step to address this problem. It has hired a few computer scientists (hardware and software specialists and computer oralgets) and made considerable progress towards paving the way for the establishment of a National Computer Center. The Centre, when fully established, will carry out research, development and service activities, and draw a comprehensive and systematic plan for hardware and software applications inorder to control the process and ensure the best end results as far as Ethiopia is concerned.

368. Biotechnology includes three major industrial processes that are based on biological systems, namely, fermentation, enzyme reaction and genetic engineering. Of these genetic engineering has the highest potential. Using the vehicle of the recombinant DNA new living cells can be produced at a rapid rate which makes the process commercially viable.

369. Genetic engineering aims at mass producing biologically significant protien enzyme or hormone. Insulin has been produced by recombinant DNA techniques. The most exciting development in this field is the cloning of human interferon which is a remarkable protien used by the body as a natural agent against attack by viruses and tumor cells. Research in this area is very poorly developed and development or service activities are non-existant.

370. In the fermentation technology new industrial techniques are being developed with attractive commercial applications in the pahrmaceutical industry. Biotechnology also has great impact on agriculture in improving the quantity and quality of the crop yield and obviating the use of synthetic fertilizers. A research project on enzyme reaction, bioconversion of waste cellulosic materials into industrially useful products, is already under way in the Biology Department of Addis Ababa University. The first phase of this project has already produced some results. As more collaboratores, sinior researchers and graduate students become available, more research in agriculture, food fermentation, pharmaceuticals, medicine and chemicals are expected to be embodied in the project.

Major Problem Areas of the Sector

371. The major problem areas of the sector spring from the lack of attention given to emerging technologies in academic and non academic institutions as well as at national level and the consquently limited capabilities in this area. The following are among the major problems that require immediate attention and action.

a) Lack of the know-how and facilities for the application and absorption of research results obtained abroad for the development and improvement of agriculture, pharmaceutical and chemical industry, health care and environmental management.

b) Shortage of design engineers and computer programmers.

c) Shortage of senior researchers in genetics and microbiology.

d) Lack of adequate R&D facility for biotechnology.

e) Lack of adequate R&D facility for electronics.

CHAPTER III

STRUCTURE AND ORGANIZATION OF THE ETHIOPIAN SCIENCE AND TECHNOLOGY SYSTEM

372 A country's S&T system refers to all organizational entities and institutions involved in the generation, mobilization and application of science and technology for national development. In the context of Ethiopia these include all scientific establishments and institutions engaged in the conduct of research and development(R&D) activities, provision of scientific and technological support services(STS) and the formulation, implementation and administration of S&T policy and plans .

373 The structure and organization of a S&T system encampasses its internal organizational arrangements as well as relationships with external bodies. The internal organizational arrangements of the system are mechanisms through which functional responsibilities and reporting relationships among the different S&T organizations and institutions are determined. Relations with external bodies on the other hand provide guidance to the system's operation and channel the flow of information, outputs and the whole array of other resources into and out of it.

374. As such an S&T structure focuses on strengthening mutualities of scientific research activities including those undertaken in universities, directly with the production and service giving sectors of the national economic system. There is also a great need for the close collaboration between the national scientific and technological policy making body and the national planning agency in matters related to resource allocation to scientific and technological activities, and ensuring large scale introduction of research results into the national economy.

375 Within this perspective the national scientific and technological effort of Ethiopia is presently organized in the following manner as reflected at the functional levels of S&T policy making and S&T management.

The National Science And Technology Policy Making Level

376 This is the level of governmental decision making as regards the choice between various major options determining the main orientations of the overall national policy pertaining to science and technology. The principal body representing this level and concerned with the formulation of national policy and plans in the S&T sector as well as the overall promotion, stimulation and coordination of scientific research and development activities in the country is the Ethiopian Science and Technology Commission (ESTC). This Commission together with its Council was established in 1975 by Government Proclamation (N 62 62/75) with the mandate to encourage, guide, coordinate and

support the search for scientific knowledge and the pursuit of technological development applicable to alleviating hard-ship in the lives of the broad mass of Ethiopians as well as their productivity.

The Council is composed of the following:-

a) two persons qualified and experienced in the field of science and technology research and development as well as in administration, appointed as Commissioner and Deputy Commissioner by the Head of State.

b) the heads or the delegated deputy heads of the following Public Authorities:-

(i) Office of the National Committee for Central Planning (ONCCP).

(ii) Ministry of Agriculture

(iii) Ministry of Health.
(iv) " " State Farms.
(v) " " Coffee and Tea Development
(vi) " " Mines and Energy
(vii) " " Internal Trade
(viii) " " External Trade
(ix) " " Urban Development & Housing
(x) " " Transport and Communications
(xi) " " Construction, and
(xii) National Water Resources Commission.

c) Commissioner for Higher Education Commission
d) Not less than six members reputed in their profession to be designated by the Head of State.
e) Not less than six chairpersons of S&T Sub-Councils.

378 The Commissioner of the Commission acts as the Chairman of the Council and at the same time the Chief Executive of the Commission under the general supervision of the Council.

379 Within the Commission and under the National Council come the Sub-Councils of S&T as responsible bodies for sectoral science and technology, executing functions alloted to them by the Council. The qualification and experience requirement of members of the Sub-Councils as well as the manner of their selection for membership is also determined by the Council; and the chairman of each sub-council is appointed by the Head of State upon the recomendation of the Commissioner. To date the Sub-Councils of sectoral S&T operating as major organizational components of the Commission are eight, viz:- food and agriculture, health, industry and technology, and transport and Communications, construction, housing and urban development, natural

resources, education and manpower, natural sciences and, S&T popularization.

380 Organizationally, because of the potentially important place it occupies in the country's S&T system's structure, the ESTC can be considered as the central body responsible for national scientific and technological activities. This however does not mean that the organization of scientific and technological activities in the nation is a network of S&T institutions grouped under the overall authority of the Commission. All research institutions or research units are under various ministries and commissions and their subbordinate institutions.

381 Therefore the whole structure has been setup on the consideration

a) that the country's organization of scientific and technical activities is characterized by a diversification of functions and structures, and,

b) that such a system could be " integrated" and " " coordinated" effectively by the National Council for S&T, in pursuance of the achievement of national development gools.

382 Accordingly, the organization system of the country's scientific activities especially as related to the national S&T policy making level, concentrates on the following functions:-

a) Formulation of national science and technology policies condusive to the achievement of national development objectives and determination of research priorities in conformity with such policies.

b) Proposition of reorganization, abolition or transfer to the Commission of any institution, and planning and establishing new institutions of scientific and technological R&D in the interest of efficient utilization of manpower and other resources.

c) Extension of support to individuals and institutions engaged in scientific and technological R&D programmes and projects.

d) Cooperation with foreign and international organizations having similar purposes.

e) Follow up of the practical application of worth -while scientific and technological findings.

f) Evaluation of scientific and technical activities.

g) Stimulation and encouragement of the pursuit of scientific and technological activities.

383 Hence in order to make it possible for the ESTC to carry out all these tasks and ensure effective coordination of scientific and technological activities, almost all ministries and other state organs as well as R&D institutions including those of the universities, and the scientific community are represented either in the National Council or the sectoral Sub-Councils. As a matter of principle, this arrangement was expected to create a conducsive situation whereby these bodies would be able to know, at least, what is going on and what the thinking is as regards the processing of S&T operations for national development and subsequently apply same to their respective sectors.

384 Despite this however, the structure has proved itself to be non-functional. This is because neither the National Council nor the Sub-Councils for sectoral S&T have had meetings of considerable regularity to assess situations pertaining to scientific and technological activities and make recommendations on the desirability of continuing or changing trends, in the interest of raising the impact of S&T on the country's socio-economic development.

385. As the result of this, the system operating at present comes completely under the Commissioner and the chairmen of the sectoral Sub-Councils whose efforts are restricted mainly to cooperative approaches to attain the designated objectives of the Commission. These include convening of conferences, seminars and work-shops whereby exchanges of views are encouraged to provide the basis for the realization of concerted and harmonized effort in the mobilization, generation and application of S&T for national development. In addition the Commission makes attempts to have some impact on the growth of the national S&T potentials through sponsoring and supporting researches including the award of training fellowships and scholarships.

386. Nevertheless, weak links with national R&D institutions and major STS organizations, together with inadequate finance, manpower, infrastructural facilities and equipment have made it very difficult for the Commission to carry out its functions effectively and efficiently.

387 As such, although conditions have improved over the past two years, financial records show that the Governments budgetary allocation for the Commission had never exceeded Birr 575,000 annually for the periods between 1975/76 and 1984/85, ie for about a decade beginning its emergence as a responsible body for S&T.

388 Concerning manpower, in 1983/84, the Commission had only 52 employees in its payroll out of which only 21 were professionals (three of the chairmen of the sectoral S&T Sub-Councils were and still are part-time employees).

389 Another factor which has made it impossible for the ESTC to carry out its functions concerns the finding that goes into research from bilateral and international donor organizations.

390 Administratively, the advantage of having one national channel through which funding should flow into research is obvious, mainly for its effective utilization can be easily coordinated and controlled , especially by an organization which is very close to and knowledgeable about researchers and research projects. But as the practice in Ethiopia enables parallel structures to negotiate and sign agreements for research assistance, the ESTC is unable to exercise its coordination role in the allocation of fund for research on the basis of established priorities .

391 As a matter of principle different rules and policies govern the funding practice of different donor organizations, and it may not be possible to get all donors agree on one common strategy of channalizing donations for research supports. It is however the responsibility of the Ethiopian side to arrange for donors to sign agreements at least guaranting that the ESTC, which is in a way knowledgeable about developments within the research sector in the country, be drawn into the negotiations of research fundings.

392 It should also be pointed out that any of the efforts of the Commission to exert influence on sectoral S&T activities in the interest of raising their impact on overall national development endeavours can be met by strong oppositions or even ignored. This is mainly because of structural constraints associated with the absence of strong legal basis by means of which they can be governed by the National Council, and the lack of firm linkages between the Commission and R&D institutions. Hence if the ESTC is to be able to really coordinate research and other scientific activities and formulate and implement national policies and priorities , mechanisms through which all research activities can be cleared centrally, and a constant two-way flow of information is ensured will have to be created and effectively implemented.

The National Science and Technology Management Level:

393. This level is represented by sectoral ministries, other state organs and parastatal development agencies. At times it is centralized as at the first functional level and involves the national science and technology policy making body.

394. At this functional level decisions regarding the execution of S&T policies are prepared and the national science and technology system is managed. This means that the sectoral programmes and the relevant budgets reflecting the objectives of the national science and technology policy as well as the time frame within which S&T activities must be executed are prepared and determined at this level.

395 In the context of Ethiopia, governmental bodies representing the national S&T management level, are mandated not only to execute major production and service activities in their respective fields of competence. They are also responsible to lessen and/or gradually eliminate the excessive dependence of sectoral development efforts on imported technologies and technical know-how through the conduct of research and experimental development.

396 Despite this however, very little research is being carried out within the ministries and the development of effective S&T system amied at serving production and better standards of living is yet to be realized.

397. According to an estimate made by a team of experts from the Research Policy Institute of Sweden in collaboration with the staff of ESTC, in 1983, the country's annual spending for various S&T activities is at a level between 60 and 70 million birr. The team's observation indicates that this roughly amounts to 0.7-0.8% of the gross national product (GNP) and when compared to the level of spending of many industrialized countries, which is between 2 and 3% for R&D alone, the Ethiopian situation is far behind. Considering the difference in absolute terms, the gap which has to be closed in order to realize full social and economic development is identified to be immense.

