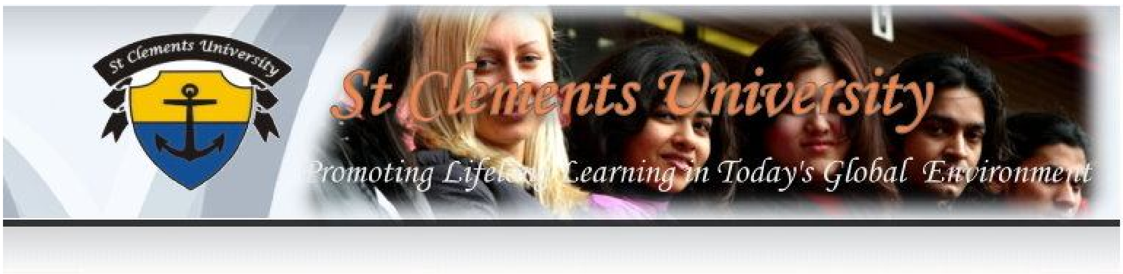

AN IMPACT ASSESSMENT OF SCIENCE AND TECHNOLOGY POLICY ON NATIONAL DEVELOPMENT OF NIGERIA

BY

ABUBAKAR ABDULLAHI

October, 2004

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(MATRICULATION NO. 3081)

A Dissertation Submitted to St. Clements University in Partial Fulfillment of the Requirements for the Award of Doctor of Philosophy in Management
St. Clements University

October, 2004

DECLARATION

I declare that this Dissertation is an output of my own research endeavours.

In pursuant of this research work, concerted efforts were made to duly acknowledge through bibliography, all sources of data and information used.

However, in case of inadvertent omissions or incomplete referencing, I nevertheless, still express the acknowledgement of such sources. I accept full responsibilities for any shortcomings and errors of judgment, logic or fact in this study.

Abubakar Abdullahi ……………………………….

Signed

CERTIFICATION

This is to certify that this dissertation entitled “An Impact Assessment of Science and Technology Policy on National Development of Nigeria” by Abubakar Abdullahi (Matriculation No 3081) is carried out under my supervision and guidance. Also, that the dissertation has been approved for submission to the St. Clements University for the award of the Degree of Doctor of Philosophy (PhD) in Management.

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Dr. Gabriel U. Moti	Professor David Iornem
“Supervisor	Academic Adviser

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St. Clements University

DEDICATION

This research work is dedicated to my wife Hajiya Fatima Abdullahi and my children Mohammed Bashar, Zainab, Jamila, Aisha, Isa, Fatima and Abdullahi for their patience and understanding, especially when the demands of office kept me away from home. They have been quite wonderful and a source of inspiration to me in realizing my vision of acquiring a Ph. D.

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ABSTRACT

It has been observed that science and technology (S&T) policies have not been a critical determinant of national development performance in Nigeria. Also, that

Nigeria has not fully realized its national objectives of S&T-driven rapid industrialization and development. It is in recognition of these observations that the study attempted to assess the impact of science and technology policy on national development of Nigeria. To carry out the assessment study, extensive literature review was carried out which formed the background knowledge to the study as well as provided the necessary input to the discussion of the findings from the study. The data generated from interviews and questionnaires were analyzed using quantitative and qualitative methods. Four hypotheses were tested in order to quantitatively analyzed the findings from the study. The analysis confirmed all the hypotheses stated as well as the fact that S&T policy has not played a critical role in national development and that Nigerian society is not aware of and hardly contribute to formulation of S&T policy.

Furthermore, the study revealed that development process in Nigeria failed to recognize the critical role of scientific and technological activities. The country lacked science culture and the existing institutional capacity for S&T development is very weak in terms of requisite personnel and facilities. The study concluded that a new policy shift is desirable which emphasizes the promotion of S&T culture, its integration into the production system and the strengthening of institutional framework for policy formulation, implementation, monitoring and evaluation in addition to promotion of S&T literacy.

Finally, pertinent recommendations were made which include among others, the need for government to place greater emphasis on achieving value-for–money on its expenditure on research. This demands increase in activities on R&D evaluation as well as strengthening of infrastructure for information and knowledge dissemination. In addition, there is need to promote goal-oriented national projects that encourages technological capability building.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Human development history has shown that sustainable development and self-sustaining progress of any country has generally followed the development and applications of science and technology (S&T), controlled by and responsive to the needs and endowment of a country (Adeniyi, 1999).

Many developed countries of the world today achieved their level of development through the adaptation of technology and development of an efficient S&T capacity. There is no doubt that the importance of S&T to national development has been recognized by nations who currently are in the forefront of human development index.

Consequently, human and national sustainable development are determined largely by the level of indigenous and endogenous scientific and technological research, the communication of research results and on the knowledge acquired and brought to bear on policy making, programme formulation, project implementation, monitoring and impact assessment.

Furthermore, any society without indigenous and endogenous S&T research capacity and capability and high level of literacy cannot but continue to remain underdeveloped (Adeniyi, 1999,). Scientific research in all its forms is the cornerstone of a nation's social and economic development (Abiodun, 1999). Though geographical and human size of a nation may be indicators of its potential power, the real power of a country is measured today in terms of its economic progress, that is, the proven capacity to translate scientific knowledge through its judicious and determined exploitation of technologies in economic productivity. It has been observed that the Nigerian society lacks an in-depth understanding of the role of S&T in national development plans (Abiodun, 1999,). The need to integrate S&T into national planning has been overemphasized.

In reviewing efforts at bringing science and technology to bear on national development, it is important to examine underdevelopment of S&T in less developed countries and relate it to current national underdevelopment. It has been established that science has a function in relation to the development of production. This function is partly driven by economic forces.

Karl Marx, a classical economist once observed the importance of economic organization in the development of link between science and production.

He argued that the requirements of the economy will eventually have an effect on the direction of scientific development itself. Furthermore, that technological advance generates new specialized skills at the interface between science and production, notably the various types of engineering skills.

The new specialists were able to interpret the needs of the entrepreneur to the scientists and economic demand began to affect the orientation of science. The prime mover here is the search for profit. There is no doubt, that economic demands for innovation had tremendous influence in the evolution of science and indeed R&D. The phases in the development of relations between science and production had been identified as follows (Bernal, 1970):

- Early part of the industrial revolution when production technologies were often the source of new scientific discoveries.

- Second phase which started with the development of the electrical and organic chemical industries informed the new relationship between science and production. During this phase, research laboratory became the source of technological innovations and entrepreneurs drew science into closer relationships with production as they began to invest directly in scientific research as a potential source of profit.

The issues raised here attempts to support the belief that science has a social function in relation to the development of production.

Furthermore, the demands of the production system can influence the way in which scientific institutions develop and the content of science.

Industrialized market economies developed based on the relationship between science and production. The form in which scientific institutions developed and linked to production in advanced countries was further strengthened through linkage of network of engineering institutions and machinery manufacturers and the types of research carried out.

Some schools of thought are of the opinion that scientific institutions such as research institutes, scientific societies, science policy organizations do not have the same social role everywhere. They argued that scientific institutions in less developed countries might as well serve different social purposes from those in advanced countries. They concluded that by building new research institutes, there are indications that they will function in the same way as the existing ones and may have very little to do with the development of production (Cooper, 1978).

An alternative view to the current state of development of scientific institutions in less developed countries was linked to “technological dependence”. The dynamics of the underdeveloped economy was observed to create a situation where local scientific institutions were alienated from production.

For instance, the import substitution industrialization strategy adopted by most less developed countries encouraged technological dependence. In most countries foreign technology was substituted for technologies that might have been developed by local scientific research and development institutions. The most important element in this view is not that there are import–substitution policy, but simply that the technologies needed generally exist already in the industrialized countries and are often proprietary (ie owned by private enterprises).

This technological dependence adversely affected the thinking and orientation of the potential beneficiaries of local scientific endeavours. For instance, there were cases where local research institutions have successfully developed the types of technology required by local enterprises, but they were rejected in preference to the foreign version on grounds that it is less likely to work.

The consequence of this is that scientific institutions over the years became alienated from production activities. In fact, they became “marginalized” as there were no demands for locally developed technologies from the production sector. Invariably, science became largely for consumption rather than an investment as in the industrialized countries. Also, lack of pressures on science from the local economy, implies that the main determinants of research orientation are the individual decision of research workers. In Nigeria, the situation was not different from other less developed countries.

The incapacity of Nigeria to use scientific and technological research as dynamic elements for social development is a consequence of the characteristics of the prevailing national projects. Unless the approach to implementation of national projects takes into consideration the aspirations of the majority of Nigerian populace, scientific resource will continue to be cultural luxury.

Since after the independence there has been considerable national activity to increase scientific and technological capacity of the country. This is reflected in the number of institutional frameworks for S &T development in the country.

Early efforts to promote the development of S & T national capacity after independence centred on direct aid from developed countries. This type of aid include donations and loans for scientific equipment, subsidies for research project, missions of qualified personnel to train nationals or to help formulate S&T policy and scholarships for further study abroad. Though the foundation was laid through foreign assistance, however, very limited efforts were made to build on this foundation and also to strengthen the existing institutional frameworks.

Consequently, scientific and technological systems in the country were very limited and totally unconnected with national problems. In contrast to situation in developed countries, science planning endeavoured to control and direct existing efficient scientific and technological research system. After more than four decades of efforts at S& T development, what are the results? A cursory analysis indicates that in general terms, there has been very limited progress made in absolute terms. One remarkable observation is the quantitative deficiencies of Nigerian R & D system.

In developed countries for instance, most R&D is on subjects that were connected directly or indirectly with national goals such as defence, social development or prestige. Scientific development was reflected in the development of industrial and agricultural technology and in the growth of production. In Nigeria, considerable numbers of scientific researches were not designed to address the basic societal problems.

