UNITED REPUBLIC OF TANZANIA

MINISTRY OF SCIENCE, TECHNOLOGY
AND HIGHER EDUCATION

THE NATIONAL SCIENCE AND TECHNOLOGY POLICY FOR TANZANIA

APRIL 1996

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I. INTRODUCTION

Rationale for Reviewing the 1985 Policy

1. The National Science and Technology Policy for Tanzania was formulated in 1985. At that time macro economic policies and strategies were based on state ownership. Since then, because of the structural adjustment policies, quite a number of changes have taken place. Privatization of major activities of the economy is now allowed, and hence the various sectors have also oriented their policies and strategies to accommodate these national policy changes.

2. In the early 1980s, when the Science and Technology Policy was being formulated the nation was, and has continued to undergo economic reforms. The first time such efforts were realised in 1981 when the National Economic Survival Programme (NESP) was launched. This Programme was intended to curb the external shocks imposed on the economy, namely: the oil crises of 1973 and 1978, the one year Kagera war of 1978/79; fluctuating international prices in traditional export commodities; variable weather conditions and the break up of the East African Community in 1977. These shocks left the nation economically weak and led to the decline in Gross Domestic Product (GDP).

3. The NESP was followed by the three year Structural Adjustment Programme (SAP) of 1982/83 to 1984/85. NESP and SAP programmes aimed at strengthening the national economy through export oriented economy by improving economic infrastructure to promote efficiency in the agricultural and industrial sectors, and placing emphasis on exports and reduction in import dependence.

4. In July 1986, the government launched another comprehensivethree year Economic Recovery Programme (ERP). The ERP which ended in 1989 had the major aim of achieving a positive growth rate per capita income, lower the rate of inflation and restore a sustainable balance of payments. The ERP continued into the second phase when the Economic and Social Action Programme (ESAP) or (ERP2) was adopted with additional objectives of rehabilitating the economy and improving infrastructure for provision of social services.

5. Since the adoption of the ERP in mid 1986, the government has implemented a number of far reaching policy reforms including the trade liberalization. These policy measures were aimed at facilitating the direction of resources to more productive sectors and at reducing the internal and external imbalances. In order to meet the objectives of the trade liberalization policy, the government formulated the Investment (Promotion and Protection) Act of 1990 which has opened up the country for a market economy.

6. In 1991/92 the government took further measures on parastatal reforms which include the revision of the Public Corporations Act to facilitate restructuring, privatization and, where necessary, closure of parastatal enterprises. In order to manage effectively the parastatal reform process, a Parastatal Reform Commission has been established.

7. Apart from macro-economic policy reforms mentioned above, some of the policy assumptions that were made in 1985 science and technology policy on sectoral objectives were not feasible. For example, the sectoral objectives of the policy with respect to the industrial sector were derived from the 1975-95 Basic Industrial Strategy (BIS), which could not actually take off as planned. A number of sectors also have been formulating sectoral policies which must be taken into consideration by the National Science and Technology Policy in order to harmonize effective and efficient implementation strategy of the 1985 policy which was drawn up in 1987 by the Ministry of Finance, Planning and Economic Affairs. The strategy, however, has never been substantially implemented due to the weaknesses mentioned above on the one hand, and the lack of integration of science and technology plan in the overall economic development plans, on the other.

8. In view of the above economic reforms and inadequacies in the sectoral policies, it is inevitable that the 1985 Science and Technology Policy must be reviewed, and a comprehensive action plan be drawn up in order to take into account the implications of these reforms.

Role of Science and Technology in National Development

9. The vital role of science and technology in socio-economic development is acknowledged the world over, by all nations, both developed and developing. It is therefore imperative for developing countries like Tanzania to embrace science and technology as a vital tool for accelerating their social economic development. It is becoming increasingly clear that developments in science and technology are not only important determinants of country's level of development but also enhance its international competitiveness and its position in

the world economy. The importance of science and technology in increasing responsiveness to changing world environment cannot be overemphasized. In this context, it is deserving to explore options open for developing countries in formulating and implementing effective science and technology policies at national level. However, just as science and technology are not an end in themselves but a means to an end, so is Science and Technology Policy.

10. A realistic Science and Technology Policy for Tanzania should, therefore, reflect the key role that science and technology will play in bringing about rapid socio-economic development and subsequent realization of self reliance. The important role played by science and technology in socio-economic development in Tanzania has been recognized. During the last two decades or so Tanzania has established a number of science and technology service and research anddevelopment institutions with the major aim of spearheading development and promotion of science and technology for socio-economic development. Furthermore, in 1986, as a result of the recommendations of the Science and Technology Policy, the government transformed the Tanzania National Scientific Research Council into the Tanzania Commission for Science and Technology with a wider and clearer mandate in coordinating and promoting science and technology in the country.

11. Developing countries, like Tanzania, however, have realized that resources for development and promotion of science and technology are limited and that it is therefore not possible to pioneer many major scientific discoveries or inventions across the whole scientific and technological spectrum owing to these limitations. It is however possible to spell out directions in which science and technology can be developed and utilized more effectively and efficiently in the key sectors of the

economy than has been hitherto. In this context there is an implicit interrelationship between the development process on the one hand, and the application of scientific knowledge, the techniques and organizational methods in the production of goods and services, on the other.

12. A national science and technology policy is needed in order to consciously orient the use of science and technology towards the economic, social and political objectives of the society. Thus one primary function of a National Science and Technology Policy is to establish relative priorities of programmes for generating new knowledge and to determine strategies for the application of science and technology for development. In other words a National Science and Technology Policy shall be a reflection of national goals, objectives and aspirations. It shall be part and parcel of an overall social and economic plan(s) that has (have) been designed to realize the stated national aims and targets. A clear National Science and Technology Policy is also needed to regulate flow of technologies and to reduceexcessive dependence on imported technologies. The policy should therefore guide government ministries and parastatal organizations, including universities and other research and training institutions as well as the private sector and Non-Governmental Organisations (NGOs) in the choice, assessment, transfer and adaptation of technologies. It should also guide the development of the national scientific and technological capability and capacity, and spell out clearly priority areas of research and development with potential of accelerating national development, and increasing national competitiveness at the global level.

13. The successful application of science and technology for sustainable national development will require the strengthening

and the building up of an endogenous and indigenous capability through:-

- expanding investment in human resources with the view to increasing capability to manage science and technology;

- paying special attention to applied research, relating research priorities to national development goals;

- increasing overall capacity for the transfer of technology (local and foreign) and, research and development;

- creating a conducive environment for unleashing creative and innovative potential of the people of Tanzania; and

- solving problems in key economic, productive and social welfare sectors such as industry, agriculture, energy and social welfare services.

14. Successful application of science and technology alsoentails establishing effective institutional framework and linkages so that the various science and technology institutions and the productive sectors work in a system that is focussed on achieving developmental goals, without undue duplication and competition. The National Science and Technology Policy should therefore address itself to the following issues:-

- the structure and functions of science and technology institutions;

- the type of national umbrella organization that should support, monitor and evaluate programmes and performance of science and technology institutions; and

- the role of the private, non-governmental organisations and public sector institutions in implementing science and technology functions.

Salient Features of a National Science and Technology Policy

15. The importance of science and technology shall be expressed through deliberate policy by:-

- allocation of funds for scientific research and technology development (about 1%) of GDP by the year 2000;

- monitoring of the importation or acquisition of foreign technology including its evaluation and selection;

- high level scientific research and technological manpower training, motivation and retention programmes; including provision of attractive termsand conditions of service for scientist and technologists;

- utilization of Tanzanian Scientists and Technologists in consultancies;
- the popularization of Science and Technology with the view of inculcating the scientific and technological culture in the society;

- promotion of professional standards and ethics through support to science academies, professional associations and science clubs and other scientific and technological non-governmental organizations;

- and the preservation or conservation of the environment or ecosystem in the process of industrialization, and utilization of natural resources.