398 Therefore, under this circumstance, it is not surprising to find that only a few of the sectoral ministries and other state organs are conducting relatively significant researches integrated to their respective production and service programmes.

399 Against this background a brief look at the organizational arrangement of scientific and technological activities reveals that the existing R&D and STS responsibilities are placed within three categories of structures including:-

a) sectoral ministries and other state organs,

b) the higher education institutions, and

c) administratively independent scientific establishments.

400 Under each category of structure fall the following R&D institutions, and units on programmes as well as S&T services.

R&D and STS responsibilities under various categories of structures.

Sectoral Ministries and other state organs

a. Mininistry of Agriculture

- Silvicultural /forestry research
- Wood utilization Research Centres.
- Soil Conservation Research
- National Veternary Institute

b. Ministry of Health

- National Health Research Institute
- Ethiopian Nutrition Institute
- Techno-Centre (responsible for medical and research laboratory equipment maintenance and repair)

c. Ministry of Mines and Energy

- Ethiopian Geological Studies Institute.

d. Ministry of Urban Development and Housing

- Building Materials Research unit
- National Urban Planning Institute.

e. Ministry of Education

- Burayu Appropriate Technology Centre.
- Curriculum Evaluation and Research Division
- Educational Materials Development Unit.

f. Ministry of Construction

- PKG (Potassium,Calcium,Gypsum) - Building Materials Research and Production Unit
- Soil Laboratory of the Ethiopian Transport Construction Authority (ETCA)
- Soil and Building Materials Testing Laboratory of the Ethiopian Building Construction Authority (EBCA)

g Ministry of Industry

- Industrial research activities of the Addis Ababa University - Ministry of Industry Cooperation Programme.

h. Ministry of Culture

- Ethiopian Language Academy
- National Library and Central Archive.

i. National Water Resources Commission

- National Meteorological Services Agency.
- Water Technology Institute at Arba Minch
- Rural Pumping Research Unit.

j. Ethiopian Science and Technology Commission

- National Science and Technology Information and Documentation Centre.

- National Scientific Equipment Centre

- Computer Research Programme

- S&T Popularization and Research Council

The Higher Education Institutions

a. Addis Ababa University (AAU)
- Institute of Development Research (IDR)
- Institute of Pathobiology
- Institute of Ethiopian Studies
- Geophysical Observatory.
- Educational Research Institute
- Natural History Museum
- National Herbarium
- Satellite Tracking Station at Debre Zeit

b. Asmara University

- Institute of African Studies
- Institute of Appropriate Technology
- Marine Biology and Fisheries R&D Programme
- Arid Zone Agriculture R&D Programme

c. Alemaya University of Agriculture

- DebreZeit Agricultural Experiment Centre

d. Administratively Independent Scientific Establishments

- Institute of Agricultural Research (IAR) with its well developed network of zonal research centres and substations at present numbering 16 altogether (11 centers and 5 sub centers)

- Plant Genetics Resource Centre (PGRC), administratively supported by the IAR.

- Armauer Hansen Research Institute (AHRI)

- All African Leprosy Research and Rehabilitation Centre (ALERT)

- International Livestock Centre for Africa (ILCA) (AHRI,ALERT and ILCA conduct specific researches in the areas of health and livestock with international mandates).

- Ethiopian Standards Institute
- Central Statistics Office
- Ethiopian Mapping Authority.
- Development Projects Study Authority (BPSA)
- Scientific Phytopathological Laboratory at Ambo, administratively supported by the Ethiopian Science and Technology Commission(ESTC).

401. By and large, as the above listing sets forth, the structural arrangement concerning R&D and STS is characterized by a dispersed and disjointed system where different R&D institutions and units as well as S&T services either come under various sectoral ministries, other state organs and universities or operate as independent scientific enterprises. It should also be mentioned that horizontal coordination of S&T activities is weak due to lack of strong linkages. Furthermore except in some sectoral ministries such as Ministries of Health State Farms and Industry where there are R&D departments, vertical coordination among R&D institutions is lacking.

402. Under this system therefore, each state organ or development agency concerned,provides conditions for the conduct of research development of R&D activities and application of results in the respective sectoral production and service endeavours in isolation from each other.

403 On the other hand the system leaves most R&D and STS organizations at a low degree of control over decision making process particularly in matters pertaining to resource management In most cases funding of research activities flows from allocations within the national budget through the treasury of the

concerned state organs and development agencies hosting R&D and STS structures.

404 It also goes without saying that administrative policies and procedures emanate from the same sources keeping R&D and STS establishments at an excessively subordinate level where they are unable to exercise full power for the realization of productive scientific and technological operations.

405 This means that all of the R&D and STS structures have either strong legal basis instrumental to set administrative policies and procedures suitable for their respective operations, or clear mandates to effectively determine research programmes, carry them out and interpret and communicate results to development agencies, planners and end users or producers.

406 Consequently, given the absence of a comprehensive national S&T policy, the gist of which consists of guidelines to ensure coherence, consistency and integration of the national S&T system of which R&D and STS are parts, the situation so far reviewed suggests a number of detering effects. Some of them are the following :

a. As the system which focuses on sectoral approach is devoid of effective mechanisms to integrate and coordinate S&T efforts, R&D programmes are in most cases bound to generate more of the same, technologies resulting in waste of human, materials and financial resources.

b. As S&T manpower is dispersed all over the social and economic sectors mainly to deal with specific technological needs of the various sectors concerned, the development of critical mass responsive to multidimentional development needs becomes almost impossible. This in turn hampers the generation of effective technology applicable to the solution of priority national development problems.

Major structural and organizational problems

407 The number of R&D and STS structures that are in existence may give an impression that there is a well developed network of S&T infrastructure and considerable research activity in the country. This appearance is rather misleading because the effectivness of the entire S&T system is greatly impaired due to many serious weaknesses and deficiencies associated with several structural and organizational constraints. In what follows some of the primary caustive ones are indicated.

a. Absence of a comprehensive and well thoughtout national S&T policy serving as part of the frame work reinforcing the S&T organizational structure and the basic S&T operations.

b. Weakness of the national S&T policy structure (ESTC) to ensure effective S&T planning, budgeting coordination, administration and promotion of S&T , as well as integration of R&D and STS activities with production and service programmes.

c. Lack of broad understanding of the basic S&T operations at all levels of S&T management . These have concern with the setting of objectives and priorities , mobilization and development of resources, establishment of linkages, assuring steady flow of information as well as output and resources between S&T structures and the broader social, political and economic environment.

d. Excessive fragmentation of R&D and STS efforts in terms of structure, manpower, equipment, funds, etc.

e) Inappropriate organizational arrangement where interaction among various R&D and STS structures, and linkages between the national policy making body and the S&T establishments are not realized and ensured.

f) Absence of adequately strong legal basis and clear mandates instrumental for S&T structures to set administrative and financial policies and procedures suitable for their respective operations as well as to determine effective S&T programmes and projects, carry them out and disseminate results among the relevant constituents.

g) Underdevelopment of adequate STS structures responsible for inter sectoral needs pertaining to reliable S&T information, scientific equipment maintenance, R&D consultancy, etc.

h) Absence of effective mechanisms by means of which flow of funding and other resources including trained manpower, equipment, etc. into research are coordinated and controlled centrally to ensure productive S&T operations.

CHAPTER IV

RESEARCH IN INSTITUTIONS OF HIGHER EDUCATION

408 As is the case in technologically advanced countries, institutions of higher learning are, at present, the major science-producing agents in developing countries. They are increasingly becoming involved in basic and applied research in scientific and technological fields. In spite of their meagre research infrastructure, they are the most important sources of scientific research and development.

409. In Ethiopia, though all the institutions of higher learning (especially the universities), are vested with full powers under their charter to undertake research, very little research is acually carried out in the universities compared to their potentials. This is partly due to the fact that the resources allocated for research have been extremely meagre. The teaching load is usually excessive in most cases, which leaves university staff very little time for research and hence not conducive to induce university instructors to undertake research work.

410. The universities possess the largest cocentration of high level scientific manpower, while their share in the national research budget has till now been minimal. In the future separate and adequate provision should be made for research in the budgets of all higher education institutions. The current allocation of research budget of universities is considered to be insignificant. In advanced nations, allocation is around 33 percent of the total budget in general universities and much higher in research universities. Thus in Ethiopia the allocations for research will have to be greatly improved.

411. A genunine transformation in the prevailing environment and attitudes in our academic institutions is urgently needed as scholarly and ccreative work is a sine qua non for the very existence of a university system.

412. The institutions for hihger education in Ethiopia under the manadate of the Commission for Higher Education are the Addis Ababa University, Asmara Univer- sity, Alemaya University of Agriculture, Ambo and Jimma Junior Colleges of Agriculture, Debre Zeit Junior College of Vetrinary Science, Junior College of Commerce, Bahir Dar Polytechnic Institute and Kotebe Teachers Training College. There are other institutions administered by other governmental organizations: The Arba Minch Water Technology Institute, which comes under the Natioal Water Resources Commission, Wondo Gennet Forestry Institute under the Ministrty of Agriculture, and Jimma Health Institute under the Ministry of Health. These Institutions provide education and training ranging from diploma to the Ph.D level:

- Municipal Tech - College
- Electrical / Electronics Inst.
- Naval Academy

413. Research carried out in these institutions takes two forms. Most of the research conducted is done by departments whose task is, not only to engage in research but also, to teach. However there are some institutes which devote all their time and energy to research only. For example there are a total of four research institutes under the auspices of the Addis Ababa University whose primary function, unlike the various faculties, is research. There institutes namely, the Institute of Ethiopian Studies, the Institute of Pathobiology, focusing on applied biological and para-medical research, the Institute of Development Research responsible for research on socio-economic development and the Institute of Educational Research dealing with pedagogical sciences, are all located in Addis Ababa. A major department engaged in research is the Geophysical Observatory under the Faculty of Science.

414. The Research and Publications Office established in 1971 is responsible for co-ordinating all research and publications activities within the Addis Ababa University under the guidance of the Senate Research and Publications Committee. This Office approves, evaluates and promotes numerous research and teaching material projects and grants finanical support to recognized university journals. All requests for support form individuals or groups of staff engaged in research are made through research grant request forms obtainable from the Research and Publications Office. Several Faculties have, in fact, established their own Faculty Research and Publication Committees thereby further strengthening the systematic administration of research and the flow of funds intended for this purpose. This is indeed a fruitful and promising beginning, but the need for further advancement goes without saying.

415. Similar offices are opened at the Asmara University and Alemaya University of Agriculture, but they are still in their formative stages.

416. Most of the post-graduate researchers working for their Masters are at the same time instructors in the various colleges and faculties. At the same time, however, there are masters students who devote their full time to research, the majority of teachers recruited by the Ministry of Education to continue their post-graduate studies falling under this latter category.

417. Although the School of Graduate Studies attempts to provide Masters programs tallying with most of the undergraduate programs there is only one subject, namely Chemistry, which has extended beyond - to the Ph.D level so far. The fact that the Medical School offers specialization in certain fields is worth noting. It is expected that Ph.D programs in Biology and in Languages will be launched in the near future.