This lack of connection between the goals of scientific research and the needs of society is a characteristic of underdevelopment (Herrera, 1978). The irrelevance of much scientific works in developing countries is widely acknowledged and hardly requires proof.

Evidence abound that agricultural production in Nigeria increased after the second world war, of which two-thirds of the increase was as a result of more land cultivated and not due to increased productivity or yield. (Adeniyi,1999). In contrast to Europe, despite the limited land availability, production increased remarkably due to increase in yield and productivity within the same period. In the industrial sector, the situation is not different either. Industrial technological research is practically non-existent.

The private sector contributes insignificantly to the total R&D investments in underdeveloped countries. In developed countries between 60 and 70% of R&D is undertaken by the private sector while in Nigeria, the private sector undertakes 0 to 0.1% of R&D (Ogbu 2003). An overview of the R&D activities in Nigeria over the years has shown the lack of social relevance. Initial efforts concentrated more on basic research than applied research.

In advanced countries far more were invested in applied and development research than in basic research. However, in Nigeria much more were spent on basic research than in applied research and development. Despite this, basic research has not contributed significantly in addressing societal needs or evoked considerable concern for greater investments in applied research. Consequently, applied research is very weak and there is practically no interaction between the different types of research and production.

The few basic research centres (especially, the Universities) function as isolated enclaves which do little to encourage local R&D. Even, the current state of the universities has further compounded the R&D problems as infrastructures have decayed as well as high turnover rate of seasoned researchers and scientists. These distortions in the S&T systems in most developing countries informed the progressive withdrawal of international funding agencies from national S&T development strategies. For instance, evidence abound that international agencies responsible for programmes of international cooperation are no longer keen in funding S&T development.

Presently, there are more tendencies among international donors to give funds for projects with "direct social interest" like housing investment and health (Coopers, 1978). This underscores why presently, there is limited attention to setting up programmes that would create the scientific and technological capacity to solve basic problems as the visible manifestations of such efforts are only a symptom. The question that should be asked is "why is the situation like this, and what can be done to redress it?

One tends to believe that the complete failure of these efforts is associated with the erroneous suppositions about the problem of incorporating science and technology in the production system. The obstacles to this process are direct consequence of the structure of underdevelopment resulting from insertion of underdeveloped countries into the international system. The bottom line of the whole scenario lies in the prevailing nature of economic and social structure.

1.2 **STATEMENT OF THE RESEARCH PROBLEM**

The importance of science and technology to national development cannot be overemphasized. However, the approach and strategies for achieving an S&T-driven economic development deserves consideration and appraisal. A wide variety of different policies have been pursued in Nigeria in an effort to foster technological development with the aim of accelerating the pace of economic development.

Furthermore, these sectoral development policies were formulated to guide the process of development in relevant areas of the economy. These policies include among others, the following:

- Science and technology policy, which aims to provide innovative initiatives for development in all aspects of social well-being such as agriculture, industry, health, etc.
- Industrial policy, which aims to increase productivity through the application of modern technologies and machineries.
- Agricultural policy, which aims to increase food production in order to ensure food security with minimum degradation to the environment.
- Other policies include health policy, environmental policy, economic and trade policy, and social policy.

The key questions to these policies are as follows:

- Has the S&T policy been a critical determinant of national development performance?

- Has the application of S&T contributed to the development of industries in Nigeria as well as increase the industrial productivity?

- How has S&T impacted on agricultural production leading to increase in food production and ensuring food security and poverty reduction?

- What relationship exists between S&T policy institutions and the socio-economic frameworks established for national development?

This study intends to address these questions as well as identify factors responsible for inability of Nigeria to fully realize its national objectives of S&T-driven rapid industrialization geared towards increasing national productive output and developing a dynamic and self-reliant economy. Also, efforts shall be made to unravel why the following ineffective mechanisms hindered the national S&T objectives:

- dearth of people-oriented, market–driven, job-creating dynamic S&T policies to guide national development efforts;

- minimum investment in the training of skilled human resources to sustain scientific creativity and technological innovation and failure to create an enabling environment for active S&T research and development;

- low investments in S&T infrastructure;

- inefficiently managed S&T institutions with duplicating mandates;

- poor intra-government cooperation and collaboration among key S&T stakeholders;

- lack of an integrated approach to national development efforts by policy makers, administrators, academicians/ researchers, development bankers, financiers, industrialists and entrepreneurs; and

- faulty mechanisms for creating an interface between S&T, industry and government.

The above issues underline the rationale for this study and it is expected that the outcome will provide strategies for establishment of frameworks for short-term, medium-term and long-term plan of action for operation of the current S&T policy. Also, practical programmes and projects will be identified for consideration by the Nigerian government in order to give focus and relevance to the S&T policy in addressing societal needs.

1.3 **RESEARCH OBJECTIVES**

The immediate objectives of the study are:

- To review the current National S&T Policy and present a critique on it based on the point of view of explicit and implicit S&T policy, and its relevance to the society.

- To identify the existence or not, of a National R&D policy which should give the necessary goals, guide lines and directions for R&D on national projects.

- To analyze the research planning process and implementation with a view to identifying the strength, weaknesses, opportunities and constraints to the total utilization of S&T policy for national development.

- To examine the existing institutional frameworks for research and relate their mandates in terms of social function of S&T.

- To identify achievements of the Research Institutions (RIs) and constraints hindering their greater contribution to socio-economic growth and development of the country.

- To examine the approach to R&D as it is currently being practiced and relate it to industrialization in the context of market-driven R&D and commercialization of viable research results.

The development or futuristic objectives are as follows:

- To lay a lasting foundation for future works on S&T policy formulation, planning and implementation as well as promoting and evaluation in Nigeria.

- Provide the required background knowledge for awareness creation on the relationship between science, technology and society.

- Provide platform for promotion and dissemination of S&T information that are designed to assist in commercializing viable research results in order to add value to the Nations' natural resources with a view to reducing heavy dependence on importation of raw materials and capital goods with attendant foreign exchange implications.

1.4 JUSTIFICATION OF THE STUDY

The essence of this study is encapsulated in the review of the past and current efforts made in Nigeria to achieve national development through the application of science and technology (S&T). Opinion makers believed that science and technology have not contributed to the growth and development of the country despite decades of its recognition as contributory sources of economic development.

These opinions often shape the society's' appreciation and understanding of the role science and technology could play in achieving sustainable development. It had far-reaching implications and influences on national development both in the area of education, agriculture, health, environment and industrial development.

Although studies have been conducted in the country on the role of research in national development as well as management of R&D and the various constraints limiting commercialization of R&D, not much has been done in the area of science and technology policy and societal development. Moreover, the first national policy on S&T was enunciated about 18 years ago and the current policy was formulated a year ago. Considering the time frame between the first policy and the current policy and relating the implementation of the first policy to the socio-economic development of Nigeria within this period, there are some challenges in terms of determining the level of impact made by S&T policy.

This study therefore, attempts to relate the two science and technology policy frameworks to societal development from the point of view of the nature of the policies, its awareness and appreciation by the society, its application in guiding societal development as well as the overall level of S&T literacy. It is expected that the study will reveal the various limitations to the evolution of S&T in Nigeria and make valid suggestions on what could be done to improve on the current approach so as to make S&T truly international and competitive in the country.

The findings of the study will be of immense benefits to all stakeholders in the science and technology sector and more importantly, to the government. Since government is the major stakeholder and financier of S&T programmes and activities, the study will provide a framework for government to begin its reform process in the field of S&T by making it more market-driven and private sector-led.

Also, it will provide a guide towards formulating measures to promote S&T in the country. The findings shall provide the background information to assess the effectiveness of S&T structure and the overall performance of its institutional frameworks. Part of the overall expectation from this study is the development of national indicators for the assessment of the impact of S&T on National development.

The study shall emphasize on the need for development of S&T infrastructure and total utilization of S&T capacity in pursuance of national projects aimed at socio-economic development. Also, the organized private sector will find the outcome of the study quite useful in shaping opinion on the need for government to foster effective and unbroken linkage sector in order to ensure that the private sector benefit from indigenous research efforts and promote technology acquisition and transfer from developed and developing countries.

It was therefore, anticipated, that the ideas emerging from the study could be used by voluntary and non-governmental agencies when implementing policies relating to science and technology. It could also be used by educational (universities), training and R&D institutions as bases for planning new programmes and research strategies and evolving appropriate support systems for application of S&T to national development.

Finally, it is hoped that the research findings from this study will generate diverse interests in the field of S&T policy formulation and implementation, especially policy study in Nigeria and Africa in general.

1.5 **STATEMENT OF HYPOTHESIS**

In order to validate the findings from the study a quantitative analysis was carried out through the use of statistical instrument. To this end, the following hypotheses were formulated for testing.

HYPOTHESIS 1

Null (Ho): The Nigerian society is not aware of and do not contribute to the formulation of S&T policy.

Alternative (H_1): The Nigerian society is aware of and do contribute to the formulation of S&T policy.

HYPOTHESIS 2

Null (Ho): Science and technology policy has not been a critical determinant of development performance in Nigeria.

Alternative (H_l): Science and technology has been a critical determinant of development performance in Nigeria

HYPOTHESIS 3

Null (Ho): Science and technology policy has not played a critical role in national development of Nigeria.

Alternative: Science and technology policy has played a critical
(H_I): role in national development of Nigeria.

HYPOTHESIS 4

Null (Ho): Lack of demand for innovations in industry and agriculture is not responsible for enability of S&T to impact on national development.

Alternative: Lack of demand for innovations in industry and
(H_I): agriculture is responsible for enability of S&T to impact on national development.