II. OBJECTIVES OF THE NATIONAL SCIENCE AND TECHNOLOGY POLICY

GENERAL OBJECTIVES

16. Science and Technology Policy is a tool to develop and manage Science and Technology in a manner consistent with physical and human endowments of any country. It is a means to organize and sustain a Science and Technology capacity that is realistic, efficient and productive. The broad objectives of the Science and Technology Policy for Tanzania are therefore to:-

- promote science and technology as tools for economic development, the improvement of human, physical and social well-being, and for the protection of national sovereignty;

- promote the scientific and technological self-reliance in support of economic activities through the upgrading of R & D capabilities by the creation of an environment conducive to scientific and technological creativity and improvement of relevant scientific infrastructures;

- stimulate the generation of scientific and technological knowledge which is to be applied in socio-economic development;

- inculcate a Science and Technology culture in the Tanzanian society;

- establish and/or strengthen national Science and technology institutions through provision of adequate facilities;

- provide attractive terms and conditions of service including adequate research facilities and conducive research environment in order to motivate and retain good scientists and technologists making them give their best services to the country;

- establish appropriate legal framework for the development and transfer of technology including intellectual property rights, monitoring and controlling of the choice and transfer of technology, as well as bio-safety;

- institute a mechanism for identification, promotion anddevelopment of special talents, and aptitudes in science and technology among Tanzanians, especially youths, in order to benefit from the rich tapestry of human intellectual capabilities which are necessary for national development;

- achieve a critical mass of scientific and technological manpower by the year 2000 so as to enable the country to fully develop, adopt, adapt absorb and assimilate indigenous and foreign technologies;

- promote rational utilization of natural resources, including energy resources, and environmentally sound technologies in order to maintain sustainable ecological and social balance;

- promote active participation of women in science and technology by creating enabling environment for them to be innovative and conscious of Science and Technology in their everyday life;

- promote appropriate technologies that reduce the chores and drudgery of life of women, hence releasing them to more productive and economic ventures;

- acquire a national capability and capacity for endogenous decision making in scientific and technological matters through appropriate institutional framework and linkages;

- promote commercialization of research results and technologies generated within the country;

- promote new and emerging technologies with the view of acquiring capability and capacity to embark on the technologies that will accelerate the national economy;

- promoting and encouraging the public and private productive sectors in developing science and technology through stimulating the creative genius of the population by providing incentives to individuals, enterprises or institutions. The incentives offered through policy or legal instruments may include financial subsidies, awards, premiums, fiscal incentives, and lending facilities.

SPECIFIC OBJECTIVES

17. Specific objectives of the National Science and Technology Policy have to be related and derived from the overall policy objectives which in turn are derived from sectoral objectives. These should provide the very basis for the overall science and technology strategy. The objectives should also indicate in clear terms whether or not the sector is to be treated as a priority area for scientific research and/or technological development innovation and/or adaptation.

    Within each sector, priorities will be spelt out in order to allocate resources for effective implementation of the sectoral policies. The sector classification need not be exhaustive in that certain activities in the economy may not fall wholly under one specific sector. It is imperative that specific criteria be taken into consideration in order to objectively prioritize the key sectors of the economy according to their potential in the development and utilization of science and technology.

(a) Food and Agriculture

Sectoral Policy

18. The overall policy in the Food and Agriculture sector is to achieve self-sufficiency in food and food security through increased food and livestock production as well as increased production of commodities for export. The Food and Agricultural Policy places emphasis on, among other things, food production and underscores the need to utilize science and technology in order to develop the agricultural sector.

Science and technology will aim at maximization of productivity through introduction of improved methods of farming, seed varieties, livestock production and better methods of food and crop processing, preservation and storage. It will also enhance the development of agricultural mechanization and irrigation technologies.

Sectoral Objectives

19. The major sectoral objectives are:-

- to develop farming systems suitable for both small scale subsistance farmers and commercial farmers based on self reliance;
- to achieve food self-sufficiency, security and improve the nutritional standards of the people;
- to raise the income of rural population, and foreign exchange of the nation through increased output;
- to provide raw materials for the nation's industrial sector;
- to develop an integrated agricultural sector, using scientific methods of crop production and, animal husbandry, as well as appropriate technologies in respect to the size of operations and national resources; and
- to ensure better natural resources management and environmental protection for sustainable agricultural development.

Strategies

20. Thus the following strategies will be adopted in order to meet the above objectives of the policy as they relate to

a) agricultural research;
b) research and development in animal production;
c) agricultural productivity and extension services;
d) agricultural mechanization; and
e) use of agricultural wastes.

Agricultural Research

21. Agricultural research should be problem solving oriented and dynamic to cope with the changing demands in the sector. In specific terms, however, in the area of food and cash crops production, the following activities will receive priority:-

- identification, collection and preservation through the national gene bank of various indigenous food crop species, with a view to improving their nutritive value;

- breeding higher yielding and more nutritious strains of staple food such as maize, banana, rice, wheat, sorghum, millet, tropical roots and tubers, as well as other high protein crops and vegetables;

- improvement of methods of preparing, drying, preserving and handling of food to ensure maximum nutritive values, palatability and reduction of post harvest losses;

- improvements in soil fertility through selective use of fertilizers such as legumes, compost manure, farmyard manure and chemical fertilizers;

- intensification of research in plant protection measures such as the use of pesticides and development of disease resistant crop varieties, as well as integrated pest management;

- studies on soil and water management techniques including irrigation, conservation and water shed management;

- research in arid and semi-arid, areas focussing on crop varieties and production systems that ensure optimal utilization of limited soil and water resources;

- development of high yielding varieties of cash crops with the standard qualities required by the international markets; and

- adoption of agricultural practices and packages that are concomitant with the ecological balance including the use of biotechnology and genetic engineering in crop and animal breeding, and in the production of biofertilizers and bioinsecticides.

Research and Development in Animal Production

22. The main areas in which research and technological development shall be directed are:-

- animal health; including control of major livestock disease like trypanosomiasis, foot and mouth disease, and tick borne diseases, and improvements in laboratory services and diseases surveillance systems;

- production of vaccines and drugs;
- improvement of livestock through breeding (including the use of artificial insemination), better feeding using upgraded livestock feeds, and by use of improved techniques of managing pastures and rangelands;
- infrastructural development, including water conservation and management for livestock use; and
- development of efficient livestock management systems.

Agricultural Productivity and Extension Services

23. In order to raise agricultural productivity and animal production, it is imperative that agricultural extension services among other factors, be considerably increased and improved in quality and quantity.

Extension workers must be well trained, have better attitudes towards farmers and farming, and be equipped with the required facilities and resources to render the required services. Extension services, should lay more emphasis on existing and new technologies which affect the bulk of rural farmers such as improved irrigation techniques, mechanization, nutrition, horticulture, vermin control, plant and crop protection measures, land planning, improved seeds and improved input packages. The extension services should therefore establish close links with research and institutions.

Agricultural Mechanization

24. Mechanization programmes will have to take into account the need of particular crops and ecosystem of the respective areas, as well as capacity to produce and maintain the different types of machines to be used. Local manufacture of farm implements should be associated with the establishment and strengthening of Agro-mechanization and oxenization centres (e.g. Farm Service Centres) that will perform both the functions of training the farmers in the use of the implements and the servicing, repair and maintenance of tools.

25. Research and development of local prototypes for mechanization must be intensified, taking into consideration appropriate designs of equipment for different soils and conditions. The use of animal traction (oxenization) will still be encouraged particularly in traditional livestock keeping regions while progressively embarking on mechanical or tractor power.