418. One major constraint hindering diversity at post-graduate level is lack of finance. Funds allocated for this purpose are very meagre. The capital budget of the Addis Ababa University during the fiscal year 1984/85, for example, was 7,349,500 EB and 5,763,717 EB and 4,699,800 EB for the years 1985/86 and 1986/87 respectively. Eventhough statistics indicating just how much money was then used for research is not available. However the total amounts stated give a clear picture of how little can be used for this purpose. This state of affairs is further aggravated by the fact that the amounts alloted to the Addis Ababa University are apparently dwindling from year to year. However, it is important to note that the two other universities at Alemaya and Asmara and most of the other institutes under the Commission for Higher Education show an increase in their capital budget. From a total capital budget of 500,000 EB in 1984/85 the University of Agriculture at Alemaya for example rose to-1,012,175 EB the following year, and reaqched 2,930,200 EB in 1985/86. Similarly the capital budget of Asmara University followed the same trend jumping from a mere 55,000 EB in 1985/86 to 1,597,300 EB in the following fiscal year. It should be emphasized here however, that a rise in the capital budget may not entail an increase in the amount utilized for research.

419. Lack of able university staff is another major obstacle hindering research. Of the 676 teachers working in the Addis Ababa University, for example, 202 are foreigjners. From the remaining 474 Ethiopian instructors only 180 are Ph.D's. Those who have Masters degrees are 218, while 57 and 19 are first degree and diploma graduates respectively. Considering the fact that the Addis Ababa University has the highest number of teaching staff, one can get a vague idea what the manpower situation of the other institutuions looks like. An additional point worth considering here is that despite the degrees they hold the majority of the teaching staff are not engaged in research. This is due to various reasons, two of them being lack of adequate research facilities and inadequate incentives. In addition, most of the university teachers coplain of overload, a situation aggravated by the higher teacher student ratio. In 1985/86 there were a total of 1207 teachers working in the various higher institutions teaching a total of 17,646 diploma and degree students. Although the number of teachers showed a slight increase of 15 in the year 1986/87 making a total of 1222 the number of students decreased with 16,699 graduating at the end of the same year. These figures indicate that the student teacher ratio is showing promising signs. However, this does not mean that there is no need for further improvement viewing the situation from the folowing comparative statistics of teacher stuent ratio: 1:15 in the Addis Ababa University, for example, as against 1:9 in Khartoum University, 1:11 in Zimbabwe University and 1:6 in Kenyatta University. Existing university policy

dictates that the ideal teaching research ratio as 75%:25% for teaching staff and vice versa (25%: 75%) for research staff. Apparantly this target has not yet been reached.

420. One other reason often overlooked but equally significant is little or no research know-how. That correct research methodologies will help to make research activities more fruitful is obvious, but even research methodlogy as a course is not given at any level in any of the faculties of the universities. It must also be emphasized that even thos who were exposed to research methodologies must be given refresher courses and training, and this apparently is not available at present.

421. Another major area of concern is the "brain-drain". Unfortunately many people sent abroad for higher education and other activities tend not to come back. Although statistics indicating just how much 'brain-drain' has taken place is not availble, the number is believed to be substantial and the problem urgent.

422 Research focusing on natioal needs is advantageous though not always practiced. Such research geared to lead to findings that will improve the daily life of the masses is often undertaken by technical department such as the technology and agriculture departments. A good example of such a mission - oriented program underway here in Ethiopia, is the one which emanated from the cooperation between the Addis Ababa University Engineering Faculty and the Ministry of Industry. This programme is believed to provide practical solutions that will help to develop the industrial sector at the same time enlightening the researchers engaged by bringing them in touch with the problems of industry. Another encouraging development is the recent soil and agricultural natural resources survey of Hararghe Region which has been launched by the Alemaya University of Agriculture. Similarly the Flora Project, which has been going on for some years now and the Fauna Project which is planned to be launched very soon by the Addis Ababa Univer- sity, Faculty of Science, is other important development along this line. It is also essential to note the fact that the Institute of Development Research has continously endeavoured, and often with success, to make studies and research on issues related to national development problems.

423. To conclude one can boldly claim that research in higher institutions is given little consideration. The very fact that most peoples' understanding of higher institutions revolves around teaching portrays that research an equally, if not more, important tasks of such institutions has been neglected. This state of affairs calls for an immediate search for solutions.

Major Problems of the Sector

424 As shown in the foregoing assessment, some of the major problems of the hector are the following

a) Lack of adequate finance for research,

b) Lack of adequately experienced university staff,

c) Inadequate research facilities and incentives,

d) Problem of brain-drain,

e) Unavailability of opportunities for improving research know-how, and

f) Lack of programs at doctoral and post-doctoral levels.

CHAPTER V

TECHNOLOGY TRANSFER AND DEVELOPMENT

425 Technology transfer, being a process by which a package of knowledge is transfered from one who either owns it or has access to it to another who wants that knowledge, requires adequate technological environment for its efficient utilization and diffusion. This enviornment relates to indigenous capability in science and technology in which the availability and promotion of scientific and technical manpower and R&D capability are among the prominent ones. The process of technology transfer consists of capabilities in technological activities of technology selection relating to where to get technological information and how to evaluate such information for purposes of decision making; acquisition involving adequate specification of technological services required and negotiation of the terms and conditions; innstallation; operation; repair and maintenance, and of renovation and spare part production. Technology development, on the other hand, comprise capabilities in technology adaptation to local conditions, raw materials and markets; in modification; in generation; and capabilities in designing and engineerig.

426. Ethiopia is both economically and technologically underdeveloped. Its percapita gross domestic product of about US $140 is one of the lowest in the world. Agriculture accounts for about 48% of the GDP and for 90% of exports and is also the means of livelyhood for about 86% of the population. The contribution of manufacturig industry to GDP is about 11% and is depending on imported machinery and equipments to the extent of 99% of its total requirements. Foreign trade is dominated by imports of manufactured goods and exports of agricultural raw products of coffee, pulses, hides and skins. Technological development as measured by the number of scientific and technological personnel, being 14 per one million population, is very low. This figure compared to the corresponding figure, contained in a recent UNCTAD Report, of 2,986 for developed market-economy countries in 1980, of 91 for Africa in 1980 and 803 for Republic of Korea in 1983 is extremely low. The low level of per capita GDP reflects low productivity which, inturn, reflects low absorption of modern technology. This situation brings into foucs the need for increasing the productivity of the country's economic system through the introduction and diffusion of modern techniques of production. Technology is universally recognized as fundamental to economic growth and development. The aim of technological development policy, therefore, has to be to develop, in the shortest possible time, a national capability that permits both technological self-reliance and the contribution of technological activities to the attainment of economic, social and cultural development objectives. The attainment of technological self-reliance requires a technological policy designed to adopt a more adequate technology, either bought or

copied if it exists abroad, making the necessary adaptation or improvements, or develop it if it does not exist or buying it aborad is disadvantageous. In light of the foregoing general frame of reference, a brief overview of the features of technology transfer, weaknesses of the transfer machanism and of the resultant pattern ofindustrialization along with its technological policy implications are considered. The features of technology transfer and development are clearly seen in the composition of imports and exports. In 1984, the country imported 1,951.1 million birr worth and exported 862,577,000 worth. The value of imports and exports by commodity section for 1984 is given in the table below.

Value of Imports by Commodity Sector for 1984

	Imports In'000 Birr	%	Exports In '000 Birr	%
1. Food & live animals	171,622	8.8	619,710	71.8
2. Beverages & Tobacco	19,549	1.0	1,891	0.3
3. Crude materials, inedible, except fuels	43,264	2.2	163.916	19.0
4. Mineral fuels, Lubricants & related materials	360,491	18.5	63,851	7.4
5. Aminal & vegetable oils and fats	24,371	1.2	5,260	0.6
6. Chemical elements and compounds	205,917	10.6	2,023	0.3
7. Manufactured goods, classfied duely by material	290,210	14.9	914	0.1
8. Machinery and transport equipment	774,069	37.7	45	-
9. Miscellaneous manufactured articles	61,550	3.1	3,809	0.4
10. Commodities and transactions not classified elsewhere	7	-	1,158	0.1
Total	1,951,104	100	862,577	100

Source: Values for imports and exports from Ethiopian Statistical Abstract, 1984, Table 1-2.

427. Seen in light of imports, exports and structure of manufacturing, Ethiopia is highly dependent on technology transfer from abroad. As can be seen from the table above, in 1984 group of imports which could be cosidered to contain highest concentration of technological imports, that is chemical elements and compounds, manufactured goods, and machinery and transport equipment together accounted for 65.2% of the total imports, were more than 47% greater than the total value of exports, and amounted to about 14% of the GDP at current factor cost or to about more than twice the share of manufacturing in GDP. Composition of exports reveal that about 91% of the total value of exports consists of agricultural products mainly live animals, meat (fresh or frozen, dried, salted or smocked), raw hides and skins, oil seeds and pulses, and coffee. On the other hand, the combined share of exports of chemicals, manufactured goods and machinery and transport equipments in the total value of exports is less than 0.5%. This external trade situation of the country coupled with the dominance of light consumer goods (food, beverages, tobacco, textile, leather, and shoe, paper printing) to the extent of 65% of total manufacturing production in 1981/82 while in the area of intermediate and capital gods the combined share of metal and electrical, wood and furniture, chemical, non-metal and metal products was the remaining 35%, of which only 4.8% is accounted by metal and electrical products, reveals the technological under development and the heavy dependence of the country on technology transfer from abroad. No recent study has been undertaken to determine the cost of technology transfer to the country. However, a study made on the issue on Ethiopia by UNCTAD in 1974, considering base elements of management fees and salaries of expatriate personnel as well as values of declared returns on fixed asset, provided an estimate of cost of technology transfer for 1969/70 birr 42 million excluding over pricing of intermediate and capital good imports and birr 108 million including over pricing. The study further indicated that the latter cost estimate compared to the 1970 GDP, net value added in modern manufacturing and annual export proceeds was 2.8%, a little more than half, and over one-third, respectively. Comparable figures, as per the same study, for developing countries have been estimated to be under 1% of their combined GDP and around 4 to 5% of their export proceeds. This situation indicates to the gravity of the burden of costs of technology transfer from abroad to the country as well as to the urgent need for regulating technology transfer and for promoting national technological capability.

428. The urgency for instituting such a regulation is even more so brought into focus by considering the huge magnitude of the foreign exchange demand made inevitable by the need to import raw material, spare parts, capital goods and consultancy services which are required for the realization of the production and investment targets of the Ten-Year Perspective Plan for Industry. The total of such foreign exchange requirement for

Industry alone is estimated to be 10.1 billion birr; of which 588.6 million birr is the envisaged expenditure on intermediate and capital goods. The aim of regulating technology transfer should include promoting the building of national capabilities in international market surveying, selection and negotiation; in technology installation, operation, repair and maintenance, and renovation and spare parts production; and, in designing and enginering, adaptation, modification and generation of technology.

429. Foreign technology, through raising the productivity of labour, has played crucial role in the economic transformation of Ethiopia. Technology, both embodied and disembodied, has been used in infrastracture building and modern commodity production. Economic transformation based on foreign technology has, however, led to industrial development highly dependent on imports of raw material, intermediate goods, capital goods, services, spare parts as well as to stunting of the development of indigenous technological capacities, which, in part, are attributable to past government policies which have been designed to encourage the inflow of foreign capital but devoid of specific contents for requlating technology transfer and for promoting national technological capability.