The above hypotheses were tested using chi-square (X^2) statistical analysis.

1.6 **SCOPE AND LIMITATIONS OF THE STUDY**

The study looked at the past (1986) and current (2003) National policy on Science and Technology and reviewed the documents along the line of their explicit and implicit functions. The assessment of the impact of R&D on national development was limited to applied research carried out by Research Institutes in Nigeria. The study will examined among other issues, the following:

- Review of the National S&T Policy
- Critique on the National S &T Policy
- Science and Technology Literacy
- Research Policy and Development

- Research Planning, Analysis and Implementation.
- Institutional Frameworks for Research (Research Institutions)
- Achievements and Constraints
- Infrastructure and Management of R&D
- Innovation and Technology Acquisition.
- Capacity Building
- Funding of S & T development and Research
- Market-driven R&D and the Role of Private sector
- Communication with Scientists and the Public

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CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Science and technology policy and its impact on society depend on a number of factors that are related to contribution to development of fundamental knowledge and technology. Also, consideration is given to its contribution to development of scientific and technical human capital. These parameters are often used to evaluate the impact of science and technology policy on the society.

Considerable volumes of literature exist on the role or significance of S&T to development of the society. However, it is pertinent to appreciate that in the context of this study, attempt is made to review past efforts towards the evolution of S&T culture in Nigeria and the translation of indigenous efforts of the scientific community towards the development of human knowledge and technology acquisition.

The various literatures on S&T policy formulation and implementation point obviously to three basic subsystems consisting of the policy framework, the institutional framework for policy implementation (Research Institutions) and the user subsystem (Bwisa 1997, Tiffin 1994). The subsystems are expected to interact in such a manner as to create the necessary impact on national development.

Science and technology policies are generated by both the internal stakeholders (S&T family) and the external stakeholders (end-users of S&T), while the successful implementation depends on the cooperation of all, including the greater society (Ajoku, 2004).

The role of the institutional framework for policy implementation is very critical in determining impact of the policy on the user subsystem. It is obvious that the second subsystem (R&D institutions) must be able to play a key role in terms of institutional support to the productive sector and the society at large which form the user subsystem. If the second subsystem is weak or unable to discharge its functions effectively, the impact of the first subsystem (policy framework) can not be felt and even measured (Ajoku, 2004).

It is imperative therefore that the subsystems should interact on a continuous basis to achieve the desired impact. This concept provided the basis for the research methods and procedures for the study which focused on the impact of S&T policy on national development.

The study therefore, documented and analyzed the level of development of S&T subsystems in Nigeria, the current and past S&T policy frameworks and their contributions in bringing about national development and strategies needed to be adopted in the future to achieve greater impact in the implementation of the S&T policy.

2.2 **HISTORICAL DEVELOPMENT OF S&T IN NIGERIA**

Historical records had it that the first sets of research institutes in Nigeria were established during the colonial rule. The essence of establishing these institutions then was to boost agricultural output and thus provide adequate raw materials for industries in Europe (Aluko-Olokun, 1999, Barrow, 2002).

In 1898, the first agricultural research station was established in Ibadan and was called Moore Plantation. Thereafter, similar research stations were established in the then Northern Region at Samaru, Zaria and Umudike, Umuahia in Eastern Nigeria. The Department of Agriculture (or Moore Plantation) was later renamed Federal Department of Agricultural Research in 1954 (Barrow, 2002).

In the early 20th century, sub-regional research stations were established by the colonial administration with headquarters in Nigeria. These institutions or centres include the following:

- West African Cocoa Research Institute, Ibadan,
- West African Institute for Oil Palm Research, Benin
- West African Institute for Trypanosomiasis Research, Kaduna.
- West African Council for Medical Research, Yaba, Lagos.

Furthermore, the West African Research Office located in the then Gold Coast (now Ghana) had research centres in Nigeria. The research centres include the following: the West African Road Research Institute, the West African Timber Research Unit and the West African Rice Research Station.

Following independence of Ghana in 1957, most of the research institutions and centres became full-fledged national institutes in Nigeria. In 1964, the Agricultural Research Institute Act was enacted by the parliament in Nigeria (Aluko-Olokun, 1999).

The institute was established to coordinate research activities in Nigeria as it relates to agriculture. Following the international conference on the Organization of Research and Training in Africa in 1964, Nigeria established a National Council for Scientific and Industrial Research (NCSIR) by Decree No. 83 of 1966. The Council was expected to act as an advisory body to government and as such, lack executive powers (Aluko-Olokun, 1999). Its mandate was quite narrow and therefore had structural weakness that prevented it from functioning efficiently. The real consciousness of the development of science and technology in Nigeria did not come into force until after the Civil war in 1970.

By the 1970s, concerted efforts were made to promote science and technology development in Nigeria. Within this period, the Nigerian Council for Science and Technology (NCST) was established by Decree No.6 of 1970 to replace the NCSIR (FMST, 1990). The Decree also, approved the establishment of four sectoral research councils, namely;

- the Agricultural Research Council of Nigeria (ARCN). established by Decree No.25 of 1971;
- the Medical Research Council of Nigeria (MRCN) established by Decree No.33 of 1971;
- the National Science Research Council of Nigeria (NSRCN) established by Decree No. 9 of 1973, and
- the Industrial Research Council.

The NCST was to coordinate research and development activities in the country in fields such as agricultural science, engineering and technology, medical science, experimental sciences, environmental and social sciences. Aluko-Olokun (1999) observed that much of the development at this period was influenced by the activities of UNESCO.

It will be recalled that in 1974, UNESCO organized the first regional ministerial conference on S&T development in Africa called CASTAFRICA I which was held in Dakar, Senegal (Khalil, 2002). The conference identified and recommended among other issues, the need for African countries to formulate their Science and Technology Policy to guide national development, especially rural and industrial development.

In 1976, the government of Nigeria, in pursuance of its commitment to the resolution reached at the first regional conference, set up an S&T policy review committee which recommended two policy options, namely:

- the establishment of an executive agency to coordinate S&T policy; or
- the establishment of Ministry of Science and Technology with all the Research Institutes under it;

Based on the selection of the first option, the National Science and Technology Development Agency (NSTDA) was established by Decree No. 5 of 1977 with all the research institutes under it. With the emergence of this new institutional framework, the sectoral research councils and the NCST were dissolved. The National Science and Technology Development Agency (NSTDA) had no Minister and were chaired by the Chief of Staff Supreme Headquarters, Major General Shehu Musa Yar'Adua (Animalu, 2003).

By 1979, additional research institutes were established by this agency bringing the total number to twenty-two made up of 18 agro-based, 3 industrial and 1 medical. NSTDA, in addition to supervising the research institutes, also, funded university-based research
(Aluko-Olokun, 1999).

The search for an ideal national S&T structure did not end with the establishment of NSTDA. In 1980, with the emergence of a democratic government and with the apparent realization of the importance of S&T to national development, President Shehu Shagari established the Federal Ministry of Science and Technology (FMST) and dissolved NSTDA through the Science and Technology Act No.1 of January, 1980.

It was at this point that the first Minister of Science and Technology was appointed with all the complement of staff as well as its own budget. Within this period, government established specialized universities to focus attention on expanding the frontiers of knowledge in S&T in addition to training of high-caliber manpower required for the technological age. This period heralded the establishment of universities of technology and more polytechnics.

However, as government changed with the incursion of the military into governance and barely four years after its establishment, the new Ministry of Science and Technology was merged with the Ministry of Education as Federal Ministry of Education, Science and Technology. In 1985, following the overthrow of the then military administration of Major-General Muhamad Buhari, the Ministry of Science and Technology was once again made a full-fledged Ministry in 1986.

It was during this period that the first "National Policy on Science and Technology" was enunciated. The choice of scientists and technocrats in the running of the Ministry of S&T informed the radical change within this period (Animalu, 2003). Some of the pertinent issues for consideration include the establishment of "National Science and Technology Fund (NSTF) as a source of funding for the implementation of the S&T policy. Also, the identification of the non-existence in the Federal Ministry of Science and Technology policy framework of an engineering infrastructure, informed the establishment of National Agency for Science and Engineering Infrastructure (NASENI) by Decree No.33 of 1992.

Uncertainty in governance of S&T in Nigeria manifested in the scrapping of the Federal Ministry of Science and Technology by late 1992. In place of the FMST, all research institutes except four were returned to their various sectoral Ministries. The Federal Ministry of Industry and Technology was created while the Sheda Science and Technology Complex (SHESTCO) came on stream vide Decree No.43 of 1991. The expected funding of S&T through the NSTF did not materialize (Animalu, 2003).

The Decree No.39 of 1987 which informed the establishment of the Raw Materials Research and Development Council (RMRDC) for the promotion of raw materials development was amended in 1992 and provided with a risk fund realized from the value added tax or surcharge on imported raw materials (Animalu, 2003). The Federal Ministry of Science and Technology was re-established in 1993 and since then has maintained a stable functioning till date.

2.3 APPRAISAL OF EVOLUTION OF S&T IN NIGERIA

Scientific institutions in Nigeria emerged during the colonial period particularly around mid-1960s, during which National Research Councils were established. It is pertinent to note that the current S&T capability was built between the late 1960s and the 1980s, a period characterized by military rule in Nigeria.

During this period, there was growing concern of some military and civilian authorities to build up the country's S&T competence as part of a broader project of national growth and self-sufficiency. The concern to build up scientific, technological and industrial self-sufficiency within this period however, did not receive the desired support in the productive sector.

Consequently, it remained for the most part, restricted to special segments of the state bureaucracy and the academia. For most firms, including the multinationals and state-owned corporations, the origin of technologies used in their production activities was immaterial than their cost and reliability.