Use of Agricultural Wastes

26. The use of agricultural wastes such as in the production of compost, animal manure, and energy should be encouraged.

(b) Industry

Sectoral Policy

27. The government's policy on industrial sector is to create economically efficient, financially solvent, and profitable enterprises in order to utilize the existing capacity fully and expand to take advantage of new production and export opportunities. It also aims at improving the business climate for the public and private sectors, increasing domestic

competition to integrate domestic producers more into world market and at restructuring of public industrial enterprises.

Sectoral Objectives

28. The major objectives of the industrial sector include:-

- development of industries which make use of locally available raw materials and/or produce for exports;
- improvement of productivity, and orientation of the industrial sector to be more in harmony with new investments and technology transferred from foreign to local sources;
- development of industries which produce basic and essential requirements for the population;
- establishment of industries which support other sectors, and increase capacity utilization in the economy (Basic Industries Strategy); and
- development of small scale enterprises for developing and providing the needed skills, and improving efficiency in the sector.

Strategies

29. The major strategies include:-

- strengthening of the national design and engineering capacity;
- encouraging regional and international cooperation among industrial research and development institutions/ establishments;

- improving mechanisms for technology transfer arrangements (from within and outside the country) with the view to strengthening domestic design and engineering capacity;

- establishing and/or strengthening research and development enterprise links in order to facilitate the design and efficient production of capital goods which are sufficiently competitive for local and foreign markets;

- establishment and consolidation of engineering workshops to undertake maintenance and repair, manufacture parts and components for machinery, vehicles, equipment, building and other infrastructure;

  and

- inclusion of Environment Impact Assessment (EIA) in any planning of industries in order to avert negative impacts of industrial pollution on human and other living resources.

30. There should be judicious and informed use of patents and licenses for industrial products and processes with a view to encouraging and activating Tanzanians to be innovative and inventive.

31. In the building and construction industry efforts shall be directed to:-

- strengthening of institutions dealing with building in order to develop and promote the use of locally available adapted designs, and alternative building and construction materials for construction;

- designing and development of low cost waste disposal systems;

- designing and development of low cost all-weather roads and infrastructure; and

- promotion of tropical architecture; and urban and rural planning and design.

32. In processing industry (including food and chemical processing), research should be directed towards:-

- improving low cost methods for optimising processing,and upgrading production quality. It is important to take into consideration the availability of infrastructure (e.g. transport, marketing and handling) and efficient pre-processing and storage technology (in order to keep down costs and prevent losses and prevent losses and quality deterioration);

- upgrading local technologies related to food processing;

- conversion of wastes to useful products associated with an analysis of the market to ascertain the potential demand of these products;

- research, development and application of new and emerging technologies such as biotechnology, microelectronics and new materials technology, in order to accelerate industrialization process in this country;

and

- participation of women at the design stage of rural and urban technologies to ensure that their genuine needs are met for effective operation and diffusion of these technologies.

(c) Energy

Sectoral policy:

33. The overall policy on energy sector is to ensure adequate and sustained energy supplies for continued economic growth and development. The energy policy places emphasis on development and efficient utilization of indigenous energy resources in order to reduce dependence on imported energy and demand pressure on our natural forests. It also aims at self-reliance in energy science and technologies.

Sectoral Objectives

The major sectoral objectives are:-

- to exploit the abundant hydro-electric power sources;
- to develop and utilize natural gas resources;
- to develop and utilize coal resources;
- to step up petroleum exploration activities;
- to arrest woodfuel depletion by evolving more appropriate land management practices and more efficient woodfuel technologies;

- to develop and utilize forest, agricultural and animal waste for energy production;

- to develop and utilize renewable and alternative energy resources such as solar, wind and nuclear power wherever feasible;

- to minimize energy price fluctuations through strengthening and rationalization of energy supply sources and infrastructure, and rational energy pricing structure;

- to develop human resources for development of energy technologies;
- to ensure the continuity and security of energy supplies through development of integrated energy production sources as reserve; and

- to promote and use treated coal for domestic use.

Strategies

The major strategies include:-

- promotion of more efficient use of energy in transport, domestic and industry sectors;

- rehabilitation of the electric power generation transmission and distribution infrastructure;

- rehabilitation and rationalization of the petroleum refining, storage and distribution infrastructure;

- generation and distribution of electricity at affordable prices and commensurate with demand;

- supply of electricity to small townships and industries, lying adjacent to and far off the grid system, starting with agro-based industries and using alternative sources;

- development and dissemination of efficient woodfuel conversion and utilization technologies, and introduction of affordable alternatives for domestic purposes in order to reduce the depletion of forest resources;
- investigation of the potential of geothermal energy in the country;

- development and utilization of natural gas development of associated conversion and end-use technologies;

- development and dissemination of simple and affordable electric, kerosene and coal stoves for rural and urban households;

- development and promotion of renewable and other alternative energy sources such as solar,wind andnuclear; and

- development and promotion of coal utilization for electricity generation and household use.

(d) Natural Resources

Sectoral Policy

34. In natural resources sector, the aim shall be the optimization of the rational utilization of the country's resources based on scientific understanding of nature and the dynamics of the resources. For living resources such as wildlife, fisheries, and forestry, rational utilization of resources must take into consideration the importance of the environment, as well as the socio-economic needs of the local people.

Sectoral Objectives

35. The policy objectives include:-

- conservation, protection and use of natural resources and ecosystems on the basis of the principle of optimum sustainable yield for the benefit of present and future generations;
- restoration, maintenance and enhancement of ecosystems and ecological processes for the functioning of the biosphere and for the preservation of biodiversity; and
- monitoring and controlling depletion of renewable and non-renewable natural resources such as minerals, land and water.

Strategies

36. The major strategies include:-

- establish and strengthen data bases for inventory, planning and management of natural resources such as mineral deposits, forestry and wildlife;
- introduction of new plant species, wherever appropriate, for increased productivity through breeding and fertilization techniques and agro-forestry practices;
- development of safe aquaculture of fish species that are rare in major rivers, lakes and in the Indian Ocean;
- developing technologies or adapting those existing for restoration and preservation of forests;
- promote research and development in wildlife in order to establish their diseases, food value, wildlife products as well as the human impact on the biosphere ecology;
- research in beekeeping industry in order to modernize it through improved quality of honey, beeswax and other bee products as well as beekeeping technology;
- protect catchment areas to ensure continous supply of water, and hence stable hydrological cycle;
- combat deforestation through afforestation programmes;
- promote sustainable natural resources utilization for economic development;

- promote natural resources processing technology; and
- modernize fishing activities to increase fish catches.

(e) Environment

Sectoral Policy

37. The overall goal of the environment policy must be the conservation and protection of the environment, and rational and efficient utilization of the natural resources. The aim of the environmental policy is to ensure that economic development is accompanied by proper environmental management so that Tanzanian natural resources and natural heritage are passed on undiminished to future generation. The policy recognizes the essential links between sustainable development and sound environmental management.

Sectoral Objectives

38. The major sectoral objectives include:-

- ensuring the maintenance of basic ecological processes upon which all productivity and regeneration on land and in the sea depend;
- promotion of the sustainable use of renewable resources and rational use of non-renewable resources, and minimization of irrational use, contamination or destruction of resources;
- preservation of the biological diversity, cultural richness and natural beauty of Tanzania; and

- ensuring that the quality of life of the people of Tanzania, present and future, is not harmed by destruction, degradation or pollution of their environment.