430. The promotion of national technological capability through the transfer of foreign technology to Ethiopia should start by acquiring it piecemeal from both foreign and local sources with the object of progressively fitting of domestic technology into the total technology mix in a project. Such activities require unpackaging skills. These skills, though in existence in a limited scope and scale in such areas as spare part manufacture, modification, civil works and consultancy in both public and private sectors, are far from being adequate.

431. Trained manpower is the basis for engaging in activities of technology transfer and development. Such manpower include qualified engineers, scientists, technicians, skilled workes, industrial managers, accountants, economists, etc. with exposure to scientific and technological developmental principles and activities. National educational and manpower development plans have yet to give due orientation to Technology transfer and development in their programmes and curriculum.

432. Technology transfer and development should be aimed at supporting and promoting national development priorities. It should promote national efforts to increase the quality and quantity of existing resources and raise the productivity of the same, enhance efficiency of production, promoting the protection of the environment and encourage the development of national unpackaging skills.

433. Furthermore, technology transfer and development activities should have as their objective the development of self-reliance in technology. Therefore, technology imports should not be based only on short-term economic considerations whereby perpetual dependence on imports would result but also on the future of the country in which national technological independence becomes critically important.

434. These policies related to direct foreign investment, tariff protection and regulation of employment of expatriates, through the incentives they accorded in such forms as exemptions and/or low corporate income tax rates, foreign exchange guarantees, protection to domestic production through raising the domestic price of protected products in relation to the foreign price and employment of expatriates in positions in industry, etc., interacted in shaping the pattern of industrial development in the country. Following the eruption of the Ethiopian Revolution in 1974, the foreign domination of the country's industrialization through direct foreign investment was terminated by the act of nationalization.

Major Problems of the Sector

435 As observed in the brief assessment above technology transfer and development is beset by different problems some of which are the following.

a) The country has no specific policy for regulating technology transfer from aborad nor the institutional infrastructure to implement the same.

b) There are no legeslation, prescribing detailed provisions for implementation, affecting transfer of technology as well as procedures and institutions to encourage the growth of a national technological capability.

c) Education policies and manpower development plans do not accord due emphasis to the development and training of manpower with orientation in technology transfer and development activities and the principles supporting the same.

d) Inadequacy of unpackaging skills.

e) lack of organize R&D capacity
f) " " " Engineering capacity
g) " " " Engineering services

CHAPTER VI

SCIENTIFIC AND TECHNICAL MANPOWER TRAINING AND DEVELOPMENT

436 Trained scientists, engineers, technicans and skilled workers constitute an invaluable national resource which is of critical importance to the successful application of modern science and technology to the development process. The production of S&T manpower must, therefore, be linked to the requirements of the national development effort and so carefully planned that smooth implementation of development plans is ensured without causing over-supply of manpower in some sectors (and consequent unemployment) or serious shortage in others.

437. Accoridng to the criteria formulated by UNESCO, developing countries having per capita GNP $100 and $200 should have 1,400 professional scientists and engineers per million of population, of whom 10% should be engaged in research and development. On this basis, Ethiopia, with a population of about 47 million in 1987 should have a stock of 63,800 professional scientists and engineers out of whom 6,380 scientists should have been engaged in R&D. The scientific manpower engaged in R&D work totaled about 587 in 1984, i.e. about 10% of the minimum required as per UNESCO recommendations. There is furthermore inadequate incentives to attract the brighter students to study basic sciences (physics, chemistry, biology, etc.). This trend of moving away from the study of basic sciences can be checked only by making careers in research as attractive as in any other professional field. It must be realized that research is a function of superior intel- lect and that filling up research positions by second rate persons is counter-productive. Urgent steps are needed to make carrers in scientific research as attractive as in other professional fields.

438. There are two major weaknesses in the education and training of R&D scientists and technologists:- (i) poor foundations in the subjects of science and mathematics at the school level. and (ii) lack of significant research programs at the university level.

439. The foundation of sound education for creative scientific work has to be laid early. Unfortunately most of what the schools stress is rote learning for examinations. There is little cultivation of the critical attitude and interest in the study of nature or experimental work. The number of schools which have adequately equipped science laboratories or libraries is small. Science teaching does not involve any "doing" of science, it consists of giving information "about" science. There is thus little understanding of the scientific method or of creative scientific activity.

440. This is partly because at all stages of formal and

non-formal education, the system is overwhelmingly dependent on import, such as paper, pencil, ink, laboratory facilities and supplies, teaching equipment and instruments, documents, including books and journals needed to keep abreast of development, typewriters, calculating machines and computers reprographic and printing equipment and publication facilities, vocational training machines and tools, research equipment, as well as any maintenance, repair and replacement parts required. The entire transmission facilities for the education by radio program the radio receivers including dry cells and spare parts are all imported. The foreign exchange costs of such imports are rapidly escalating. This has narrowed rapidly the range and volume of imports which can be paid for out of the nations slender foreign exchange and with generous aid of international friendly countries and organizations. The degree of dependence on external inputs for education is disturbing and shows every sign of intensifying rather than diminishing.

441. Along with these grim and alarming situations, it must be noted that there are humble but steadily and progressively growing beginnings along this line. These include the establi-- shment and strengthening of curriculum development proces and educational material and equipment production and distribution system of the Ministry of Education, the textbook and science equipment production scheme of the Higher Education Commission, and the establishment of the Scientific Insturments Center of the Ethiopian Science and Technology Commission. Such attempts, however, must not give a feeling of satisfaction but show the need to build indigenous technological capacity to provide comparable domestic substitutions.

442. There is also a severe shortage of adequately trained teachers for science subjects. The salary scales for teachers are too low to attract the more talented and brighter people to careers in teaching profession. The number of students in a class is normally too high for effective interaction and learning process. In the 1986 - 87 academic year the student-teacher ratio were 50:1, 37:1, 15:1 in primary and junior secondary, in senior secondary schools and in vocational-techincal, teacher training and higher education institutions respectively. These figures, however, are deceptive in that in schools of urban areas the ratios are much lower for example 1:67 than the given averages, while in rural areas (1:25) they are higher. Such ratios must be compared with what are considered to be reasonalb-e, i.e., 50:1 in primary schools, 40:1 in junior and secondary schools and 10:1 in technical-vocational, teacher training and higher education institutions.

443. The rapid rise in student numbers has not been matched with adequate allocations of resources for elementary and secondary education. The 1985-86 recurrent expenditure for education was over 327 million birr of which 298 million was for

salary and 30 million for operational and administrative costs. The capital budget for same year was about 55 million birr. This in terms of unit cost, is 81 Birr for primary, 121 birr for junior and 160 birr for senior secondary schools. Such realities have forced the shift system thus exposing students to only irreducible minimum of teaching and learning opportunity. Situations of these nature have drastically reduced the quality of school education. The problem the country is facing in this area is very critical and requires the most urgent attention for its solution.

444. Another very important issue is the case of technical and vacational education and training. This is an area in which strong programs must be planned and implemented to effectively develop a large number of technically, well-trained manpower-technicians and skilled workers- to perform many essential taks in various spheres of national life. It has, however, been observed that there were problems of maintaining coordination and unity of curriculum and standards among the different technical and vocational institutions run by different governmental and non-governmental organizations.

445. The Technical and Vocational Education Advisory Council of the Ministry of Education which could have been the focal point for such coordination does not have the legal power to initiate, expand, administer and control technical and vocational education institutes and schools in the country. It has been difficult for the Council, operating from within the Ministry, to promote development and coordination of technical and vocational education and training under the responsibility of a variety of agencies. Therefore, the Council has not been able to contribute to the creation of a united technical-vocational training and education to produce technical manpower in various categories; hence development of a variety of technical and vocational education and training system.

446. At present there are over sixteen technical and vocational schools and institutes in the country. Of these twelve belong to the Ministry of Education and offer broad courses covering agriculture, construction, home economics, commerce and industrial technology. There are another four schools under the countrol of missionaries and whose curriculums are similar to those of the Ministry of Education. In addition there are specialized institutions, controlled by specialized agencies and established for specific purposes, of which the following are examples.

- Electrical and Electronics Institute of the Ethiopian Electric Light and Power Authority concentrating on the training of electrical and electronic technicians who are totally absorbed by the Authority.

- Telecommunications Training Institute belonging to the

Ethiopian Telecommunications Authority and specializing in the training of telecommunication technicians and administrative and finance personnel.

- Tourism and Catering Training Centre of the Ethiopian Hotel and Tourism Commission focusing on the training of personnel for tourism and hotel services.

- National Health Research Institute among its various activities , provides training for junior and senior laboratory technicians.

447. The technical and vocational schools under the Ministry of Education are not attached to development and employing organizations which can provide both theoretical training and practical assignments. Their curriculum as indicated above, are broad covering specialized courses offered at the specialized training institutions. This, in a way, has created overlap and duplication of efforts in the establishment of training facilities and in the production of trained manpower. That such a situation exists is proven by the following example. Examining the curricular contents of the Electrtical and Electronics Institutes, one observes that the courses are divided into "general" and "specialized" areas. The courses under "general" consist of English, Physics, Mathematics, Philosophy and Political economy, and mechanical drawing; while the specialized courses are basic electricity, workshops, instrumentation, electrical diagram, electrical machines, electronics, power protection, power system, power generation and electrical diagram, electrical machines, electronics, power protection, power system, power generation and electrical drive. Similar if not identical courses are offered by the schools under the Ministry of Education. Furthermore examination of the curricula of the other specialized institutions and centers show similar situations.

448. It is therefore essential that the Technical and Vocational Education Advisory Council be strengthened and given necessary legal status to coordinate the activities of schools, institutes and centers; to suprvise the unity of curriculum and standards and to maximize the efforts of the various institutions.

449. Education at the university level is also beset with a variety of serious problems. To mention just a few:- courses are highly influenced by the contents of imported textbooks which are in short supply and in most cases out-of-date and inappropriate to local conditions; a high proportion of the faculty members (of which 18% are expatriates with high turn over rate) are junior staff with no or very limited practical experience; laboratory and workshop equipments and teaching materials are inadequate; the number of students per techer

(1:15) is too high; the teaching load of teachers is generally considered to be too heavy; remuneration for research is unattractive: the salary scale for teachers is too low thus forcing them to look for part-time jobs elesewhere instead of concentrating on their teaching and research works.

450. At higher level education the opportunities for research degree in the various sciences are very limited and in some cases totally absent. Even in those fields in which graduate programs at a masters level have been started there is usually critical shortage of experienced staff to teach, guide and supervise the students, the research component of the graduate program of universities is mostly dependent upon foreign financial assistance which has created a great deal of uncertainty and dependency. To date none of the universities in Ethiopia offer Ph.D degrees except an embryonic Ph. D program started in Chemistry at the Addis Ababa University. The projects of research institutions and experiment stations in the country are mainly in the hands of persons without the necessary academic qualifications and experience. A recent survey conducted to assess the research manpower profile of 14 research institutions has revealed that the percentage of Ph.D's among their research staff is only 6%. This is a clear indication that the existing research institut- ions are inadequately staffed with high level manpower. Research, it must be recognized is a function of trained minds and it is unproductive to maintain at heavy cost research establishments without adequately qualified researchers.