Furthermore, there was little or no understanding of the effective mechanisms and policies leading to technological innovation in the productive sector. Also, the need to strengthen Nigeria's basic technological infrastructure, metrology, normalization, quality control and certification received minor attention.

2.3.1 **Main Initiatives**

The main initiatives include the following:

i. Educational reforms of the early seventies with emphasis on science and technical education.

ii. The integration of science and technology under the national economic policy.

iii. The creation of institutional frameworks for science and technology such as Federal Agency/Ministry for Science and Technology.

iv. The establishment of a few centres for research and development.

v. The formulation of National S&T policy.

2.3.2 **Crisis in the Eighties and Nineties**

Despite the initial efforts made in promoting S&T development in the country, there were several constraints, among which were the following:

- There was very weak linkage between S&T and the productive sector.

- There was lack of strategy for acquisition of advanced technology in an economic environment characterized by protectionism and reliance on cheap labour and natural resources.

- The exception to this situation was in the field of agriculture where the sector benefited from research on the introduction of high yielding crop varieties, disease resistant crops with significant gains in productivity. This development marginally boosted the export oriented sector of agriculture.

- Within this period, in the universities, research and graduate education remained isolated from the productive sector. The quality of scientific institutions created and expanded in the seventies started diminishing.

- The 1990s brought a great instability and uncertainty in the S&T sector as attested to by the various changes in the existence of the Ministry of Science and Technology as well as its governance. Within this period, there were great institutional tumoil of bureaucratization and budgetary uncertainty.

- It was also, in this period that funding of S&T gradually feasled out due to increasing budgetary constraints and inflation. The Structural Adjustment Programme (SAP) further accentuated the fiscal constraints.

- The operators in S&T sector started going about with cap in hand pressing for more resources often with partial or no success at all.

- The early nineties saw a renewed effort to resuscitate the S&T infrastructure, albeit by creating new ones with a view to making S&T more directly relevant to industrial competitiveness. This heralded the birth of Technology Business Incubators, Science Parks, Agencies for Engineering Infrastructures, Raw Materials Research and Development Council, among others.
- Given the persistence of economic stagnation and political uncertainty in the early nineties, the impact of the renewed efforts could not be felt.

- Consequently the research institutions were deprived of funds and support which affected their work ability and contributed to both internal and external "brain drain".

- Even, universities suffered from budget limitations as well as increasing salary costs and the absence of incentives for performance efficiency.

2.3.3 Progress Made and Realities

The above chronicle of constraints, present a scenario of failures, however, some measures of progress were made such as enumerated hereunder.

i. The basic scientific and technological competence acquired by Nigeria in the past three decades was an important asset for continuous drive for social and economic modernization.

ii. The institutional frameworks established as delivery systems for S&T development are currently on ground and require only restructuring and modernization to make them more relevant once again.

iii. The realities of the experiences of the 1980s and 1990s informed a re-think on the assumptions made at that time that S&T is an “endless frontier” worth expanding for cultural reasons and its promises in terms of practical applications.

iv. At that time there was the belief that all field of knowledge were equally deserved and all projects and initiatives must get public support.

v. Furthermore, the notion that scientists should be funded by the state, free to control their institutions and distribute research resources according to their own criteria gradually changed.

2.3.4 The Planning Process

Science and Technology planning process passed through different stages of development. The need for reliable information and stable decision procedures for resource allocation and establishment of long-term projects were recognized. The planning process was however, encumbered by large bureaucratic structures, thus making the decision process very difficult.

2.3.5 Prevailing Economic Policy and S&T Development (Import Substitution)

During the era of import substitution economic policy of Nigeria, the development of S&T was seen as part of a broader pattern of import substitution strategy with the clarion call for self-reliance and inward looking. The call for protection of local infant industries and local sourcing of raw materials was not marched with increased support and funding of S&T. The “protectionist syndrome” further closed the doors for international interchanges of knowledge and collaboration with scientific communities. Research institutions and programmes were hardly exposed to international standard of quality and evaluation.

Finally, considerations about regional inequalities and short-term needs as well as political pressures for the creation of academic and research institutions through out different geopolitical zones/states in Nigeria eventually led to the weakening of the criteria for resource allocation by the government agencies.

2.3.6 S&T and Education

One of the features of the emerging S&T development efforts of Nigeria in the early seventies was the emphasis on science education, its management and diffusion. However, there were no organized efforts to bring the benefits of scientific knowledge to the populace or to the productive system except in the field of agriculture.

At some period, efforts were made to generalize the university research model and also less emphasis was placed on basic, secondary, technical and mass higher education. The university research model remained restricted in scope and application to elite universities.

2.4 EMERGING REALITIES

2.4.1 Changing Role of S&T in the Global Scene

Since the sixties when Nigeria first embarked on its quest for S&T development, the global scene has changed dramatically. Some of the main features of the emerging realities include the following:

- S&T are much closer to industry and markets than before. Industries are externalizing for the development of new management skills, processes and products. The fallout of these are increase in R&D investments, the setting up of specialized laboratories and research departments and search for new linkages with universities.

- The pace of technical innovation and competition in industry accelerated, requiring from firms a permanent capability to change its organization, absorb new technologies and processes and generate new products.

- Science is now more global than ever as the speed, quality and low cost of international information flows brings researchers and research sites into immediate contact. It is now much easier to have access to the international scientific community than in the past.

2.4.2 Emergence of Scientific Enterprises

In the present dispensation, there is an emergence of scientific enterprises which compelled R&D to be market-driven. The old process of transiting from scientific development to technological change is no longer tenable. Currently, there is a change in the old system or "Simplest Linear Model" of S&T development that starts with basic research to applied research/invention and terminates with entrepreneurial innovation; thereby creating new products and processes which can later be diffused through imitation or reverse engineering.

The current situation is more complex with scientific discoveries assuming the context of application. The consequence of this changing landscape is the loss of support for basic research if it is not linked to identifiable products and results.

Furthermore, new patterns of international scientific cooperation emerged resulting in the establishment of large scale international ventures. Examples include human genome project, biotechnology and genetic engineering, global research activities in fields of meteorology, global warming, astrophysics, etc. Such cooperation is characterized by large scientific installations and networks of scientists and research groups. Also, considerable number of new activities and disciplines linked to scientific assessment emerged in areas such as technological forecasting, technology assessment and evaluation of environmental effects of innovation.

Science and technology capabilities in Nigeria failed in the eighties and nineties to adapt to the changing international environment and as such, entered into prolonged period of economic stagnation and inflation from which it is yet to recover fully. One of the major reasons for this was the failure on the part of governments to implement long term policies of economic growth, social welfare and environment protection.

The situation of instability and lack of vision affected the S&T sector in two important ways:

i. The reduction of resources for most existing S&T programmes.

ii. Lack of perspective for new projects and initiatives even when multilateral assistances which require matching funds were concerned.

Other factors include institutional and financial instability. At certain point in time, the agency established for S&T development changed name and status several times; budget allocated to R&D institutions fluctuated and actual delivery of the funds was not guaranteed
(Ogbu 2003). The situation was further deepened by lack of consensus in government, public opinion or international agencies about the importance and role of scientific research.

The long time it takes for scientific institutions to mature relative to the speed in which they decay in conditions of budgetary and institutional insecurity gives course for concern and worry (Schwartzman, 1993). It can be said without equivocation that the state of federal agencies for

S&T support in the country was such that they were limited in their ability to grant resources for research projects.

Secondly, the administration of some federal agencies for S&T suffered from the effects of over bloated bureaucracies, low salaries, low morale and political militancy of employees reflected in terms of number of labour strikes or work-to- rule (Ajoku, 2004). Some agencies were under staffed and unable to recruit competent persons to fill the vacancies. Operational activities were paralyzed by lack of resources and incentives.

2.4.3 Human Resources for S&T Institutions.

R&D demands highly qualified and skilled personnel. This caliber of skilled personnel requires substantial resources to develop and maintain which are in short supplies due to scarcity of resources. The situation was further confounded by immigration of skilled researchers to developed countries in search of greener pastures. It has been reported that "there are as many Nigerian Scientists in the West as expatriate living and working than there are Europeans in Nigeria (Ajoku, 2004, Khalil, 2002).

For those researchers/specialists who opt to remain, the situation was not in any way better. The public institutions which were mainly funded by the Nigerian government were poor payers compared with the private sector or even the private universities.

This situation resulted in the flight of skilled and experienced researchers to the private sector and private universities, leading to what is termed **“internal brain drain”**.

The fact is that even, with the small number remaining, there are still constraints that need to be addressed if this important resource is to be effectively utilized for socio-economic development of Nigeria. This group needs to be trained for example in the art of translating R&D results and patents into commecializable products and services (Khalil, 2002 and Schwartzman, 1993).

2.5 CRITIQUE OF NATIONAL SCIENCE AND TECHNOLOGY POLICIES

2.5.1 Explicit and Implicit Science Policy

To critique the national S&T policy of Nigeria, it is pertinent to examine it from the point of view of explicit and implicit S&T policy.

Explicit science policy is regarded as the official policy expressed in laws and regulations as well as the statutes of bodies in charge of scientific planning, in development plans and in governmental declarations. It is constituted by the explicit resolutions and rules which are commonly recognized as the science policy of the country (Cooper, 1978).

Implicit science policy on the other hand, determines the real role of science in society. It has no formal structure and in essence, it expresses the scientific and technological requirements of the "national project" of a country. Explicit and implicit science policies are not necessarily contradictory or divergent. Divergence becomes critical when there is contradiction in the national project.