Strategies

39. The major strategies include:-

- preparation and adherence to integrated land use plans at national and local levels;
- establishment of permanent programmes for monitoring the status of the environment;
- increasing public knowledge about the environment and motivating the people to use natural resources wisely;
- strengthening conservation of Tanzanian indigenous plants and animals on land and in the sea in order to preserve biodiversity;
- research on resources management systems, species distribution, ecology and regeneration, paying special attention to species valued for their variety or distinctive local forms;
- promotion of the rational use of non-living resources with minimal damage to the environment;
- prevention of the depletion, degradation chemical pollution or misuse of fresh water resources;
- incorporation of Environmental Impact Assessment into procedures for the design of development projects;

- devising mechanisms for access to transfer of environmentally safe and sound technologies through support to endogenous capacity building; and

- promotion of the role played by women in environmentally related activities, with a view to achieving increased women involvement in such areas as forest, agricultural and water management programmes, on account of their essential responsibilities, skills and knowledge in these sectors.

(f) Health, Sanitation and Population Planning

Sectoral Policy

40. The primary focus of the health sector is to utilize scientific and technological know-how to minimize and overcome the health problems relating to communicablediseases, maternal and child-health, poor personal hygiene, poor environmental health, malnutrition and non-communicable diseases. Population policy shall lay special emphasis on regulating growth rate, enhancing population quality and improving the health and welfare of women and children.

Sectoral Objectives

41. The major sectoral objectives include:-

- improvement of the health of the people and the quality of the environment;

- application of scientific use of traditional medicine in health care delivery systems;

- improvement of the standard of living and quality of life of the people through the provision of basic human needs in such areas as health, nutrition, clean and safe water, housing and environment;

- strengthening of preventive family planning services in order to promote the health and welfare of the mother and child through prevention of illness and premature death in the family, the community and the nation and eventually reduce the rate of population growth; and

- promotion and strengthening of proper youth upbringing and growth including the creation of an environment that will allow optimal development of their various talents.

Strategies

42. The major strategies include:-

- development and application of new tools for the diagnosis and management of the common human health problems;

- acquisition, storage, processing, and effective utilization of reliable data on the prevalence of major human diseases;

- identification of the most cost-effective and disease control measures;

- development of environmentally and culturally sound technologies for manufacture of low cost equipment and drugs from indigenous materials for solving national pressing health problems;

- carrying out intensive studies (research and development) on the use and effectiveness of medicinal plants for treating various disease;

- transferring of traditional medicines, including traditional family planning practices, from informal to the formal sectors for effective health care delivery;

- strengthening research and development in health and environmental sanitation with the view to combating disease agents and hazards due to environmental pollution and poor personal hygiene;

- strengthening of the development and use of appropriate family planning techniques with the view to effectively controlling population growth and ensuring health of mothers, children and youth; and

- development of effective scientific ways of combating drug abuse and juvenile delinquency with the view to making them more productive.

(g) Transport and Communication

Sectoral Policy

43. Transport policy focuses on the strengthening of all existing modalities of transportation viz national, intra-regional, interregional and international transportation systems. Communications policy will aim at, among other things, establishing and/or strengthening telecommunication networks, including television network, as well as improvement of mass media facilities.

Sectoral Objectives

44. The major policy objectives include:-

- establishing and/or strengthening maintenance of transportation systems (railways, shipping, air and road transport). Also maintenance system should be strengthened;
- improvement, adaptation and integration of traditional and modern transport systems;
- increasing capacity and capability to acquire and disseminate scientific and technological information through development of high speed telecommunication networks and databases;
- improvement of postal and telecommunication systems in urban and rural areas;
- strengthening road maintenance centres, and
- improvement of forward and receiving facilities i e harbour ports and provision of modern facilities.

Strategies

45. The major strategies include:-

- improvement of road transport services which include linking regional and district centres and village feeder roads by:-

  a) strengthening of road maintenance; and

b) improvement and extension of road transport services with the view of linking regional and inter-regional transport systems, and making use of a good geographical position of our country.

- strengthening railway transportation system by:-

  a) development and improvement of facilities; and
  b) manufacture of spare parts and components for railways networks;

- development and strengthening of inland waterways, shipping and port management, including marine instrumentation and safety facilities;

- strengthening and improvement of urban transportation services, including studying the possibility of introducing other urban transport systems such as trolleys, underground trains, and trams;

- intensifying the finding of alternative fuels for running public vehicles;

- strengthening of air transportation which includes improvement of airport facilities, strengthening air craft maintenance facilities and establishment of a fully-fledged Aviation Training Institute;

- establishment and improvement of communication services which include postal delivery systems, telephone, telex services, telefax, mass media facilities (e.g., radio and television transmitters), printing facilities, and telematics;

- maintenance of satellite and computer technology facilities in order to improve communication services and productivity will be emphasised;

- strengthening meteorological services through the use of modern communication facilities with the view to detecting climatic variability, air pollution and ozone depletion; and

- instituting an early warning system which will enable the nation to get prepared for natural disasters such as floods, hurricanes, drought, gales and locust invasions.

(h) Science and Technology Education and Manpower

Sectoral Policy

46. Tanzania needs trained and a well prepared critical mass of human resources and a mechanism for controlling brain drain if there has to be an effective and successful application of science and technology for socio-economic development. This calls for the projection of long-term manpower needs, spelling out what school enrolment is needed, what disciplines should be encouraged and how talents should be developed and harnessed.

Sectoral Objectives

47. The major sectoral objectives include:-

- development of the education system and updating it in such a way that it can supply the required number of adequately qualified manpower of various skills;

- provision of adequate, secure and attractive employment opportunities and conditions with the view of reversing brain drain; and provision of adequate incentives to science and technology personnel;

- restructuring of education system so that it can respond to the envisioned needs and aspiration of Tanzania;

- promotion of the social usefulness of the science and technology manpower and foster the integration of science and technology results into production and essential services such as health, housing, transportation and education;

- provision of adequate science and technology teaching and learning facilities in schools and colleges, as well as appropriately qualified and experienced science and technology teachers and instructors;

- bridging the glaring gaps in some scientific and technological fields and frontier technologies e.g biotechnology and microelectronics; and

- involvement of local expertise in consultancy services.

Strategies

48. Strengthening science and technology education in schools, colleges and universities through:-

- improvement and review of science curricula and methods at all levels;

- enhancing and expanding training of science and technology teachers at all levels;

- development of local production of science kits and laboratory equipments;

- review of vocational training programmes and technical colleges curricula;

- review of university curricula and programmes with the view to incorporating some scientific and technological fields and other frontier technologies in order to produce high level manpower that is equipped to embark on new areas of science and technology for propelling the nation into the 21st century;

- creation of high level centres of learning for post graduate training and research in science and technology through strengthening of the existing ones or establishing new ones in order to meet the challenge of the modern society;

- provision of incentives and facilities for scientists and technologists, as well as utilizing their expertise in consultancy services;

- deliberate provision of science and technology education to a higher percentage of women to enable them enter scientific and industrial sectors;

- creation of flexible and expanded science and technology programmes in order to produce more scientists and technologists; and

- increase the enrolment of science and technology students at all levels. (starting at secondary level).

III. CRITICAL FACTORS IN POLICY IMPLEMENTATION

49. Formulation of a science and technology policy is only meaningful if certain critical factors and elements which lead to its smooth implementation are considered. Often times there are gaps between declared objectives of the science and technology policy and the actual implementation means of such objectives. Notable among these gaps are poor science and technology education, low level of support to science and technology system, low level of expenditureon research and development activities, weakness in coordination and operational instruments and lack of support and appreciation of the role played by scientists and technologists in national development by decision makers. The latter, in turn, lead to poor motivation, and lack of participation by stake holders, weak legislation measures to promote demand for locally supplied science and technology output, and weak emphasis on basic and applied research.