451. The lack of talented and well trained scientific workers is today the major weakness of our S&T sector, which must be overcome with the utmost speed if we are to reap full benefit from the investment in S&T development. Emphasis should, therefore, be placed on attracting talented students to scientific studies and on cosolidation and improvement of the existing institutions of higher learning rather than on opening of new institutions. There is no point of openig new institutions unless they are adequately staffed, finaced and administered.

452. Consdering the fact that the total female population in Ethiopia, according to 1984 census, was 21,071,141 (50.1%) and realizing their potential role to socio economic development, their participation in education in general and in S&T education in particular must be seriously studied to determine their contribution to the scientific and technological advancement of the country. The proportion of girls, in the 1986/87 academic year, in primary, junior and senior secondary education were 38.6%, 39.4% and 38.7 respectively. Similarly the female population in technical-vocational education for the 1983-84 year was 36%. The female enrollments in the science and technology faculties of the Addis Ababa University are now 0.07% and 0.05% respectively. Apart from these figures a study undertaken

in 1986 has clearly shown that the performance of female students in Addis Ababa University was relatively lower than that of male students.

453. Such conditions, in the past, had grown as a result of unenlightened traditions and cultural values based on a patriarchal system, i.e., women were forced to play a second role in a social life dominated by men. In the process of dividing labour by sex, women produce childern, prepare and cook food and perform other similar chores around the home. Even at presnet although the societal definition of the division of labour is somewhat changing, traditional attitudes still persist. A great majority of female professionals are inclined to choose jobs usually class- ified by society as areas for women : nursing, food processing, etc. Rarely do women take up jobs in S&T management and administration, and in the various engineering and scientific fields. Traditions and social values have conditioned women to low aspiration, low motivation and low expectation in their performance in S&T activities.

454. With encouragement and favourable conditions, however, women's contribution to scijentific and technological advancement can surely be significant. This has been amply demonstrated in the developed and some developing countries. Efforts must therefore be made to increase the enrollment of female students in scientific and technical disciplines in technical - vocational institutions, in colleges and in universities and to induce and attract larger number of women to S&T related occupations particularly to R&D establishments. Their access to education and training in scientific and technical disciplines must be facilitated through quotas reserved for them, special scholarships and training awards including training abroad. Their conditions of services and working environment should be suitably improved on the pattern of progressive countries wherein because of such facilities the percentage of women in scientific and technical services has increased rapidly during recent years.

455. The Ministry of Education is fully aware of the need of manpower planning because it is already feeling the pinch of overproduced manpower from its twelve technical and vocational schools (leaving aside those who have completed secondary education). The clear indications of unemployment have made the Ministry to reassess and redirect its general development strategies and to critically study the need for opening technical and vocational schools of the existing types. The Ministry's deep concern in this matter is reflected by the support it gave to the Ministry of Labour and Social Affairs in its effort to produce a manpower forecast.

456. Similarly the Higher education Commission has been requesting for a manpower plan whcih it could not get. It has therefore resorted to producing high level manpower based on current

capacities and continuing along existing specializations. i.e. basing its intake on availalbe teach- ing-learning facilities and graduating those who were capable to satisfy the requirements of the universities and coleges. This has created unemployment for some graduates in such fields as psycholgy, sociology, political science and international relations and pharmacy. There are some signs of overproduced manpower even in the basic sciences. Taking such emperical information into consideration, the Commission is in the process of reducing intakes and/or planning closure of some institutions.

457. Being cognizant of the fact that the training of high level manpower (at degree level) is conducted in foreign countries as well, there is a need for setting quantitative and qualitative targets for both the local and foreign production of manpower to avoid duplication and overlap of efforts and to reduce possibilities for unemployment. In connection with this situation it is important to note that during the 1981-88 period 6859 students have been sent abroad: 2340 in engineering, 1862 in agriculture, 930 in health sciences, 1074 in social sciences, 540 in natural sciences and 113 in fine arts. Of these 2925 have returned and most of them have been employed in their respective fields of qualification.

458. As indicated above, it is essential to realize the fact that almost all foreign trainings have been at degree levels: B.A/B.Sc to Ph.D. This means that training of sub-professional personnel has beem implicitly left to home institutions.

459. One of the task forces involved in the preparation of the Ten-Year Perspective Plan was the Manpower Task Force. Recognizing the need for coordinating the education and manpower requirement plans, one of its policy recommendations was to devise ways and means by which the two plans could be balanced. Such an action is yet to come, and come it must as soon as possible if development of manpower is to be according to the requirements of the socio-economic plan of the country.

460. Aware of the need for strengthening scientific and technical education and research, the Workers Party of Ethiopia in its policy documents states that

> ....in order to accelerate the development of S&T, great emphasis must first of all be given to the provision of scientific education in a strengthened from in the regular schools and to the development of research and investigation. In order to develop S&T extensively, a conducive system must be laid down outside of regular schooling to produce professionals in all fields and at all levels, and to develop their professional competence and political consciousness.

461. The Party Policy continues to note "that steps will be taken to create favourable conditions that enable the provision, at all educational levels, of qualitative scientific and technological education relted to the country's objective conditions and to productive activity and to enable teachers to undertake in a strengthened manner and side by side with their teaching activities research work relevant to the needs of the country"

Major Problems of the Sector

462. The education sector is beset with a variety of serious problems of which some of the fundamental ones are the following.

a. Poor foundations in the natural sciences and mathematics fields at primary and secondary levels and lack of significant research training programs at the university level.

b. Lack of adequate S&T educational facilities due to rapid quantitative rise of students at primary and secondary levels and inadequate allocation of resources.

c. Severe shortage, at primary and secondary levels of talented and adequately trained teachers for the natural sciences and mathematics due to unattractive salary scales.

d. Uncoordinated training and lack of unity of curricula and standards of technical vocational education.

e. Very limited postgraduate, doctoral and post-doctoral training programs.

f. High student-teacher ratio.

g. Poor link between S&T education, research and production and inadequate exposition of students to practical and research challenges, inadequate research culture and experiences and as a result low level of R&D underakings.

h. Lack of special S&T training programs for gifted students.

i. Low participation level of women in S&T education.

j. Excessive dependence on imports of S&T learning teaching equipment, materials and other facilities.

k. Lack of manpower plan and so lack of coordination between education and training and manpower plans.

CHAPTER VII

SERVICE CONDITIONS AND INCENTIVES FOR SCIENTIFIC AND TECHNICAL MANPOWER

463. The successful implementation of the National Science and Technology Policy would depend critically on the competence, devotion and job satisfaction of the personnel working in scientific institutions and establishments. The development of S&T is dependent upon the intellectuals who are part and parcel of the working people of the nation. However, scientists and technologists in Ethiopia are handicrapped by such factors as inadequate facilities, lack of conducive work environment, unsatisfactory service conditions and poor payments. These have been the main causes of the brain drain phenomena, which have grave implications for the future of a developing country like Ethiopia.

464. A rough survey made by the Commission in 1984 indicated that only 5% of the potential R&D manpower with university degrees were engaged in R&D activities. The shortage of S&T manpower in the various R&D institutions is acute and so far no corrective measures have been taken to reverse the flight of talent from R&D to production and service sectors where the very highly qualified personnel is less efficiently used. Furthermore, talented scientists migrate to developed and neighboring countries for want of higher pays and better opportunities.

465. The causes for this tendency have been brought to attention under several occasions; First, research and development activities, especially in the field of agricultural research, are mainly carried out in areas where infrastractures are not well developed. As a result the researcher does not have proper accommodiation, health and education services, shopping and entertainment facilities and employment opportunities for his family. Neither is he given compensatory remunerations for dislocation and incoveniences. He, therefore, sees his position worse to that of his counterparts in other non research ventures and is more often forced to withdraw from his commitment.

466. Second, even those who hang on to research out of commitment, lack on overall framework in which their activities fit to make a meaningful contribution. Research priorities are not clearly drawn, procedures for budget allocation and disbursement are cumbersome and serious concern for the assignment of vital resources like manpower, raw materials and equipment is lacking. Furthermore, proper library, information and documentation facilities, adequate laboratory and workshops are not organized and made available. Operating under such circumstances does not only reduce the efficiency of the researcher but also leads him

to frustration.

467. Unless the R&D project is well defined, in line with national priorities and all the necessary inputs provided and the work process simplified, it will not be appropriate to expect good results. Neither would it be possible to hold the researcher accountable for unsatisfactory performance.

468. Third, the system prevailing in many R&D institutions according to the survey carried out by the Commission is not conductive to researchers in general. There are internal problems of the institution itself and then problems associated with the supervising authority or even with institutions doing research in the same field of activity.

469. The internal deficiences are lack of accepted organizational structure, absence of a proper management system and working procedures, shortage of finance, lack of adequate and qualified manpower, accepted work programmes and norms. A system of promotion for good performance, better remmuneration and incentives for innovative works and attractive career prospects very seldom exist in R&D institutions.

470. Externally, there is little or no active support from supervising authorities. The horizontal cooperation between R&D institutions in the same field of activity is discouraging. Lack of coordination of efforts and exchange of information is a common phenomenon.

471. While the demand for R&D activities is becoming crucial and even increasing in light of developmental requirements and the crucial problems now facing the country, environmental factors have become the discouraging factors to attract talented and dedicated people to the research field.

472. Fourth, there is lack of encouragmenet for R&D workers to improve their skills and capability through participation at international S&T seminars & conferences, through collaborative R&D programmes with foreign scientists and institutions. Non-existence of a sabatical leave system and very limited mobility between research, teaching and production on rational basis, is another issue of concern.

473. A system and procedures of sending scientists and engineers to specific institutions or target areas for the acquisition of particular knowhow and skill has not been prctised. Even when delegations are sent for attending conferences, the system of selection and follow-up afterwards is not fairly established.

474. Fifth, scientific associations which could be instrumental to identify able scientists for the various pertinent needs and R&D positions have not been given the support required. The

contributions these associations could render in rating the various scientists and also in organizing talent to solve particular national problems on call basis has not been properly tapped. Furthermore, access to international scientific associations and encouragment of selected nationals to join them has not been given due consideration. Such forums could be used to acquire information and exchange of experiences through publications and other forms of contacts.

475. Sixth, a system of intellectual property rights to encourage inventions and innovations and an office responsible for this do not exist in the Country. The Commission convinced of the need, is now in the process of establishing such an office. However, in some institutions like in the Ethiopian Airlines, a system of incentives in the form of pecuniary rewards for creative and financially feasible technical solutions exists. In industries, various instruments such as bonuses, certificates and prizes for best performances including for creative works, promotions, etc. are practised to motivate workers for better productivity.

476. Furthermore, the WPE and Government have initiated awards, in the form of medals and prizes in kind, for people who have made outstanding contributions in the field of S&T. Recent examples include prizes at the founding congress of the PDRE and the prize given to researchers in coffee plant improvement, pollution control in Addis Ababa abattoir etc.

477. Although such efforts are also made in various other institutions, no global systematic procedures and sets of requlations exist to mobilize the creative potential of scientists, technologiests and workers. To improve this situation the Commission is trying to create a forum where inventors and innovators could exchange experiences and receive honours and recognition from the public as a stimulii for better results.

478. In general, the environment for scientists and researchers should improve significanctly. Working conditions should be ameliorated, a system of motivation should be instituted and measures should be taken to develop socialist emulation. In this regard, the WPE cognizant of the importance of creating favourable working conditions for scientists has noted in its S&T policy document that "since the Country's scientists and researchers will have a great contribution to make to the success of the work of such institutions (research, dissemination and design), the provision in a concerted manner, of favourable work conditions should continue in order to enable them to fully put into practice their knowledge and experience".