Furthermore, implicit science policy is based on the idea that modern science only develops when there is some effective demand for it from society. Implicit science policy is like unwritten S&T policy while explicit science policy is the written and documented policy (Herrera,1978). S&T policy in less developed countries is often not built on national project. The issue of national project is the exclusive preserve of the elites or bureaucrats. The national project is a set of objectives to which the social classes which have direct or indirect-economic and political control aspire. National project is different from national aspirations or ideals which represents the social expectations of the community.

These social aspirations can only be a national project when the "authorities in power" adopts and are able to implement them. It is pertinent to note that a country may not have an explicit science policy, but always have an implicit one by virtue of interaction of the social system at large and the science system.

However, if the explicit science policy is not a real reflection of the scientific and technical requirements of the national project, it is considered therefore as an "artifact" and will diverge from the implicit, unstated but real science policy (Herrera, 1978).

A.1986 S&T Policy

The guidelines of the 1986 S&T policy recognized the fact that scientists and technologists in Nigeria had over the years engaged in their work without well defined national direction (FMST, 1986). Researches were carried out without much effort made towards commercialization, apart from publishing them in journals.

Furthermore, no conscious policy was established to galvanize S&T efforts into a coherent activity for use to promote self-sustaining economy. Also, the existing entrepreneurs were averse to risk and as such, were not willing to commercialize viable research findings. This situation which was considered unsatisfactory informed the establishment of an S&T policy framework for ensuring national development.

The policy framework was expected to provide direction and coordination for scientific and technological activities as well as development of manpower, creation of science culture in the society; intensification of basic and applied research, the application of research findings to developmental activities in agriculture, healthcare, industry defence and security and to provide employment opportunities for the citizens.

The national objectives in 1986 as captured in the fourth development plan include among others, the achievement of self-reliance through:

- acquiring enough technical know-how, skills and materials to defend the integrity and security of the nation;
- being technically self-reliant in the production of capital and consumer goods and raw materials, and
- maintaining a flourishing national export capability of goods and services.

S&T are expected to play a significant role in achieving the national objectives (FMST, 1986).

The objectives of the 1986 S&T policy are enumerated as follows:

- increasing public awareness in science and technology and its role in national development and well-being;
- directing S&T efforts along identified national goals;
- promoting the translation of S&T results into actual goods and services;
- creating and maintaining an increasing indigenous S&T base through research and development;

- motivating creative output in S&T;
- increasing and strengthening theoretical and practical scientific base in the society, and
- increasing and strengthening technological base of the nation.

The policy document addressed the following key sectors of the national life:

- **Educational System:** The policy stipulates that" educational system shall emphasize science at all levels.
- **Mass Movement**: The policy states that "there shall be mass movement for science and technology development in the country."
- **Motivation:** The policy states "that individuals engaged in S&T development projects shall receive special incentives and/or remunerations."
- **Capital Goods:** The policy thrust was to encourage the "production of machinery/equipment and spare parts based on local inputs".
- **Materials:** The policy states that "the exploitation, processing and utilization of the nation's material resources shall be programmed in such a manner as to promote self-reliance and enhance export."
- **Energy:** The policy states that "the nation's energy resources shall be developed, protected and optimally harnessed in the overall interest of the nation."

- **Technology:** "The policy stipulates "that in all aspects of the day-to-day activities of the nation, advantage must be taken of technological development."

- **Military Science:** The policy states that "there shall be a fully developed military science and technology complex".

- **Environment:** The policy states that "the activities of the nation shall be conducted in a manner to ensure sound environmental management culture".

- **International Exchange and cooperation in S&T:** The policy states that "the nation shall actively engage in bilateral and multilateral exchanges and cooperation in S&T".

- **National System of S&T:** The policy stipulates that the country shall be committed to S&T development and shall set up a National Council for Science and Technology (NCST).

- **Financing S&T Development**: The policy states "that S&T development activities in the country be financed through a funding system involving the Federal Government and its Parastatals, the State Government and the Private Sector.

- **Research, Development, Application and Marketing**: The policy states "that products of research shall be actively promoted and dispersed throughout the national socio-economic system".

Concerted efforts were made to implement these policies by successive Ministers of Science and Technology. However, considerable progress was made more in the area of establishing institutional frameworks to implement the policies.

The performance and achievements of these institutions varies as well as the impact of their activities. However, it could not bring the desired technological development of the country. It is important to note however, that successes were recorded in the field of agriculture. Within the life span of this policy, achievements were recorded as follows:

- development of improved varieties of crops by the agro-based research establishments leading to improved yields per hectare;
- increased seed multiplication and distribution to end-users of hybrid maize and other crops;
- provision of better storage and preservation facilities;
- better management and nutrition, genetic selection and breeding of animals and fish, including fish fingerlings for fish farming;
- improving the flowering of valuable timber species e.g. **Obeche** and **Terminalia ivorensis;**
- devising a new technique for chemically treating the heart-**wood of Gmelina arborea** to make it more durable.
- development of animal poultry vaccines and sera for combating animal diseases in order to boost animal production;
- development and production of farm implements such as harvesters, milling machines, cassava pelleting machines, graters, etc;
- development of malted sorghum for brewery and confectionery industry;

- development of composite flour for bread;
- design and development of prototype Nigerian car by PRODA;
- increased awareness for and development in coal utilization, solar energy and other alternate sources of energy such as biogas.

The policy lacked effective implementation mechanism as well as evaluation and monitoring strategies. Consequently, most of the research results could not be translated to commercially oriented activities. Research results were therefore left on the shelf without commercialization.

Due to lack of national indicators in addition to effective monitoring and evaluation, research orientation was not targeted at the productive sector. The private sector felt alienated from the S&T community despite the government policy compelling them to contribute to the national S&T fund. Instability in the existence of the Ministry affected also, the implementation of the policy.

This perhaps, explains why it took 17 years before the policy was reviewed and updated in line with global trend in the development of S&T. This time lag confirms the fears expressed by the then Honourable Minster of Science and Technology, Professor E. U Emovon in his foreword to the 1986 policy document which reads that, "I hope this Blueprint will need to be updated from time to time with changing circumstance………………"

B. 2003 S&T Policy

The Federal Ministry of Science and Technology in realizing the changing global policy on S&T and emerging frontiers of knowledge, embarked on a review of the 1986 S&T policy document. The Ministry noted that S&T are becoming more important than ever to raise the standard of living of the Nigerian people, consolidate a modern economy and participate as a significant partner in an increasingly integrated global world (FMST, 2003).

It is in recognition of the changing global landscape of S&T that a new policy framework was articulated to:

- stimulate initiative and creativity of the S&T community while establishing strong links between their works and requirements of the economy, the educational system and of society at large;

- make S&T truly international while strengthening the country's educational and S&T capabilities;

- encourage the mobility of scientists and researchers to network and explore best opportunities and alternatives in the country and abroad for use and improvement of their competence.

- increase the share of the productive sector in the national effort for scientific and technological development especially by supporting greater R&D activities in the productive sector.

- build strong indigenous competence in order to participate as an equal in international negotiations in areas such as protection of intellectual property and rights of access to information, biotechnology and biosafety, environmental control and establishment of technical standard in international communication networks.

The revised policy therefore emphasized on the need for a coherent, systematic and comprehensive approach to the determination of technological programmes and their implementation taking into account; domestic productions in agriculture and rural development, energy and environment, health, food security, biotechnology, industrial manufacture, infrastructural facilities including those for information and communications technologies (ICTs) and space exploration (FMST, 2003).

The new policy expanded the frontiers of S&T as contained in the 1986 policy document by identifying three core areas were national capabilities should be built. These include information and communication technology (ICT), biotechnology and space technology. The policy statements on core subject areas are briefly highlighted:

Information Technology: The policy states that the nation shall ensure an enhanced IT capability to become a key player in an emerging information society.

The information technology policy holds greater potential for societal development as information is power. The need for information technology policy is to improve coordination among various S&T institutions and those from the private sector in order to satisfy the country's information technology need.

The successful implementation of IT policy is hinged on the political will of the policy makers and the provision of adequate IT infrastructures. The ability of the nation to take a number of imaginative and pioneering decisions in bringing the use of information technology to bear on the development of the resources of the country will guarantee the success of the IT policy.

- **Biotechnology**: The policy states that the Nation shall urgently initiate appropriate steps to explore the use of biotechnology for the benefit of Nigeria. The initial effort made in implementing this policy was to establish an institutional framework which is the National Biotechnology Development Agency (NABDA). Preliminary steps to get legislation on the biotechnology bill are being taken with an earlier approval given by the Federal Executive Council.

- **Space Research:** The policy states that the nation shall vigorously pursue the attainment of space capabilities as an essential tool for its socio-economic development and enhancement of the quality of life of its people.

  The policy on space research had a chequered history of evolution dating back to 1976. It is pertinent to note that though the policy has been approved by the Federal Executive Council, it is yet to be legislated by National Assembly. Also, it is desirable to point out that part of the strategies for its implementation which entails the establishment of space Technology Centres of Excellence will create undue bureaucracy and might suffer from lack of effective coordination and budgetary constraints.

An existing institutional framework or a Centre of Excellence might be able to cover all the areas of activity identified in the policy.

- **Linkage of FMST With Universities, National and International Research Institutions**: The policy states that a mechanism shall be put in place for coordinating science and technology R&D efforts in such a way that link the Federal Ministry of S&T with Universities, National and International Research Institutes in a productive manner. A short-term action plan of 1-2 years has been designed to accomplish this policy. A new arm of the Federal Ministry of S&T called Science and Technology Research and Development Coordinating Division (STRDCD) is proposed to be established as a coordinating unit.

The establishment of this unit is considered to be another bureaucratic expansion of the operations of the FMST as the existing departments can handle this function. In a period of lean resources and budgetary constraints such expansion might not be desirable.