Basic and Applied Research

50. Basic research is the foundation of the nation's research and development enterprise. It generates new ideas, concepts, techniques and tools upon which both science and technology endeavour are based. Equally important is the role of basic research in satisfying curiosity about the world in which we live and its immeasurability to the cultural and intellectual vitality of the modern world.

51. In basic research there are considerable returns on investment but there is, sometimes, a lag between the time when new knowledge is discovered and its appearance in the form of

new products and/or processes. Such a lag between the efforts that lead to a basic research discovery and the social returns from application of its returns underscores the investment character of research. Failure to invest in research now may result in diminished economic returns in the future, a decline that cannot be quickly reversed.

52. Applied research is the application of knowledge generated by basic research in solving specific sectoral problems with a view to bringing about desired changes in socio-economic development. It should be as relevant as possible to the needs of the users so that the knowledge generated by this type of research can become unequivocally applicable; it should be oriented to the clientele needs.

53. Strategies to enable research and development play the role in implementing science and technology policy include:-

- creation of a mechanism to plan and coordinate research efforts in areas where demand for developed services or goods is clearly defined through stakeholders' participation in the planning and identification of researchable areas at the outset;

- availability of adequate financial resources allocation to research and development activities ensuring a proper balance of expenditure on research on the one hand, and on development on the other, should be spelt out since both activities are crucial to the implementation of science and technology policy;

- financial support to both research and development activities should be increased to above the critical level needed for productive performance of the system to achieve targeted objectives;

- involvement of recipients of research and development output in the financing of activities should be institutionalized as a means to ensure linkages between supplies and demand of research and development output;

- establishment of mechanism of acquiring and managing science and technology information system.

- linkages between science and technology institutions and other bodies that may influence the work of the institutions or be influenced by it should be institutionalized in effective mechanism;

- monitoring and evaluation mechanism must be institutionalized to ensure effective and productive performance of science and technology systems; and

- establishment of fora for dialogue among groups concerned with science and technology;

54. In addition to the current research programmes, which focus mainly on addressing basic human needs, and the means to solve them and alleviate poverty, basic and applied research shall consist of series of research projects by research and development institutions including universities, firms and individuals with a focus on the following areas as we move into the 21st century:-

- research into the new materials technology including high temperature super conductors;

- remote sensing and cartography;

- new energy sources including atomic energy new and renewable energy sources; computer sciences and technology including computer aided systems, software development computer assisted learning, data bases distributed information system networking and data communication, super conductors, microchip parallel processors;

- robotics;

- biotechnology;

- microelectronics;

- telecommunications and information technology;

- marine technology and oceanography;

- genetics and genetic engineering; and

- natural products including research on the exploitation of medicinal agro chemical and industrial chemicals.

Training of Scientific and Technological Manpower

55. Human resource is the most important factor in the implementation of the science and technology policy.

Onecrucial factor in this regard is the training of scientific and technological manpower at all levels including artisans, engineers, technicians, scientists and managerial personnel.

56. Scientific and technological education and training requires significant proportion of personnel having a basic orientation in sciences. This entails a drastic change in the orientation of education and training programmes.

57. The aim of human resource development is to ensure that a critical mass of highly qualified experts in science and technology is always available. A number of world class research and training institutions in critical areas must also be developed and sustained.

Strategies

(i) *Pre-school Exposure*

58. Pre-school exposure to scientific and technological knowledge through simple and safe education aids/toys should be introduced in day care centres, orphanages, as well as homes. Manufacturing of the audio-visual aids/toys should be undertaken in order to instill scientific and technological culture at the very grassroots of human resource development.

(ii) *Primary School Level*

59. At primary school level, the aim shall be to provide basic knowledge in science and mathematics, and to provide instructional materials suitable for highlighting the role of science and technology in society in simple and demonstrative manner.

60. Primary school leavers be given vocation oriented scientific training including basic training in agricultural operations and/ or industrial arts.

(iii) *Secondary Schools*

61. Scientific and technological education at secondary schoollevel should be broad based to include all the basic science subjects and mathematics in order to equip students with adequate scientific knowledge and skills so as to diversify and lead into practical/applied work programme in the future. Secondary schools curricula should be reviewed with a view to determining realistically the type of content and facilities required for teaching.

62. Establishment of centres for the development and maintenance of school teaching equipment and materials where possible, using locally available materials, will go a long way in spearheading strategies for implementation of the national science and technology policy. The training of school laboratory assistants and technicians who will assist in minor maintenance and repair of school science equipment and other teaching aids should be established and/or strengthened.

(iv) *Technical Colleges*

63 • At technical college level, the aim should be to produce intermediate level experts in science and technology with a good mix of theory and practice.

• Technical college curricula and programmes shall be reviewed with a view to making them more flexible and adaptable to contemporary changes in science and technology.

(v) *Teachers Training Colleges*

64 • The aim in as far as science and technology is concerned of teachers training college is to produce teachers in adequate numbers and quality to teach science and mathematics in pre-school primary and secodary schools.

• Teachers training curricula will be reviewed with the view to introducing flexibility and to adapt them tothe teaching needs at the various respective levels.

(vi) *University Level*

65. At University level, the main objective is be to produce scientists, engineers, teachers and technologists who are well grounded in theory and practice. It is from the universities that the nation's high level scientific and technological manpower will be drawn. Universities should not restrict themselves to undergraduate and postgraduate training, but should encompass continuing education for upgrading professional knowledge and skills.

66. Regarding specific fields of training at the university level, those fields that are crucial and relevant to the country development efforts should be adequately catered for, taking into consideration the bridging of the glaring gaps in crucial technical fields such as new and emerging technologies (e.g. biotechnology and microelectronics) which enable the nation to leapfrog in scientific and technological advances.

67. The newly established Open University should play a crucial role in training and dissemination of scientific and technological knowledge to the general public using various methods including audio visual techniques.

68. Centres of excellence for postgraduate training and research should be established in order to cater for talented individuals by giving them opportunities to work on areas of national priority. The centres will also act as a fountain for spearheading discovery and advancing frontiers of knowledge in science and technology. Incorporation of Science and Technology in the National Economic Planning

Incorporation of Science and Technology in the National Economic Planning

69. Science and technology should be deliberately and systematically integrated into overall national economic planning in order to provide the nation with the means for reaching its overall development targets. The government should ensure that science and technology play a leading role in promoting socio-economic development.

70. National Science and Technology Implementation Plan should be fully integrated into the overall national development plans, which in turn, must influence and be influenced by the national science and technology policy. For a national science and technology system to become an effective instrument for development, particularly in solving problems affecting the majority of the population, political commitment at the highest level of government should be secured and this political commitment should then be translated into increased resource allocations to science and technology programmes/activities.

71. The government should create the necessary mechanisms for actively involving scientific and technological personnel in national development planning as well as in the implementation of various development programmes and projects.

Professional Associations and Clubs

72. The government should support the formation and/or strengthening of professional associations, science clubs, academies of science and arts, especially in educational institutions, in order to enhance scientific culture, public awareness and overall progress in science and technology. These professional bodies should cooperate with public regulatory bodies in order to institute measures for maintenance and observance of professional ethics, code of conduct, standards and practices. They should also take an active role in popularizing science and technology through seminars. workshops, lectures, films, and publications.

Legal Framework and Technology Policy Instruments

73. In addition to stengthening the various legal institutions and instruments already enacted over the last two decades or so, there is a need of establishing a high powered scientific and technical advisory committee on science and technology to advise the President, in addition to the Inter-Ministerial Technical Committee (IMTC) of the Cabinet.

74. For effective coordination of implementation of the Science and Technology Policy and integration of science and technology in the overall national macro-economic plans, a position of science advisor to the President should established, and the status of Tanzania Commission for Science and Technology should be upgraded so that it falls under the Presidents Office.