Major problems

479. The brief assessement above has shown that service condit-

ions and incentives for scientific and technical manpower are not good and among the various problems some are given below.

a. Inadequate facilities and conducive work environment in scientific institutions and establishments.

b. Unsatisfactory service conditions and payments for S&T manpower engaged in R&D and as a result flight of talent from R&D to production and service sectors. This situation has also resulted in external brain drain.

c. Absence of compensatory renumerations for dislocation and inconveniencies discouraging S&T manpower to work in areas where infrastructures are not well developed.

d. Lack of encouragment for R&D wokers to improve their skills and capability.

e. Non-existence of reward and efective system to enhance S&T activities.

f. Absence of a system of intellectual property rights and an office responsible for this to encourage inventions and innovations.

g. Inadequate support to scientific associations.

h. carrer structure

i coordination

j. administration

k. talent identification

CHAPTER VIII

POPULARIZATION OF SCIENCE AND TECHNOLOGY

480. Creation of widespread awareness of S&T, dissemination of R&D findings and diffusion of indigeneous and appropriate foreign technologies are absolutely necessary if these are to be utilized as instruments for improving the quality of life of the people in Ethiopia. This is not an easy task, particularly because the level of education of the vast majority of the people is extremely low. The strategy for making society science and technology minded have therefore to incorporate a multiple approach, taking into account the attitudes, interests, educational and cultural background of the various sections of the urban and rural population.

481. Inorder to ensure sustained interest of the general public, it is necessary that the people be kept regularly informed of the advances in S&T as well as their applications, and a systematic campaign launched to involve them in programs for technological development in both rural and urban areas. The most effective way of mobilizing the people to innovate, adapt and apply such knowledge and technical knowhow in practical fields and of changing their attitudes to enable them to utilize the scientific method in their every day lives is therefore through sustained S&T popularization programs.

482. At this juncture it is appropriate to ask the question "What is S&T Popularization?", and give it some form of definition. S&T popularization is the program for the stimulation and creation among people an awareness of the goals, objectives, contents and methods of science and technology through which they may be actively and fruitfully participating in socio-economic development activities, i.e, science and technology programs focusing on the provision of scientific literacy and technical knowhow, and formation of scientific attitudes through formal and informal educational systems. This in short is communication of science and technology to different types of audience with the aim of enabling them to attain scientific knowledge, scientific attitude and technical skills essential for their socio-economic development.

483. S&T popularization programs must be able to provide appropriate contents, methods and activities suitable to needs of each group and sub-group of their varied audience (peasants, students, teachers, workers, social science professionals and sub-professionals scientists, engineers, technologists,etc.,). The following are some activities, identified by UNESCO and practiced by developed and developing countries, applied in the popularization of science and technology:-

- dissemination of R&D results proved to be appropriate and useful;
- diffusion of inadegenous and foreign technologies;
- the creation and strengthening of science clubs;
- the organization of science exhibitions and fairs;
- the production and distribution of scientific and technical literature;
- the supply of popular science and technology literature and annotated bibliographies;
- the establishment of advisory programs for careers in science and technology;
- the production and utilization of science and technology films;
- establishment of museums of natural history;
- use of the mass media;
- strengthening the role of scientific and technological associations in popularization activities;
- organizing contests, olymiads, competetions, etc., in S&T fields; and
- establishing all purpose science laboratories, technical workshops, extension services, and information and documentation centres.

484. What are the past and present situations in the country regarding S&T popularization programs? Various government organizations have projects of science and technology popularization related to their specific areas of concern. They use various media for communicating with their respective audiences. The Ministry of Education, for example, owns eleven radio transmitors situated in different parts of the country and covering 95% of the total area. They are devoted to braodcasting programs of the formal and informal educational contents. Supporting radio programs give emphasis to the basic understanding of scientific consepts and the use of simple and effective technologies. The activities of the Awraja Pedagogical Centres (APC) and Community Skills Training Centres (CSTC) are primarily and basically concerned with science and technology popularization programs.

485. Similarly the Ministry of Information, on its own initiative and incooperation with other government organizations, uses national radio and television for broadcasting programs in science and technology. It allocates space in its daily and weekly newspapers, for science and technology contents. The Ministry's other publications also include subjects of scientific and technological interest. Examples of such activities are "Mr. Wizard" on TV, the Friday science and technology column in the Ethiopian Herald, and the various interviews of scientists and technologists broadcased by Ethiopian Radio.

486. Both governmental and non-governmental organizations produce, regularly, publications with emphasis on S&T contents of special interest to the general public. The Ministry of Agriculture issues posters focusing on defined topics and relevant for different seasons and geographical areas, an example being the posters on afforestation and reforestion program. In its quarterly magazine, "Zena Gebrena", the Ministry includes S&T acticles of popular interest. The Institute of Agriculture Research produces annual proceedeings on national crop improvement, livestock improvement, crop protection and livestock pasture and forage R&D. It also produces special phamphlets covering different topics and addressed to peasants specially. Some other organizations making similar efforts are the International Livestock Centre for Africa, the Ethiopian Standards Institute, the Addis Ababa Urban Dwellers Association, Revolutionary Ethiopia Women's Association and Handicrafts and Small Scale Industries Development Agency.

487. Ethiopian Sccientists and Researchers of the 1950's and 60's, having been educated and trained in foreign Universities and in the process having been exposed to S&T publications produced by those communities, had the tendency of depending on those journals for publishing their R&D findings. Such an attitude had, for a long time, hampered the development of local S&T publications.

488. With the increasing number of higher education institutions in the country and so with the increasing number of local graduates taking up research work, the attachment to foreign S&T publications has been steadily waning. The establishment of the Ethiopian Medical Association and along with it the coming of the Ethiopian Medical Journal was a major break through for S&T publications in Ethiopia. As a consquence, in the recent past and at present scientists and researchers have began to organize themselves into professional associations and societies, and they have started to initiate their journals, newsletters, bulletins, etc. They have also come to realize that their publications were not for their own use only but also for reaching the general public. This is to say that their R&D findings could be effectively disseminated and their practical applications enhanced through such publications. This was clearly demonstrated by the

interest and enthusiasm created among high school teachers and students, by the contents of Hissab, the Mathematics Journal, the Bulletin of the Chemical Society of Ethiopia, Voice of Teachers and SINET, the Journal of Sciences.

489. The WPE program stipulates that in order "to develop the scientific and technological knowledge of the people and disseminate sceintific and technological information, scientific and technical exhibitions will be organized; permanent and mobile science and technology museums, libraries, archives and other facilities that will help in expanding scientific and technological knowledge will be established ". In accordance with this policy five government organizations consisting of the Ministries of Agriculture, Health and Industry, and Ethiopian Science and Technology & Water Resources Development Commissions have taken steps to develop effective definitive and continuous science and technology popularization programs in their respective areas of concern. The programs have tried to be practical and to focus on "now and here" problems. They have also attempted to deal with long-range problems. They have utilized the written word, radio and television for passing their messages. Their stress on applying simple and comprehensible language and application of relevant audio-visual aids was steadily improving.

490. Notwithstanding such recent efforts, it cannot be said that effective and efficient mechanisms have been established to disseminate local and/or imported R&D findings and to diffuse indigenous and/or imported technologies and techniques. This is mainly due to the lack of organizational, manpower and financial coordination and cooperation of R&D institutions on the one hand and operational and implementing bodies on the other. It is also due to lack of proper consideration, at the planning stage, and to the low priority level given, at the implementation stage, to S&T dissemination and diffusion programs. Lack of proper dissemination and diffusion techniques is another reason. Furthermore the monitoring and evaluation systems for S&T dissemination and diffusion in the various sectors is weak.

491. The Workers Party of Ethiopia, has further noted that "measures will be taken to encourage workers, members of the Revolutionary Army, intellectuals, the youth and the working people in general to develop their abilities to create new and improved working techniques and instruments, and in this connection, measures will be taken to develop socialist emulation".

492. Based on this guideline, the Ethiopian Science and Technology Commission prompted to focus its attention to the promotion and coordination of scientific and technological popularization activities in the country. From the outset, the Commission had accepted that one of its basic and most important objectives was that of raising the general level of appreciation

of science and technology on the part of the people. It has always been convinced that it was not simply enough to confine scientific activities to the modern sector only since general development and social integration could not take place without mass participation.

493. Such a conviction had prompted a study into the problems of science and technology popularization. It was realized that part of the backwardness of the mass was due to lack of awareness of what benefits modern science and technology could bring interms of improved standards of health and hygiene, better production methods, improved skills and access to higher incomes and therefore higher standard of life. It was recognized that if the people had such an awareness, not only would they improve their own living conditions, they would also be more assertive to government programs to improve socio-economic development. The question was, how can such awareness be created?

494. Empirically speaking there are two broad constraints to the popularization of science and technology and these are:-

a. A resistance to accepting ideas where these conflict with traditional religious and value systems and

b. A resistance, for social reasons, to changing established practices with respect to personal hygiene, sanitation, housekeeping, diet, epidemic control and work.

Unfortunately very little is known about what is behind these constraints, how important they are relative to each other and how they infringe on different national and social groups. It is for this reason that special emphasis is given to determining the causes of these and other constraints, before embarking upon any kind of definitive science and technology popularization program.

495. With respect to finance, the programme has been drawing upon external sources in addition to government contribution. Funds secured through bilateral and multilateral agreements have been instrumental in carrying out several projects. For example, UNICEF supplied radio receivers (which SIDA is also now doing) to the Ministry of Education for use in the formal and non-formal educational services. It also supported the efforts of the National Commission for Children in the study for the determination of superstitions and other unscientific beliefs harmful to mothers and children and the health education programmes of the Ministry of Public Health. The purchase of the eleven radio transmitters (referred to above) was effected through loans from the World Bank. Another project worth mentioning is the EEC financed Water and Timber Project which had been integrated in the labour education programme of the formal school sector. The United Nations Financing System for Science and Technology Development, through the Ethiopian Science and Technology

Commission, granted funds for a project to coin science and technology terms in Amharic. FAO was involved in the popularization programs of the Forest and Wildlife Conservation and Development Authority. A new project entitled "Afforestation and Soil Conservation Education" jointly run by the Ministry of Education and SIDA has recently been launched. IDRC supported the Ethiopian Science and Technology Commission to undertake a research project aimed at determining the origins and sources of non-scientific beliefs among the different nationalities of Ethiopia. UNDP is poised to support educational television program.

496. Indeed rudiments of programs of popularization of science and technology did exist and were given attention in some form at different times in the past. However, the attention was not continuous and consistent. The choice of contents and methodologies was not in consonance with the type of audience they were supposed to address. More than anything else no effort was made to monitor and evaluate relevance and effectiveness of the programs specifically as concerns their impact on S&T development or their acceptance amongest the masses.