- **Human Capacity Building and Transfer of Technology by Multi-national Companies:** The policy states that "the nation shall through R&D create the necessary environment, incentives and penalties for promoting technology transfer by the multi-nationals, while at the same time promote the provision of necessary infrastructures for technology absorptions by Nigerians". This policy is an attempt to address the issue of technological capability in the implementation of past "national projects" that could have served as a launch pad for technological development of the country. Through this policy the issue of "local content" in the implementation of core and strategic national projects could be addressed.

The worry on this subject matter is on the issue of commitment to the implementation of such policy.

- **Energy Research and Development:** The policy states that the nation's energy resources shall be developed and utilized on a self-sustaining basis through appropriate tools of research and development and the profitable application of relevant results.

  It is important to carry out need assessment on the energy requirements of the country and fashion out research policy in this sector to address the needs. Emphasis on research on renewable energy resource should be made as it will have far reaching impact on the rural populace. The evaluation and monitoring of the energy research policy is imperative to determine impact.

- **Cooperation on Implementation and Funding of S&T:** The policy states that the nation shall strive to address the missing link in ensuring adequate funding and proper coordination of S&T related projects while ensuring the understanding and cooperation of all stakeholders at all levels of governments. Prior to now, the FMST has been criticized as not promoting effective linkage with other related government agencies whose activities are affected by emerging developments in the field of S&T.

  The new policy therefore aims at fostering the necessary linkage and cooperation in achieving the national goal on S&T and development. To this end, the Ministry intends to propose the establishment of a National Science and Technology Coordinating Council (NSTCC) with Mr. President as Chairman to give the necessary impetus to the development and application of S&T to national development. The linkage with the three levels of government need to be strengthened as the current efforts through the National Council on S&T is not effective.

- **Empowering SMEs through Appropriate Technologies:** The policy states that the nation shall facilitate and ensure the emergence of a large pool of technologically empowered SMEs as a means of achieving sustainable economic growth, eradicating poverty and play a key role in the global economy.

  The issue of empowering SMEs is appearing for the first time in the country's national S&T policy document. The strategies designed to implement this policy unfortunately did not give emphasis to the issue of industrial technology extension which is very critical to the growth and development of a virile SME sector. The policy should be able to come up with a conceptual framework for identifying industrial technology extension providers and activities for the small and medium size manufacturing enterprises. Need assessment study is desirable on the current state of technology extension to SMEs in order to identify their technology needs as well as the institutional arrangements that could best meet the needs of SMEs.

- **Engineering Materials Research and Development:** The policy states that the nation shall ensure effective utilization of the knowledge of materials science, engineering and technology to establish a pervasive mastery of materials development and applications for the transformation of Nigeria from a primarily natural resource-based economy to a knowledge-based economy within a decade.

  This policy is wide, covering engineering materials development and value addition to natural resources through application of technology. The policy should have separated engineering materials from value added transformation of commodities for ease of implementation and impact assessment.

- **Science and Technology Data Banks:** The policy states that the nation shall ensure that S&T are managed with a view to optimizing the use of natural resources including human capital and to facilitate decision-making at national and international levels.

- **Intellectual Property Rights:** The policy stipulates that the nation shall create a conducive environment for the generation of new commercializable ideas, technologies and applications that would help catalyze national efforts at wealth creation and poverty alleviation.

  Intellectual property right awareness is lacking in the country as well as the desired infrastructure. The existing institutional framework for technology acquisition could be strengthened to handle IPR policy. For successful implementation of the policy the enabling environment must be created.

- **Traditional Medicine Development:** The policy stipulates that the nation shall employ the machinery of R&D to promote growth and development of natural medicine and its practices throughout Nigeria with a view to facilitating their integration into the nation's health care delivery system.
  The bio-resource potentials of the country which include resources of medicinal plants are not effectively being explored and exploited. Therefore, the use of herbs in the treatment of illnesses is still confined to tradition. A policy on the development, utilization and promotion of use of herbs in treatment of diseases will complement the orthodox medical practices. Considerable research works on medicinal plants need to be carried out. The policy need commitment and serious government support for it to succeed. A public-private sector approach to its implementation is advocated.

2.5.2 S&T and National Project in Nigeria

The "national project" which prevailed in Nigeria evolved at the colonial period. Within this period, the country was regarded in the international system as peripheral dependent economy, exporting raw materials and importing manufactured goods from the large industrial countries of the world. Also, the articulation and stability of national projects rested basically on the relationship between key stakeholders within and outside the country.

The national projects were based on exploitation of the main sources of raw materials by foreign enterprises and on limited industrialization to produce a few basic consumer goods. These schemes of development generated no local scientific and technological demand. Invariably, there was no stimulus for development of technological research.

However, there was a small amount of basic research mainly related to few disciplines with social demand such as medicine and agriculture. The basic research that developed albeit precariously in isolated nuclei was almost unrelated to the need of local environment.

The above reviewed process helps to clarify the shortcomings in the early efforts at developing S&T policy. It will be appreciated that industrialization started with import substitution strategy and the required technology was imported. The inability of local R&D to carry out researches that are supportive to the emerging industries or even adopt technologies developed abroad contributed to the current declining international competitiveness of the local industry (Abubakar and Ajoku, 2001). At this time, it was necessary, in fact, desirable to create a local R&D system capable of efficient interaction with the production sector. This however, did not come through and therefore contributed to the current low level of industrial development of the country.

At this point, the nation lost direction as the elite failed to recognize and admit the contribution of S&T to national development. Therefore, the concept of science as an instrument and a tool for change met with deep rooted prejudice. A particular aspect of this situation was that whilst there was a definable need for local science and technology for industrial development, the social and political system effectively prevented the growth of science.

The passive resistance to S&T was obvious as the elite were subconsciously indifferent to it and unaware of its potential benefits. The deterioration of the socio-economic situation and growing popular pressure generated the need to strengthen the apparatus of political dominance. The most conspicuous being the appearance of politically autocratic and economically liberal military governments.

In furtherance of this line of thinking, policies for formal support of S&T were made, characterized by regulations and laws to encourage scientific activity including requests for cooperation from international organizations. Also, continuous verbal praise of the value of science as a vehicle for development was in vogue. Above all, the creation of organizations to manage and to plan science, that is, National Council of Scientific Research emerged with statutes and structures similar to those in developed countries. All these constitute what is called explicit science policy.

However, the real science policy, which is implicit science policy, is very different from this brilliant front. The objective of the leaders at that time was not to create R&D system which will make the country scientifically autonomous. They rather created a scientific and technological system which will only help to solve minor problems without putting the system itself in question.

Gulma (1999) observed that though Nigeria is well endowed with human and material resources, including technologists and engineers, it is however, deficient in technology. This implies that the human and material resources are not properly utilized.

In Nigeria, the strategic infrastructures established post independence were all based on foreign technology. Granting the fact that the country had limited manpower in the area of science, engineering and technology at the time of independence, however, as time progressed, the approach to development through the utilization of local human resource did not improve. For in stance, in the area of power generation, of the 8 power plants established after independence, both hydro, steam and gas turbine, all the suppliers of the equipment were foreign vendors from UK, Sweden, Japan, Austria, USA, Switzerland and Germany. Apart from minor maintenance work, all other works including civil and electro-mechanic were carried out by foreign experts (Gulma, 1999).

Furthermore, in 1973, the Federal Government of Nigeria set up 6 centres for vehicle assemble which include Mercedes at Enugu, Volkswagen at Lagos, Leyland at Ibadan, Peugeot at Kaduna, Fiat at Kano and Steyer at Bauchi. Unfortunately, these vehicle assembling plants had limited local content, despite the ambitious goal of achieving 90 per cent of local sourcing of component within 10 years of operation.

Available information indicates that under the various National Development Plans of 1962-68 and the Structural Adjustment Programme of 1986-1991, several infrastructural facilities were put in place, covering education, health, transport, energy, aviation and industry. However, not much was done to use these national projects to build S&T capabilities. The petrochemical industries, refineries, steel rolling mills, the aluminum smelting plants, paper mills, steel complexes, machine tools, etc are core strategic national projects that could have launched Nigeria into technology development (Abdullahi and Ajoku, 2001).

Unfortunately, the policy makers have not considered building S&T capabilities in the planning process and implementation of these projects. Development planning in Nigeria had been based on a perceived need to significantly improve on the economic conditions as well as enhance the welfare of the people. Very limited or no research has been carried out in order to extract adequate data required for planning and execution of development programmes. As a result of inadequate projections and a chain of uncertainties, these programmes were either not completed or failed woefully to deliver the expected socio-economic benefits (Abdullahi and Ajoku 2001)

In line with this observation, one time Permanent Secretary in the Federal Civil Service Chief Philip Asiodu noted ”that in Nigeria, the iron and steel complex was planned and executed without basic information on quality, characteristics and quantity of available primary raw materials”. This information gap delayed the commencement of the project from 1970-74 plan period to 1980s. Similarly, the cement industries were established without adequate geological investigation which informed the wrong choice of technology in some projects (Momah, 2002).

Other projects like Kainji dam and Lake Chad project, Aerostat balloon project (Ile-Ife) and the Nigerian Radar Project on Vegetation Mapping (NIRAD) present similar examples (Momah, 2002). There is every indication that these projects could have had their desired impact on the country if indigenous research efforts were considered in the formulation of the projects (Achinivu, 1999)

Achinivu (1999) noted that the inability of Nigeria to carry out effectively the rehabilitation or turn-around maintenance of the refineries is due to lack of specialized skills and requisite spare parts. He argued that rehabilitation engineering is beyond the classical design engineering. The rehabilitation engineer or team must be part investigator, part designer, part materials performance specialist and part construction inspector.