75. A legal framework has been laid down through the (Investment Promotion and Protection) Act of 1990, and the Tanzania Commission for Science and Technology Act No. 7 of 1986 which spells out the establishment of a National Centre for

Development and Transfer of Technology. The Centre is charged with powers of establishing rules and regulations for rationalizing the acquisition, evaluation, choice, coordination and development of technology; as well as conceiving policy measures that will facilitate an enabling environment for technology autonomy and sustainable development.

76. The Commission in which the Centre is based will also create a registry of technology transfer agreements, inventories of scientific equipment/facilities, directory of scientific and technological personnel, and the results of the scientific and technological research.

Technology Acquisition and Transfer

77. Technology transfer involves acquisition, choice, selection, evaluation, monitoring, assessment of imported technology, as well as commercialization and effective utilization of locally generated technologies. In this regard, the government policy will be to assist Tanzanian enterprises in acquiring foreign technologies which are appropriate and environmentally friendly under equitable terms and conditions.

78. In working out strategies for technology acquisition and transfer, emphasis will given to a mix of endogenous and exogenous technologies that are easy to assimilate, adaptand internalize. In order to minimize technology dependence and for smooth and effective transfer of technology, emphasis should be laid on building and strengthening endogenous capacity in process and engineering design, spare parts and components manufacturing, standardization and quality control, packaging, technological information, technology transfer, contracts drafting and negotiation, including adaptation, innovation, internalization and commercialization of technology.

79. In drawing up management and technical consultancy agreements and technology transfer agreements with foreign partners, appropriately qualified Tanzanians shall be involved in the evaluation of legal, technical and social-economic aspects of such agreements in order to avoid undesirable effects that may have legal, socio-economic and environmental implications. In this regard, IPC, the Patents Office and the Centre for the Development and Transfer of Technology should harmonize their relationships.

80. In order to gain access to technologies which are in the public domain, various technology information sources including patents documents shall be accessible and used. In addition, cooperation between technology suppliers and technology users should be enhanced as a means of safeguarding mutual benefits.

81. Where possible, industries should establish R&D units for carrying out essential activities related to the development and improvement of their products and processes, and also to serve as a critical link with the academia.

Motivation and Utilisation of Local Experts

82. It is essential to provide scientists and technologists with an environment conducive to creative work, attractive careers, incentives and improved conditions of service in order to encourage creativity and inventiveness. Where such expertise is available, there is need to ensure that local scientific and technological personnel are utilized for consultancies in government and parastatal studies/projectsin preference to foreign consultancies.

83.(a) For the purpose of promoting expertise among young professional scientists in the various sectors of the economy, there is need to establish a fund for professional development through participation in national and international scientific and technological fora.

(b) There is need to institute a broadbased system of awards and recognition of scientists and technologists who have made outstanding achievements in order to encourage creativity and innovativeness among the scientific community. This is in addition to the existing Tanzania Award for Scientific and Technological Achievements (TASTA) which is administered by the Tanzania Commission for Science and Technology.

Identification of Special Talents

84. A system or machinery for identifying, encouraging and developing special talents and aptitudes shall be established by the Tanzania Commission for Science and Technology with the view to harnessing their potential in spearheading national development. Existing educational infrastructure be adequately equipped, in terms of facilities and manpower, to cater for talented students.

Services and Technology Support Facilities

Standardization and Quality Control

85. There is need for coordination of the various bodies with the view to ensuring adherence to Tanzania standards particularly with respect to improted goods.

Servicing and Maintenance Facilities

86. There is need to increase awareness to establish and/or strengthen facilities for servicing and maintenance ofmachinery and equipment in industrial firms, research and development institutions and education institutions. Maintenance should be conceived as part and parcel of the overall design process.

Dissemination and Utilization of Research Findings

87. Efforts must be made to ensure the dissemination and utilization of the already available research findings both generated from within and outside the country and adopt or adapt the available technologies in order to suit our needs with the view to optimizing the limited resources at our disposal.

Information and Documentation Services

88. Today's rapid pace of technological innovation and the high degree of specialization are responsible for the "information explosion" or the availability of a large mass of scientific and technological data, which calls for the establishment of data bases for storage and dissemination of information effectively and efficiently. The provision of up-to-date and efficient scientific and technological information system including libraries, documentation centres and computer systems is vital.

89. An up-to-date inventory of scientific equipment and directory of the nation's scientific and technology manpower should prepared by the Tanzania Commission for Science and Technology. Where possible, the directory of manpower should also give brief notes on the scientists research

project(s). The inventory and the directory should be updated from time to time.

90. The Tanzania Commission for Science and Technology should also act as a focal point which will strive to establish an industrial and technological information system consisting of, among other things, patent information services, database on local and imported technologies, technology suppliers, data on technology costs and contractual agreements details.

Popularization of Science and Technology

91. In order to inculcate a science and technology culture andharness the various science and technology talents among Tanzanians, it is necessary to establish mechanisms for popularization of science and technology through science and technology fairs, scientific and technological exhibitions, television, radio programmes, science camps, science clubs, and participation in trade fairs. There should be deliberate effort to run mobile services that would involve the whole country on regular basis with the view to creating mass awareness and participation.

92.(a) Create a conducive environment for inquisitiveness.

(b) The tremendous potential of mass media, particularly films, newspapers, radio and television in popularization and promotion of scientific and technological knowledge, as well as enhancing general education and sensitization of youths and adults including decisions makers, should be exploited.

Participation of Women in Promotion and Utilization Science and Technology

93. In order to enhance the active participation of women in the promotion and utilization of science and technology, the government should implement the following:-

- review policies and establish plans to increase the proportion of women participation in decision making, and planning;

- strengthen women's non-governmental organisations and groups in enhancing capacity building for sustainable development;

- take deliberate measures to raise the level of literacy among females, expand enrolment of women and girls in educational institutions, and increase educational training opportunities for women and girls in science and technology;

- establish programmes to reduce of drudgery and increase comfort for women, and girl children at home andoutside through the establishment of facilities and promotion of the provision of appropriate technologies which have been designed, developed and improved in consultation with women; and

- design programmes to develop consumer awareness and active participation of women in productive activities.

Mechanisms for Extension, Diffusion and Commercialization of Technology

94. Extension, diffusion and commercialization of technology are crucial in order to generate technology which has an impact on the society. In order to do so, efforts must be made to strengthen mechanisms for extension, diffusion and commercialization of the technologies that are relevant to the needs of the society in order to alleviate the chores and drudgeries of life, especially in the rural areas. Strategies to achieve this should involve end users at all stages. Production and user organizations which are associated with and which participate in technology development efforts should be encouraged and given the necessary support in the form of fiscal, commercial and administrative nature.

Preferential Treatment of Locally Manufactured Goods

95. The liberalization policy has opened doors for technological competition between locally produced and imported products. Often times imported products appear to be of better quality and cheaper than the indigenously developed products. Support must, therefore, be provided through fiscal and other measures for a limited period with the view to promoting innovation, inventions, and increase the use of indigenously developed technology and to enhance inhouse research and development in industry. Furthermore, foreign investments should be clearly directed, through appropriatenational priority areas where the nation can develop competitive advantage for absorption and adaptation of the imported technology. It was noted that there was need to protect local industries without necessarily compromising efficiency.

National Research and Development (R&D) Institutions

96. As a pre-requisite for the transfer of technology on better terms and conditions, the development of science and technology base, and the strengthening of research and development institutions in key sectors of the economy are essential. For effective transfer of technology, these institutions must develop close working relations among themselves, and the central coordinating body (COSTECH) so as to harmonize their activities and mandates.