Problems and Shortcomings of the Sector

497. The present science and technology popularization programs are beset with the following problems and shortcomings:-

a. The importance of science and technology popularization cannot be said to have been fully recognized and so had not been given the attention it requires for effective implementation.

b. It does not have clearly enunciated objectives, strategies, policies, programs, projects and investment.

c. There has never been a central coordinating and administrative body of science popularization activities.

d. Existing science popularization programs are not based on essential research findings and so they tend to be spontaneous in nature and not properly fit to audience needs and interests. That is, no research has been conducted in order to determine the contents and methodologies of science popularization that are appealing and appropriate to the Ethiopian masses.

e. There are no properly trained personnel to effectively

carry out science popularization programs.

f. Existing programs have not been monitored and evaluated to determine their effectiveness.

g. Written and other materials and equipment that are essential for the popularization of science and technology are not readily and easily available.

CHAPTER IX

FINANCING OF SCIENCE AND TECHNOLOGY

498. It is now a well established fact that the widening gap in living standards between the industrialized and the developing countries is principally the Science and Technology gap and is due to the fact that spending on Science and Technology in the industrialized countries is of the order of 2-2.5% of their GNP, whereas the developing countries spend less than 0.2% of their GNP. Scientific and technological development in the present day world demands heavy investments. Research and development is now a $150 billion global enterprise, employing some three million scientists.

499. A survey carried out in 1973 by the Organization for Economic Cooperation and Development (OECD) showed that the share of the developing countries of the world expenditures was less than 3%. Even within the developing world, approximately 60% of this total investment on R&D is concentrated only in a few countries. The consequences of this maldistribution of resources vis-a-vis global R&D effort are manifold. The most obvious is the fact that the focus of the world's research capability continues to be largely on political, economic and soical needs of the rich countires, while hardly any scientific research effort is devoted to the solution of far more pressing problems of the developing world. More recently, the developing countires too have realized the imperative need for investment in R&D as the most promising input for the achievement of their socio-economic goals and several forward looking developing states have increased their investment in R&D substantially in order to achieve a quantum jump in the field of science and Technology.

500. Despite the growing trend in R&D outlays of developing countries, however, it is still low. It appears that the third world countires are just not serious about Science and Technology.

501. The Lagos Plan of Action observed that limited volume of financial resources devoted to S&T is one of the important

factors which is hindering the development of scientific and technological base in Africa. It is safe to state that the relatively poor performance of African countires in science and technology is largely due to inadequate budgetary resources of their own devoted to research, experimental development and the related scientific/technological services carried out in Africa. The regions share of global R&D expenditure is on the average around 0.3 per cent. The percentage of the GNP devoted to R&D appears that the overwhelming majority of African states do not yet devote 0.5 per cent of their GNP to R&D. In fact many African countires do not include S&T as an item in their budgets. No wonder that Science and Technology capability is the lowest in the world. One should make no mistake about it. No Science and Technology capability is po, ible without a nation spending an inescapable minimum of funds on it.

502. Another equally disturbing fact is the heavy reliance of many African countires on extrnal sources to finance their R&D activities. According to 1987 UNESCO report, foreign funds acounted for 58.8% of total R&D expendture in Burkina Faso in 1981. In the same year the figure was 28.3%, 33.3%, 92.8%, 26.4% and 69.0% for the Cote d'Ivoire, Mali, Mauritania, Niger and Senegal, respectively. The figure for Ethiopia in 1986/87 period was 37.7 per cent. Although foreign support can play a vital role in S&T development, over reliance on extrnal support could also lead to dependency situation.

503. The Lagos Plan of Action recommended that Member States should take steps to improve existing and create new funding mechanisms to provide funds on a predictable and continuous basis at the national level, with a view to substantially increasing the resources available for the development of their scientific and technological capabilities and to the implementation of the Program of Action. To demonstrate their political will and commitment to improving the lot of their people, Member States are urged, within the coming decade, to aim gradually reaching the target of mobilizing, at the domestic level, 1 per cent of their GDP for the development of their scientific and technological capabilities.

504. In Ethiopia scientific and technological research activities are carried out in only small sectors of the national economy. A few sectors have shown greater appreciation of the critical importance of R&D component in development, e.g., fully 3.5 per cent of the developmental expenditure on agriculture is spent on research. This sizeable investment in agricultural research has resulted in obtaining some high yielding crop varieties and cultural practices for major crops. If these research findings were vigorously disseminated to and effectively utilized by the peasant sector, the agricultural sector would have been able to contribute billions of birr to the wealth of

the nation and make the country self-sufficient in food supply. On the otherhand some other sectors have more or less neglected research, e.g., the industrial sector spends less than 1 per cent of the developmental expenditure on R&D research. There is thus not only a general inadequacy of resources, both human and material, devoted to R&D there are also serious inter-sectoral imbalances; some sectors being almost totally deprived of funds for R&D. Detailed R&D plans and programs would have to be worked out by each of the various ministries to secure firm financial commitments for their sectors. At present most of the sectors appear to have only scant realization that Science and Technology can be applied to development and as such, have failed to strive for self-reliance.

505. In Ethiopia, R&D activities are being conducted by research establishments, developmental organizations and institutions of higher learning. Except for research establishments and in some few cases for higher education institutions most sectors do not have a separate item for research in their budget. This makes it extremely difficult to get adequate information of the status of Science and Technology financing in Ethiopia.

506. It is, however, possible to get some idea about the magnitude of R&D financing from a survey made by the Ethiopian Science and Technology Commission in 1985. According to this survey which was made for the period of 1974-84, the country's R&D expenditures had amounted to about Birr 212 million (or about $103 million) for the time under consideration. It is also interesting to note that out of this total, Birr 49 million ($24 million) was for capital expenditure and Birr 34 million ($16 million) for recurrent expenditure. The remaining Birr 129 million ($63 million) could not be determined whether it is capital or recurrent expenditure.

507. It was also possible to learn from the survey that out of the total expenditures for R&D, about Birr 84 million ($40 million) was obtained from foreign sources and about Birr 101 million ($49 million) of it came from domestic allocation. Out of the remaining Birr 27 million ($13 million), except for a very small amount (about Birr 7 million from domestic source), the rest of it could not be traced to any source. It is also worth noting that more than 40 per cent of the R&D expenditures had come from foreign sources.

508. The survey also indicated the following sectoral allocation of the R&D expenditures:-

Sector	Amt. in million birr	Amt. in million Dollars
Food & Agriculture	118.7	57.3

Health	16.9	8.1
Education & Culture	0.7	0.3
Natural Resources	49.8	24.0
Industry	13.7	6.6
Trade	9.5	4.6
Construction	5.9	2.8
	212.2	103.7

509. As can be seen from the above allocations, Food and Agriculture received 56 per cent, Natural Resources 23 per cent and Health 8 per cent of the total R&D expenditures for the period under consideration. These three sectors received between then about 87 per cent of the total R&D expenditures. Industry's share was a mere 6 per cent of the total. Sectors such as construction, Trade, Education and Culture received only a tiny fraction of the country's R&D expenditure. The pattern of allocation incdicates a great deal of disparity and imbalance among the between the sectors in the share of the country's R&D expenditures.

510. The national paper of Ethiopia specially prepared by the Ethiopian Science and Technology Commission at the request of UNESCO for the CASTAFRICA II Conference reported that about 81 million birr had been allocated in 1983/84 to various scientific and technological activities in the country. This is approximately 0.8 to 0.9 per cent of the GNP. This is a high percentage figure compared with many developing countries. It is, however, very difficult to know just how much of this amount went to wages and salaries and other administrative expenses and how much of it was allocated to actual research work. There are , however, some indications that this figure included infrastructural as well as R&D expenditures. Besides this was merely a budgetary figure and not an actual expenditure. Moreover, there is no consistency in the amount of fund approved from year to year as there is a great deal of fluctuation. In the same paper it was noted that in 1985 the R&D expenditure had amounted to 0.32 per cent of GNP. This is far below the 0.5 per cent of GNP target for R&D laid down by the United Nations and the Lagos Plan of Action.

511. By taking into account the critical position agriculture holds in the national economy, the Party and the Government have decided to allocate a substantial amount of fund to R&D work in this sector. Acordingly the R&D budget for agriculture has been raised from 27.6 million birr in 1985/86 to 61 million birr in

1986/87. The sources of this fund and the allocation to the various organizations conducting R&D activities in the agricultural sector are indicated below.

Organization	Source of fund (in'000 birr)		
	Treasury	Foreign	Total
IAR	32,967.7	18,813.4	51,781.1
PGRC/E	1,257.7	211.9	1,337.6
AUA	3,108.4	2,749.9	5,856.3
AAU	584.4	220.0	804.4
SPL	-	1,000.0	1,000.0
	37,918.2	22,995.2	60.913.4

512. This is a substantial increase in the R&D fund for the agricultural sector. It is also worth noting that about 38 per cent of the allocated R&D budget had come from foreign sources and it is also important to realize that a good portion of the amount is for infrastructural spending.

513. The Ethiopian Science and Technology Commission has been able to get about 19.3 million birr since its establishment from various international organizations to support R&D activities in the country. The major donors included SAREC (14.5 million birr), UNDP (2.17 million birr), UNFSTD (1 million birr), and IDRC (0.097 million birr). Such assistance has been instrumental in helping support a large number of high priority research projects as well as training programs for the development of top level manpower. In general the potential that exists formultilateral and bilateral funding of S&T is not fully exploited in Ethiopia.

514. Scinece and Technology capability building requires the allocation of adequate amount of fund on a continuous basis. Otherwise the S&T capability that is so desired by everyone would not be forthcoming. Here the commitment of the government to allocate a certain fixed percentage of the GNP to S&T activities would be essential.

515. Almost all of the current R&D expenditure is undertaken by the Central Government, and the public sector spends almost nothing to the total outlay on S&T. It is, however, the latter which are responsible mostly for the productive sector and for national resources development with which R&D should be effectively linked. Without such grassroots linkage, even the financial resources that are now available are likely to be frittered away

on research irrelevant to the actual situation. The potential thatexist for cooperatives to finance certain S&T activities relevant to them is hardly tapped.

516. Another serious problem is that Science and Technology organizations encounter unnecessary delays and dificulties in getting their budget even long after it has been approved by the government. The procedures followed are too cumbersome and frustrating. In some cases the organizations may even totally fail to get payment of part of their approved budget. No sustained effort can be made in S&T capability building under this kind of a situation.

517. Still another area of great concern to scientific and technolo- gical establishments is the requirement that taxes be paid on items imported for scientific work. This is counter-productive and greatly discourages the scientific and technological development efforts of the country.

518. Another self-defeating action is the requirement placed on S&T establishments to give up the income they have generated from their various activities. Actually allowing such establishments to use the income they have earned would have gone a long way towards the attainment of financial self-suporting in the long run.

519. Various measures that are used in many developing countires tofinance S&T activities are not used in Ethiopia. Measures such as the inclusion of an S&T budget in the socio-economic development programs of the planning zones, using S&T tax fund, establishing President's S&T fund, allowing R&D institutions to meet part of their financial need by being self-supporting, and encouraging cooperatives tofinance certain S&T activities that are of direct interest to them, etc. are nonexistant in the country. Such measures would have contributed greatly to the overall S&T fund available in the country.

Major Problems of Financing Scinece and Technology

520. It is possible to identify some of the major problems of Financing Science and Technology in Ethiopia as follows:-

(a) Financing of Science and Technology, besides being inadequate is not made available in a sustained and continuous manner.

(b) Various sources of S&T fund are not adequately developed and fully utilized.

(c) The procedures followed in releasing the approved S&T budget is too cumbersome and time-consuming.

(d) Imported materials for scientific and technological activities are taxed and clearing procedures are very cumbersome.