Furthermore, the $3 billion iron and steel sector was established at Ajaokuta Steel Plant without planning for technological capability building. Also, the industrialization strategy adopted in establishing public sector managed engineering and basic industrial chemical industries did not take into consideration building technological capability (Abdullahi and Ajoku, 2001). The high import content of the assembling plants and manufacturing production as presented below shows a lost opportunity for technological capability building:

Industrial activity	Import Content
* high technology group	100%
* basic industrial chemical	57.3%
* glass products	92.9%
* make-up textile goods	91.8%

Transfer of technology through capability building is a strategy devised by Korea to develop its technological capacity. Korea used the instrument of technology transfer to develop her capabilities in the technologically mature sectors such as the labour-intensive textile sector and heavy chemical industries. Through investment in manpower training in process design and operations, Koreans were able to acquire considerable expertise and technological capabilities in steel production (Bamiro, 2004)

Various national projects that had potentials for transfer of technology through capability building including as the Liquefied natural gas (LNG) project were not being utilized. Bamiro (2004) observed that the LNG, a joint venture investment is bedevilled by the low intensity of technology transfer to Nigerians by the Joint Venture partners. He wondered if there is any strategic plan to build up the requisite technological capabilities to exploit the enormous gas reserves so as to achieve optimal national development and ensure future turn around maintenance.

The inability of government to come up with a national strategy for ensuring “ l**ocal content”** in the choice and adoption of technology for implementation of national projects has affected the technological capability development of the country. The elements of technological capability build up at national level include the following:

- capital goods manufacturing capability;
- educational and training infrastructure;
- techno-managerial consultancy service capability;
- R&D capability;
- financial infrastructure, and
- S&T information infrastructure.

The importance of local engineering consultancy firm possessing capability in process technology and plant design cannot be overemphasized. Collaboration with foreign consultancy firms will help to fill the capability gaps (Abdullahi and Ajoku, 2001).

The National Engineering and Technical Company (NETCO), for instance, is an engineering consultancy firm established in 1989 as a joint venture between Nigerian National Petroleum Company (NNPC) with an equity share of 60% and Betchel, an American-based multinational engineering and consulting company with share of 40%. NETCO acquired expertise in handling of projects in the oil and gas industry in Nigeria. For instance, NETCO handled the detailed engineering design (involving 13,000 man-hours) of the $550 million Escravos Gas project recently completed (Bamiro, 2004).

2.6 INDICATORS OF S&T FOR DEVELOPMENT

Anandakrishnan and Moritalou (1988) observed that in policy-making and planning in S&T, decisions are made based on past performance and on perceptions of emerging trends of importance to a country's overall development process. However, in Nigeria, there is very little accumulation of past experiences to serve as guidance for future directions, especially in planning for the use of S&T. Impact of investment decisions on S&T takes a relatively long time to show up (Anandakrishnan and Moritalou, 1988).

Consequently, policy and planning decision for S&T are either based on an ad hoc consideration or undervalued among competing claims from many other development projects and activities which may produce quicker and more visible results. In social and economic fields, many indicators have been successfully applied in the analysis of trend and status of socio- economic activities.

Anandakrishnan and Moritalou (1988) stated that there is no single indicator representing all aspects of social or economic development. They averred that there is no such thing as a unique social and economic indicator and as such, a unique indicator for S&T does not have any real value. Indicators can be comparative among countries either with respect to other indicators such as productivity over given acre of land or with respect to time.

2.6.1 Value of S&T Indicators

Some existing S&T indicators have value only in specific contexts. Typically, indicators currently used relate to S&T manpower, R&D expenditure and intensity, patents and publications (Khalil, 2002). These indicators are valuable for assessing particular aspect of S&T to arrive at::

- international comparism among different countries;
- a relative distribution of available potentials among different sectors; and
- the synoptic/aggregate view of scientific and technological activities or potentials of a country but not necessarily the actual performance that is realized from these potentials.

The principal aims in developing S&T indicators are to assess a country's scientific and technological capacity, monitor the progress made, evaluate the performance as well as forecast the future trends (Anandakrishna and Moritalou, 1998). With such indicators, the goals of S&T can be closely linked to socio-economic development objectives. Invariably, policy-makers would thereby be able to recognize the actual importance of S&T as an agent for fostering development.

2.6.2 Use of S&T indicators

Certain parameters or factors have been used as indicators to monitor progress made in respect of S&T development. These parameters include among others, manpower, R&D expenditure, patents and bibliometric indicators.

A. **Manpower**

The practice in respect of the use of manpower as an indicator has been to look at the following:

- number of scientists and engineers in aggregate terms as stocks;
- rate of growth with respect to time;
- S&T manpower as a proportion of the total population;
- proportion of support personnel vs. professionals;
- distribution among different functions such as R&D, educational, public and private sectors; and
- number of graduates from S&T discipline.

Granting these indicators, it is pertinent to note that the issue of manpower count might reveal little or nothing to national capability in S&T when viewed from the perspective of quality of S&T personnel and their work. For example, figures such as the number of scientists and engineers per million populations have no comparative value when two countries of totally different size of population are compared.

B. R&D Expenditure

Concerning expenditure on S&T the following indicators are used:

- total expenditure on S&T;
- expenditure as a proportion of GNP;
- expenditure per capita;
- expenditure per discipline;
- expenditure by sector; and

- rate of growth in expenditure over time;
- it is pertinent to note that lack of updated data has made it increasingly difficult to measure these indicators.

C. Patents

The essence of patents is to encourage the disclosure of inventions for the benefit of the public at large in return for a monopoly for a limited time or special compensation granted by the issuing government. In developed countries, patent data are readily available as they serve as convenient tools for interpretation of technological progress and also provide information on advances of technology of a country. For developing countries patent data have serious limitations.

The usefulness of patent indicators to measure the technological output of countries is questioned when the values given are insignificant (Wad 1988) The number of foreign patents and its rate of growth in a country can help policy makers to understand the nature of dependency, extent of inter-country technological transactions and their monetary value in favour of or against that country.

D. Bibliometric Indicators

Bibliometric indicators include the following:

- number of publications (books, journals and articles) within and outside the country;
- publications by disciplines;

- citation counts within and outside the country;
- number of publishing authors.

Bibliometric indicators for S&T is relatively controversial and limited in scope, especially for developing countries (Wad, 1988) The value and usefulness of bibliometric indicators for developing countries are affected by the following:

- the outlets for books, publishers journals are much fewer.
- the current concentration of activities on modifications, improvements, adaptations, etc, have not enabled science and engineering activities to be published. Some of the developments result in valuable findings but are not publishable.
- access to current journals and reference materials is very limited even in areas where competent R&D activities are carried out.
- support facilities for publishing scientific works such as grant, printing, etc are also, limited.
- access to foreign publication of books is not available as often, foreign publishers find it difficult to publish based on issues such as quality, formats or styles.

Bibliometric indicators are useful in the following areas:

- as a tool to evaluate performance and trend of research activities at the level of institution;
- to scrutinize the usefulness and value of certain work, especially unpublished reports, mimeographs, etc;
- to assess the impact of scientific and technological work published from the number of citations made.

Caution however, should be exercised in the use of citation as it does not measure the quality of work published nor does it give information on how well a published work is used in stimulating other scientific and technological activities (Wad, 1988). There is the need therefore, to estimate the extent of research collaboration through co-authorship.

Anandakrishnan and Moritalou (1988) concluded that the presently available S&T indicators are potentially useful but practically insufficient as a policy making tool for developing countries. Given the lack of valid data to serve as a basis for conventional quantitative indicators, efforts are needed to develop new types of indicators based on both quantitative and qualitative information.

In order to evaluate performance and trends of S&T activities, qualitative assessment by experts of work accomplished is more important than the number of publications. This is where the peer review mechanism is absolutely necessary. The goal of constructing S&T indicator useful for developing countries is to facilitate policy makers in providing a conceptual scheme for linking scientific and technological activities to development objectives.

2.6.3 Unified Policy Approach

For S&T to contribute to the socio-economic development of Nigeria, policy strategies in these areas must take adequate account of the nation's needs. It implies that national S&T should be a reflection of long-term national goals and objectives and the overall economic and social development plans designed to achieve these aims. It is only within the parameters of such an overall plan that a valid S&T policy can be articulated. Though, S&T is a driving force for socio-economic development, however, it must be understood that it is not the magic wand, but only a means to an end (Wad, 1988).

2.7 IMPACT OF RESEARCH AND DEVELOPMENT ON SOCIETY

To study the impact of R&D on national development demands an indepth understanding of the evolution of scientific institution in a country. Impact of R&D on the society is dependent on the ability of R&D activities to meet societal needs. Often, such impacts are measured in terms of ability of R&D to address socio-economic needs or improvements in the production of goods and services.

The current trend in the development of manufacturing production and engineering in developed countries could be linked to the form in which scientific institutions developed. Scientific institutions in these countries were strongly linked to production through a network of engineering institutions and machinery manufacturers. (Coopers) This orientation of scientific activities determined the types of research that these institutions carried out. A society that is uninformed of the benefits of S&T to national growth and development cannot encourage the evolution of S&T (Coopers).

The evolution of S&T in less developed countries including Nigeria lacks the basic ingredients required for sustainable growth and development which include production and societal awareness or pressures. Science and technology activities in Nigeria are neither production-oriented nor society-determined (Nsa, 2003).

Furthermore, production and societal needs are critical factors among others that shape the development of a scientific culture and institutional frameworks required for technological development. Without the scientific culture and institutional framework, formulation of scientific policies and their implementation will not be attained quite easily.