97. The majority of the research and development institutions lack adequate financial resources and trained science and technology personnel and research facilities. they also lack strong linkages among themselves and with the potential users of their research findings. These factors have had very adverse effects on the performance of the scientific and technological personnel leading to research and development results not having visible impacts. It is essential, therefore, that deliberate efforts to mobilize and allocate adequate resources be made.

98. In addition to strengthening the research and development institutions, critical review of their Acts should be undertaken with the view to ensuring that resources allocated to each one of them are utilized for performing the activities for which they are best suited and special attention will be given to the critical role of each institution.

99. The role of engineering, designing and consulting organisations should be underscored in that these are critical in developing endogenous technological capability and capacity. The establishment and progressive developmentof local designs and consultancy is crucial to the development of endogenous technology. This will lead to the:-

- constant building of endogenous capacity and capability;
- promotion of the commercialization of technologies into viable projects; and
- promotion of endogenous industries.

100. Institutions which are involved in design, engineering, research and development, and consultancy, should be provided with the necessary skilled manpower, facilities and finance in order to accelerate industrial development in this country. The government should also create appropriate incentives for the private industries to establish research and development units in order to develop capability in science and technology and to promote the quality of industrial processes and products in this country. Another crucial factor is the effective management of industrial enterprises which will take into consideration the development of innovations and utilization of endogenous resources.

Research and Development (R&D) in the Universities and Other Institutions of Higher Learning

101. Creating active research and development base in universities and other institutions of higher learning is crucial for building national capability and capacity to implement science and technology policy in the country and can be achieved by:-

- intensifying and organizing research and development and directing it to serve the community and itsdevelopmental needs;
- finding solutions for problems that affect social and economic development; and

- imparting scientific knowledge and technical know-how and expertise to the future stock of specialists and technological personnel.

102. Universities should lead the way in advancing the frontiers of knowledge through basic and applied research. Science and Technology Policy priority areas should be addressed by university personnel with the view to carrying out relevant research that will be able to accelerate national development.

103. Bearing in mind the very important role that the universities play in scientific research and technology development, and in the training scientists and technologists, it is of utmost importance that:-

- the role and potential contribution of the universities in promoting the development and application of science and technology be recognized by the government;

- the universities in turn must be prepared to shoulder greater responsibilities in promotion and development of science and technology;

- the universities shall be given greater autonomy and adequate resources to enable them carry out their research and development activities, and thus facilitating full utilization of their potential.

Expatriate and Counterpart Personnel in Research and Development Programmes

104. Expatriate participation in research and development in this country has taken many forms. These include:-

- collaboration with local institutions and individuals;
- research associateship;
- foreign students programmes; and
- foreign researchers in general.

105. In most of the above forms research clearance permits have to be secured from the Tanzania Commission for Science and Technology. Proper legal monitoring mechanism for expatriates should be established in order to safeguard the nation against foreigners who enter this country to carry out research that may jeopardize her social and economic development and welfare.

106. The government should also ensure that expatriates and local counterparts do not violate regulations governing the access of materials and take living organisms and data that are the property of this nation and people. Urgent measures should also be instituted to safeguard intellectual property rights against their possible violation by foreigners working in Tanzania.

Review of Scientific and Technological Activities

107. There should be instituted a periodical review system which will regularly monitor and evaluate the performance of scientific and technological activities in the country in order to update plans of science and technology activities. The system will therefore ensure effective and optimal utilization of resources.

IV. SCIENCE AND TECHNOLOGY INDICATORS

108. Tanzania needs to develop her own science and technology indicators that are consistent with her specific needs. Such indicators should reflect the stage of development, resource base, special features of the system and, in most cases, the overall objectives of the science and technology policy.

109. The development of science and technology indicators is an essential tool for measuring science and technology capacityand capability. Science and technology indicators once developed are very helpful in:-

- acquiring information on interdependence of science and technology systems;
- acquiring information on impact of science and technology on degree of competitiveness of technology, productivity of resources and employment;
- identifying trends that require science and technology policy measures;
- setting goals of science and technology system and monitoring its progress;
- planning, and as a review tool of science and technology system;
- using them as background information for appropriation and allocation of resources for various science and technology activities especially research and development; and

- utilizing them as essential information for taking various measures to improve science and technology system in the country.

The following science and technology indicators should be used by Tanzania to measure its science and technology capacity.

Size of Research and Development Expenditure

110. The ratio of total research and development expenditure to GDP is one of the most commonly used science and technology indicators throughout the world. Usually, expenditure means actual fund spent on salaries of manpower conducting research and development work, operational funds, support to research and development activities in educational institutions, and costs that recur every year and are spent in research and development activities in all science and technology sectors.

Ratio of Research and Development Manpower to Total Labour Force in a Country

111. The number of full time equivalent (FTE) scientists working in research and development activities for each ten thousand of total labour force in the country is an indicator of how much such science and technology activities are part of the national efforts of manpower development.

Ratio of University Staff Members to Number of Students Enrolled

112. This is one of the most significant indicators that are used to measure the standard and quality of higher education system.

One important aspect of this indicator is the percentage of staff time allocated to research in addition to teaching. However, there is need for Tanzania to develop her own ratio of university staff members relative to the number of students enrolled by the year 2000.

Ratio of BSc. to MSc and Ph.D Graduates in Science and Technology Educational System

113. The degree of adequacy of higher educational system is usually determined by the spectrum of types and level of programmes offered beyond the high school level. Science and technology activities require the full spectrum of training levels that range from senior technicians, technologists, Bsc., MSc., and Ph.D holders. The ratio of graduates in each major discipline at various levels, is another indicator by which higher education systems is measured. The ratio of BSc. graduate on one, hand and MSc.and Ph.D graduates, on the other, varies from one major field to another. MSc. and Ph.D graduates, for example, are needed more in the field where research and development activities are considered a major science and technology indicator of maturity of educational system. The more there is a demand for graduates holding advanced degrees, the more developed the S&T system is.

Publication in Scientific Journals

114. The number of papers that are published by scientists and technology specialists in scientific journals is another indicator of science and technology efforts in the country. Countries are usually ranked in the order of their contribution to the world science and technology literature. The higher the average number of papers published annually by each country, the better the science and technology system is ranked.

Patents

115. The number of patents in major patent system that are granted to science and technology system or individuals of each country is another indicator of the productivity of the science and technology systems.

Registration of patents has become one of the major areas in which science and technology systems compete throughout the world. Since production of technology is the major target of research and development systems, patent registration among countries has become the recognised way of protection of research and development output.

Science and Technology Working Facilities

116. The availability of appropriate working facilities for scientists and technologists such as workshops, expandable supplies, raw materials, machinery, equipment, transport and instrumentation, determine the output of the researchers and their ability to ensure that research and development results reach the people for demonstration and actual use or application; and is therefore an essential indicator for successful science and technology activities.

Other Indicators

117. The number of books published, expenditure on emerging and new technologies, share of industry in research and development expenditure, share of industry in research and development activities (i.e. industry as a performer of research and development activities), venture capital invested in science and technology production projects, the degree to which informatics and computers are used in the society and the

level of employment of science and technology manpower, are all indicators that measure the health, productivity stage of development and competitiveness of national science and technology systems.

V. FINANCING OF SCIENCE AND TECHNOLOGY

118. The allocation of financial resources to science and technology sectoral activities will be based on the following criteria which are used in priority setting:-

- contribution of a sector to the Gross Domestic Product (GDP);
- availability of resources;
- potential of a sector in developing other sectors;
- contribution of a sector to socio-economic development;
- urgency;
- long term implications; and
- attainment and maintenance of national competitive advantage.