(e) The system does not encourage institutions to generate revenus and use it for self-financing.

(f) Cost-benefit analysis of major R&D projects has not been practiced. Any finance allocated should yield financial benefits.

CHAPTER X

International Cooperation in Science and Technology

521. Science by its very nature is international. It has traditionally moved across political, geographic and ideological barriers, through the movement of scientists, meetings, lectures and discussions at seats of learning and research, and above all books and journals. The increasing consciousness of problems common to peoples all over the world, requiring scientific solutions, has brought about a sharper awareness of the need for closer international cooperation. Numerous formal and informal mechanisms have been developed with the purposes which operate efficiently, even amongst competing power blocks, as evidenced from S&T agreements between the USSR and USA in space science and technology.

522. While a great deal of science and technology is readily available, not all of it is freely shared. Science and technology are the sources of power and wealth and nations are in competition with each other to acquire these resources. A very large proportion of the global investment in research is for defence and industrial purposes. Scientific knowledge and technology so generated is not available or can be acquired only at very high cost. S&T transfer has, a consequence, become a critical area of foreign policy, and there is selective sharing based on political and ideological orientation.

523. The development of active cooperation in the field of science and technology makes it possible to promote collective self-sufficiency by pooling scientific and technological resources potential and eliminating duplication in specific large scale programmes.

524. In Ethiopia as in many other developing countries scientific and technological cooperation mechanisms are a relatively recent development and thus, international cooperation in science and technology is scarce. Since the 1979's, however, some advances have been made in order to strengthen cooperation in science and technology with developed as well as developing countries through bilateral and multilateral agreements. Some of the S&T cooperation programmes which ESTC has information about are explained as examples.

Regional S&T Cooperation Programmes

525. Ethiopia collaborates with regional and sub-regional organiza- tions like Desert Locust Control for East Africa (DLCOEA), African Leprosy Research and Training (ALERT), International Livestock Centre for Africa, (ILCA), etc. Ethiopia's collaborative activities with regional and sub-regional networks and associations of Education and R&D institutions and production

and service organizations include the Association of African Universities (AAU), the Committee of Engineering Education in Middle Africa (CEEMA), the Association of African Airlines and the like.

ARCT - (African Regional Centre for Technology)

526. ARCT is an intergovernmental organization established by the Heads of States and Governments in Africa under the auspices of OAU and UNECA. The framework within which the centre's programme of work is conceived is the Lagos Plan of Action for the imple- mentation of the Monrovia strategy for the Economic Development of Africa. The work programme of the Centre stresses on: development of indigenous technological capabilities; human resources development and utilization; rural development; contributing technologically towards the activation of the priority sectors of socio-economic development; strengthening the information and data base on technological requirements and on natural resources and their exploitation. The financial resources of the Centre are annual and special contributions from the member states; assistance, and, loans gifts or grants from governments, bodies or individual persons; and fees and other charges that may be levied by the Centre for services rendered. Ethiopia, one of the 29 member states which have acceeded to the constitution of the Centre, is committed to pay an annual contribution about Birr 100,000 and about a total of Birr 1,016,000 has been committed for payment for the Centre since its establishment in 1977. Only US $20,000 has been granted to Ethiopia from the Centre. ESTC has become the national focal point for the Centre since the beginning of 1980 Ethiopian fiscal year.

527. But there are many more regional and sub-regional organizations and institutions which are concerned with R&D activities which Ethiopia does not collaborate.

528. Scientific and technological cooperation between Ethiopia and other developing countries in other regions does not exist and as a result the experience of countries in other regions facing similar problems and that of newly industrialized countries such as India, Brazil, Korea, Mexico, etc., is not drawn.

Bilateral Agreements

529. With regard to scientific and technological bilateral cooperat- ion, a growing number of cooperation exist.

a) - SAREC (Swedish Agency for Research Cooperation with Developing Countries)

SAREC which founded in 1975 with an objective to assist developing countries in their endevour to strengthen their scientific

and technological capabilities has supported Ethiopia since the fiscal year 1979/80. During the nine year period, 1979-1988, SAREC's support to research in Ethiopia has totalled SEK 45.14 million (about 13 million Birr). Ethiopia is the highest receipient of the support given by SAREC to developing countries. All SAREC support is channelled through the ESTC. SAREC's contribution to the total cost of SAREC supported projects is about 57% while that of the government is about 43%. The highest portion (about 37%) of SAREC's fund has been allocated to Natural Science Research. 15.7% and 15.6% have been allocated to Health Research and Natural Resources Research respectively while only 10.9% and 6.5% are allocated to Food and Agriculture Research and Industry and Technology Research respectively. Research projects are planned jointly from the outset.

b) -IDRC (International Development Research Centre)

IDRC, which was established in 1970 as an autonomous public cooperation with the objective of initiating, encouraging, supporting and conducting research into the problems of the developing regions of the world and into the means of applying and adopting scientific, technological and other knowledge to the economic and social advancement of those regions, since 1972, has approved grants totalling C $10,155,815 for 44 institutions located in Ethiopia. Grants totalling C $6,338,070 have been awarded for 28 projects run by national institutions while the balance C $3,817,745 has been awarded for 16 projects run by international or regional institutions. The national focal point to IDRC now is the office of the state Committee for Foreign Economic Relations (OSCFER). IDRC directly deals with the concerned institutions, and only the outcome of the funding negotiation through a copy of the memorandum of grant conditions is reported to ESTC.

c) -IFS - (International Foundation for Science)

IFS, a non-governmental organization, was founded in 1972 to promote and support in developing regions the research efforts of scientists working in the field of agricultural and biological sciences and related technology. IFS has been active in promoting science in developing countries since 1974 and since, some 1137 granteesin 88 developing countries have received financial and intellectual support from it. Ethiopia is a member of IFS and pays annual membership fee. It has paid a total of about US$ 2,220 Since it has become a member. ESTC is the national focal point to the Foundation. Out of the 1041 grantees supported by IFS from 1974-1986, 15 grantees were Ethiopian researchers. The granting process is that a candidate submits an application directly to the IFS secretariate, where it is prescreened and sent to member organization for opinion on national needs priorities.

d) Cooperation with Socialist Countrys

The scientific and techniiological corporation with the USSR is the only S&T cooperation with a socialist country that is known. Ambo Phytopathological Laboratory which has been established in accordance with the agreement signed in 1972 between PDRE and USSR, has been in existence for the last 12 years. According to the Soviet side, the Laboratory receives about Birr one million annually in the form of research specialists, equipment, building material, etc., from the USSR.

e) UN Organizations

(i) IAEA - International Atomic Energy Agency

IAEA established in 1957 as an autonomous intergovernmental organization, is one of the 16 specialized agencies in the UN system. Its main objectives are to seek, to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world and to ensure that the assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose. Ethiopia is one of the founding members of the IAEA. Since December 1978, the ESTC has been the national focal point to the Agency. The total amount of money that Ethiopia has paid for membership fee and voluntary contribution from 1976 - 1988 is US $83,359. Ethiopia has received assistance valued at US $1,323,900 from the Agency in the form of equipment, fellowships and experts from 1958, the beginning of the Agency's technical cooperation activities, to 1986.

(ii) - UNDP - United Nations Development Programme

UNDP which is a funding agency of the United Nations supports different projects in the world which share a common goal:- the fuller and better use of available natural resources, and of human talents and energies. Many of the R&D institutions in Ethiopia have received assistance for scientific and technological activities from UNDP in the form of manpower training and development, consultancy service and scientific equipment. UNDP, has granted US $1,140,000 for four projects namely: S&T Manpower Training and Development, S&T Information and Documentation Center, Scientific Instrumentation Center and S&T Policy and Planning that are directly being undertaken by the ESTC and US $50,000 for Science and Technology Terms Translation Project (STTTP) which is being run by the Academy of Ethiopian Language in collaboration with ESTC. It is the government which allocates UNDP funds to the various sectoral ministries.

(iii) UNFSTD - (United Nations Funds for Science and Technology for Development)

UNFSTD, a successor to the former United Nations Financing System for S&T for Development, was established by the General Assembly and set organizationally as a special purpose fund within the UNDP from 1 January 1987. Its aim is to provide a stronger operational focus for S&T at the multilateral level and a better integration with social and economic development within UNDP. US $459,650 and US $10,000 have been granted by UNFSTD for Science and Technology Terms Transportation Project (STTTP) and S&T policy and planning project respectively.

(iv) UNESCO-

UNESCO which was established in 1946 is one of the specialized agencies of the UN system. It has 158 member states and programmes (regular and participation) are approved by a biennial General Conference of all member states. Its main objective is the building up of peace among the peoples of the world through the development of education, science and culture. The national focal point to UNESCO is the Ethiopian National Agency for UNESCO. Ethiopia is not a major beneficiary in scientific and technological activities. About US $104, 000 assistance in the form of equipment, consultancy service and training has been received by the ESTc.

530. In addition to the above mentioned organization there are many other organizations like EEC, WHO, SIDA, FAO, WMO, etc., and countries like USA, France, UK, GDR, FRG, Japan, Belgium, Netherlands Czechoslovakia, etc., which have supported S&T activities in the various R&D institutions. But the types and extent of support given by these organizations and countries are not known by the Commission and information is scanty to identify the support for S&T activities.

531. From the above mentioned facts the following conclusions can be drawn.

a) Since International Cooperation in S&T is neither approved nor coordinated by the national S&T policy making body (ESTC), it has not been possible to ensure that the cooperation programmes contribute to the strengthening and development of national capabilities. It is also difficult to avoid duplication and to achieve the optimal use of avail- able resources.

b) Many S&T international cooperation activities are not planned and no national budget is allocated to foster

links, bilateral and/or multilateral with African or Third World countries as a conscious effort to promote collective self-reliance.

c) With the exception of SAREC which is manifested by the very charter it was established the choice of some research projects is left to the donor organizations and therefore these projects may not necessarily be in line with the national plan and priorities of the country. So at best it has only been possible to make compromises.

d) Impact of such cooperation has not been evaluated.

e) Initiation of cooperation in S&T approving and financing of S&T projects more often depends on the will and programme of the cooperating foreign institution and hence creates uncertainities and problems of planning of R&D activities etc.

Major problem in International Cooperation in Science and Technology

532. Although Ethiopia has realized the value of and need for cooperation in science technology, the extension and effectiveness of such cooperation is still encountering a great many obstacles. Some of these major obstacles are the following.

a) Many international cooperation agreements are not conducted based on informed knowledge followed by negotiations and discussions to ensure mutual benefit for all parties.

b) Collaborative R&D programmes are not actively pursued through national, regional and international research establishments.

c) Planned study visits and participation of Ethiopian scientists and technologists in international conferences, symposia, workshops and seminars are not adequately promoted and facilitated.

d) Direct linkages between the R&D organizations in Ethiopia and in the developed countries are not adequately established.

e) Active cooperation was not fostered with other developing countries. And as a result appropriate technologies and know-how that were developed by some developing countries and which are easily transferable, were not transferred.

f) Ethiopia is not actively participating in international S&T conferences and research programmes by various international organizations, etc., due to shortage of finance, especially

shortage of foreign currency.

g) International assistance and cooperation in the field of S&T have not been coordinated at the central level hence no knowledge on the extent of cooperation & assistance.

h) Such cooperation has not been consciously planned & organized to foster national S&T capabilities, avoid duplication of efforts and also direct R&D activities to areas of national priorities.