119. The above criteria will be given objective weighting with the view to establishing the relative importance of each sector so that there is equitable and judicious distribution of resources in those areas that will have a multiplier effect to the national economy. The criteria for objective weighting will be developed and will be dynamic. Theallocation of research and development funds to the different sectors in accordance with the relative importance of the sectors does not in any way exclude consideration of other sectors with future potentials for development. It may also happen that a great deal of research has already been done in certain sector so

that only moderate back-up research is required to maintain the tempo of productivity or social welfare.

Criteria for Priority Setting

Contribution of the Sector to GDP

120. Science and technology in the country will be meaningful only if the sectors contributing to the national Gross Domestic Product (GDP) will receive the attention they deserve. Such attention must be translated into financial allocation to the activities falling in the sectors.

Availability of Resources

121. Sustainable economic development is easily achieved when most of the inputs needed in the economic projects are readily available. A thorough countrywide assessment of the available material and human resources should, therefore, be conducted. Sectors with available material and human resources should receive the priority.

Potential of a Sector and in developing other sectors

122. Some sectors of the economy have got more potential to develop other sectors than others. Priority for financing should be given to sectors which have a potential to be developed and/or to develop other sectors of the economy.

Contribution of the Sector to Socio-Economic Development

123. The present socio-economic development be maintained, sustained and improved upon. When allocating funds to aspecific sector, its contribution to the socio-economic development will determine its share.

Urgency

124. Sometimes conditions may demand urgent tackling of a certain activity which if delayed will have damaging social, political or economic consequences. In such circumstances, the activity shall receive priority for financial allocation irrespective of the sector it falls in.

Long Term Implications

125. Most activities in the science and technology arena have very positive long term implications. There should be provision for funding such activities.

Attainment and Maintenance of National Competitive Advantage

126. Modern market trends require that we develop a competitive advantage over the other nations in order to benefit from the international trade. Therefore, priority of financial allocation shall be given to sectors which contribute towards building this competitive advantage.

Allocation of Minimum Percentage of GDP to Science and Technology Activities

127. Traditionally, financial allocations to science and technology system, in general, and to research and development activities, in particular, come from government budget. On the whole, such allocations are integrated in the various line items of the budget such as salaries, capital investment and operational funds. Allocations to science and technology should be considered a pre-requisite to the successful science and technology system. Theimplication of this policy is that allocation of funds for research and technology development

activities will be according to the predetermined ceiling in a given year and will reflect the recommended proportions.

128. There is need to specify the percentage of GDP to be allocated to scientific and technological activities in annual national budgets. As an indication of government commitment to the development of science and technology, it is proposed that a minimum of funding for science and technology be gradually increased to 1% of GDP by the year 2000.

National Fund for the Advancement of Science and Technology

129. The National Fund for the Advancement of Science and Technology should be established. (Act 7 of 1986 part V Section 23-26). The fund will get contributions from the government budgetary allocation, public and private institutions, as well as individuals.

130. In addition to the fund, the government should devise an incentive package to encourage public and private firms to devote greater resources to science and technology activities.

VI. INSTITUTIONAL / LEGAL FRAMEWORKS AND LINKAGES

Institutional Framework and Linkages

131. In order to accord science and technology its central role in national development, it is important to ensure that effective institutional framework and linkages are established at various levels. Moreover, it is proposed that there be established a high powered national scientific and technical advisory committee to advise the President of the United Republic of Tanzania on science and technology issues related to:-

- policy development and implementation measures, encompassing technological innovation and adaptation, information exchange and personnel development;

- institutional development measures deemed necessary to promote science and technology development; and

- science and technology in general.

132. There should be a science and technology advisor to the President on matters related to science and technology.

133. Similarly, the following committees on science and technology should be established:-

- Cabinet Committee on Science and Technology;

- Inter-ministerial Technical Committee on Science and Technology;

- Parliamentary Committee on Science and Technology; and

- Village, District and Regional Science and Technology Committees.

134. The above mentioned committees will be responsible for the analysis of the science and technology needs in their relevant areas of competence, pinpointing where emphasis should be placed, which resources are required and which ministries and organizations should be charged with specific tasks. The committees should also sensitize decision and policy makers in science and technology.

135. Institutions charged with the development, promotion, monitoring, and coordination of science and technology have to work functionally and structurally as a system geared towards the optimization of the available resources and achieve those functions.

136. The ministry responsible for science and technology should have the overall mandate to oversee science and technology and research and development institutions.

Legal Framework

137. There should be a clearly defined legal framework to facilitate harmonious functioning of all institutions dealing with the promotion, development, transfer and utilization of science and technology. There should also be clearly defined structural and functional linkages to harmonize and synchronize all the functions of these institutions. Such systems include, among others, the research and development institutions (RDIs), science and technology services (STS) institution, science and technology training institutions, professional organisations associations, Centre for Technology Development Transfer, industrial establishments as well as non-governmental organisations.

Integration of Science and Technology in Socio-Economic Planning

138. The Planning Commission should be broad based to include professionals from the relevant sectors of the economy, including science and technology.

139. Science and technology should be integrated fully into the national socio-economic planning process so as to improve national planning in both productive and social sectors.

140. Planning must be enhanced in order to ensure that the activities that are placed in the short term plan have the ability and capacity to catalyze other development activities. The objective for the short-term plan should be to obtain a wide range of technologies that can be integrated into the corresponding socio-economic development plan, taking into consideration those technologies which are most appropriate and at the lowest possible cost. In the medium-term and long-term plans, emphasis should be placed on strengthening the science and technology capability by adapting and improving existing technologies.

141. Technology planning requires drawing up technological profiles of the various sectors of the economy, paying particular attention to the potential or key sectors. Detailed technological profiles will serve as the basis for formulating projects for the choice in technology adaptation and development. The initial phase has to be limited to selected sectors, which are critical for the time period under consideration. A technology plan should also focus onthe creation of a national capital goods sector, which is important in the overall process for enhancing technological autonomy.

142. Associated with the above development is the planning for skills formation, focused much more on technological skills. Human skills or technical knowledge is the most fundamental agent in technological transformation. Universities and technical institutes must intensively be used for the production of high level manpower. There must also be focus on training middle level skilled technicians of all kinds and extension service workers.

VII. COOPERATION IN SCIENCE AND TECHNOLOGY

143. It should be acknowledged that it is in the mutual interest of developed and developing countries to share the world's technological achievements. The development of science and technology in any country has both national and international dimensions which are derived from the universality and consultancy of scientific and technological knowledge, irrespective of national boundaries and varying ideologies.

144. There is a need, however, to be selective and develop the basis of cooperation in science and technology. Cooperation with developed countries should focus on collaborative research on a reciprocal basis with a view to facilitating technology transfer. Active participation and exchange of ideas and technologies should be enhanced through the United Nations system as well as multilateral and bilateral cooperation.

145. Maximum utilisation of South-South scientific and technological cooperation under the spirit of Technical Cooperation among Developing Countries (TCDC), Economic Cooperation among Developing Countries (ECDC) should be encouraged.

146. Regional and sub-regional cooperation in science and technology should be promoted and supported, and the roles of the United Nations system and other regional organisations such as SADC, PTA, KBO, ANSTI in promoting this cooperation should be strengthened in the spirit of collective self-reliance.

147. Institutional cooperation within the country should be promoted and supported, and the role of COSTECH in promoting this cooperation should be strengthened.

VIII. IMPLEMENTATION OF SCIENCE AND TECHNOLOGY POLICY

148. The institutional framework and linkages are necessary in order to ensure that the detailed plans which will be drawn for the implementation of the science and technology policy are facilitated.

149. Above all, the science and technology policy must be fully integrated into the overall socio-economic plan if it has to have any impact in enhancing the welfare of the people.