Research institutions are the delivery system for implementation of national S&T policy. In Nigeria where firms level of research and development is still at nascent stage, these institutions are often looked upon to play a significant role in building national technological competence of the industries. They are equally expected to contribute to the national innovation system (Nelson, 1999).

The performance and relevance of research institutions have been called to question in recent times. Pradosh and Mrinalini (1999) observed that the performance and relevance of research institutes in less developed countries have been under strong criticism for their activities not being fully geared towards addressing societal needs, especially in industries.

This situation calls for a review of the existing research orientation. The research institutes established in Nigeria have enabling Decree and, or legislation that gives its existence and activities legitimacy. Consequently, these institutions evolved their policy, goals, objectives and strategies in accordance with the Decree establishing them (Oke, 1999). These policies aggregate to form the implicit policies of the institutional frameworks and the overall national innovation system.

The call for a new research orientation is informed by the growing need for research institutes to contribute significantly to the economic development of the nation. Although, the expectations of government and possibly the public are deeply rooted in applied research and innovation which are believed to bring about industrial growth and development, most research institutions are still engrossed with basic research. Their research efforts are measured in terms of the number and quality of their publications. Unfortunately, these efforts could not be related to contributions to industrial development or greater linkage with the productive sector of the economy.

It is this perceived non-performance and relevance of research institutes in addressing national needs that informed their current funding status. Nsa(2003) observed that this non-performance could be responsible for the declining interest of government in funding R&D as reflected in the reduced budgetary support to research institutions in recent times.

Given the above development, it is indicative that irrespective of government policies, industries cannot attain their full potentials in less developed countries if there are no improvements in their ability to access, absorb, adapt and exploit new technologies and business techniques (WAITRO, 1990).

Measuring the performance of research institutes has been a problem as there are no standards or benchmarks for doing so. In the past, performance had been associated with financial success or profitability from product development, especially in developed countries (Baguley, 1994). It is in this regard that financially related measures such as return on investment, liquidity, payback period, discounted cash flow, indirect costs and others are used to determine the performance of research. In non-profit making organizations such as public research institutions, these financial measures might not be used to determine their performance.

These financial measures are being criticized as inward looking and more concerned with resource utilization rather than satisfying customers or clients need (Baguley, 1994). Boer (1999) observed that accountability conventions treat R&D as an expense and not an investment and that past financial performance is not a reliable guide to future performance.

For industrial R&D, financial thinking about R&D has evolved well beyond basic discounted cash flow models (Boer, 2002). Currently, private research organizations assess performance in terms of new processes or products with measurable profit after commercialization. Performance measurement in public research institution is therefore, difficult to carry out.

Certain variables however, have been proposed for performance assessment of research institutions such as productivity, which might include the number of referred publications, citations in the literature, persons trained and qualitative narratives that evaluate scientific excellence, relevance, and dissemination of project results.

The above indices are considered as discrete outputs which are attimes difficult to measure in terms of quality and relevance. Other variables that can be used to determine performance include percentage earnings from industry support services to the overall operational expenditure and the number of contract-based research earnings.

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CHAPTER THREE

RESEARCH METHODOLOGY

3.1 INTRODUCTION

From the preceding literature review, it was found that despite the considerable investments on S&T in Nigeria, very little is known about the actual impact of S&T on national development. Therefore, there are pertinent questions that require answers in assessing the impact of S&T to development. Some of which include the following:

- is S&T policy producing intended benefits?,
- what are the possible impact of S&T activities on national development?,
- could S&T policy be formulated in such a way as to achieve intended outcomes?, and
- are resources being spent efficiently to achieve the desired goals ?

These questions can only be answered fairly through an impact assessment study. Impact assessment study of this nature is very difficult to carry out considering its wide scope and possible limitations in terms of informed response to requests for information from the major stakeholders. Therefore, the availability and quality of data is a serious constraint.

The knowledge gained from this impact study will provide critical inputs to the appropriate design and formulation of S&T policy and R&D programmes.

The impact study is intended to determine in broad terms whether a program had the desired effects on society including institutions and whether these effects are attributable to the program intervention (Baker 2000) Impact study can also explore unintended consequences whether positive or negative on beneficiaries.

In planning for this study cognizance was given to the main output and impact indicators. Furthermore, attempt was made to establish a hierarchy of indicators ranging from short-term impact indicators to longer term indicators.

The research method adopted aimed at reviewing the various strategies and techniques of achieving the goals and objectives of the study as earlier stated. Also, attempt was made to explain in clear terms the various methods adopted in obtaining information and data from the target respondents. The information and data generated were subjected to statistical analysis for effective interpretation. Simple statistical methods were adopted in addition to qualitative analysis. Citation analysis was also carried out by including references of previous works done on the subject matter at the end of each chapter.

3.2 **RESEARCH DESIGN**

The aim of the survey is to obtain insight into the relationships between variables rather than to get an accurate picture of current practices or a simple consensus as to best practices. In research design, the essence is to structure the investigation in such a way as to identify the variables and their relationships. A well articulated design is desirable for the objective of data collection that will assist to address the research questions as well as test the stated hypotheses. The research design therefore serves as a veritable guide for data generation, especially primary data. In this study, survey and ex-post factor design were used.

These approaches were adopted because the study focused on sample population of the science and technology community (especially research institutions). The respondents were chosen in terms of their likelihood of offering insightful contributions. A representative sample of scientists in the existing S&T institutions was identified in order to select respondents that will provide different types of experiences. The information from the survey carried out was supplemented by a number of unstructured interviews with people who had considerable experience in the field to be investigated.

Furthermore, it was noted that there were existing information on the subject matter exists which are pertinent to the study. These data and information were accessed which made the study also retrospective. The research design adopted two survey methods which include questionnaires and interviews. These two methods were used to elicit responses from the target population of the scientific community.

The use of questionnaire was considered as an important method of collecting quantitative data. It is in recognition of this fact that the questionnaire was designed to ensure accurate capture of data and high response rate.

In preparing the questionnaire, it is sufficiently assumed that people who have responsibility for the execution of S&T policy know what it is. This informed the choice of respondents from the S&T community and the structure of questions provided in the questionnaire. The questionnaire was used to collect information from scientists, researchers in public R&D institutions and from the Federal Ministry of Science and Technology.

In designing the questionnaire measurement scale was used to get the opinion of respondents. Measurement scales such as ordinal scales and interval scales were considered appropriate to measure the variables. Furthermore, measurement of attitudes, perceptions, opinions, appreciation and understanding were carried out using scaling technique. This technique enabled the researcher to translate verbal expressions of feelings, opinions and attitudes into numerals for ease of analysis.

The type of scale used informed the structure of questionnaire designed and administered to respondents. Both four-point scale and five-point scale were used. Significant use was made of summated rating scale of the "**Likert type".** This type of scale enabled the researcher measure the intensity or degree of agreement or disagreement by the respondent to statements made on S&T policy as well as on R&D activities. With Likert Scale, it was possible to compare responses among individuals using bar-chart and X^2 (chi-square) analyses.

Interviews were used to collect information from Chief Executives of S&T institutions who were so busy and could not find time to respond to the questionnaire. The interviews were conducted using semi-structured interview schedule and where desirable, separate interview schedules were prepared for policy makers and key stakeholders. Other sources of information used include personal or informal discussions with colleagues in the S&T community and personal documents made available by them.

In using such personal documents certain criteria have been met, which include:

- that the document must be a written one;
- the document must have been produced on the authors initiative or if not , in such a way that their introspective content has been determined entirely by the author; and
- document that focus on the authors personal experiences.

These criteria exclude interview materials.

3.3 **THE STUDY POPULATION**

The choice of population for this study was informed by the need to extract relevant information that will assist to make informed findings and recommendations at the end of the research. The characteristics of the population were determined by limiting the study to scientists as well as researchers who are integral part of the overall population of research institutions in Nigeria.

There are 35 Research Institutions (RIs) spread all over the country and it is difficult to study all the institutes. The 35 RIs as well as the Federal Ministry of Science and Technology constitute the population of the study.

Subject to this, 25 RIs were sampled in order to have a sufficient knowledge of their perception of the impact of S&T to national development. Also, relevant staff of the Ministry of S&T was included to form the sample size. The population characteristics of the study therefore include the researchers in the RIs and scientists in the supervising Ministry.

Stratified sampling procedure was adopted by grouping the population under study into some definite characteristics called strata. The staff of research institutes studied were stratified into the following groups:

a. Chief Executive
b. Directors
c. Deputy Directors/Assistant Directors
d. Chief Scientific Officers.

The choice of these groups of staff was based on the perceived level of their participation in management decision making process. Also, they form the core competence for policy formulation and implementation within the science and technology community in the country.

Furthermore, considering the subject matter of the research, it is perceived that not all top level and middle level employees will be capable to respond vividly to the questionnaire. In this regard, only those with science background were considered in the sampling process.

This sampling procedure was considered quite pertinent as efforts were made to use extra measures of representativeness by first, identifying some characteristics of the groups that are being researched and then using these characteristics as basis for further sampling of the entire population. The population sizes of the RIs were derived from the Federal Ministry of Science and Technology.

The population sizes for the RIs consisted of the Chief Executives of the 25 research institutes, the Directors, the Deputy Directors/Assistant Directors and the Chief Scientific Officers. This informed the distribution of four questionnaires per RIs bringing to a total of 100 questionnaires distributed.

For the Federal Ministry of Science and Technology, twenty questionnaires were distributed to the following category of staff including the Honourable Minister, the Permanent Secretary, Directors of Department, Deputy Directors and Assistant Directors and Chief Scientific Officers.

The distribution of the questionnaires to these categories of staff was limited to only those with science and technology background. Inherent weakness experienced was in the difficulty to persuade people to complete and return the questionnaire.

3.4 **DATA COLLECTION**

Primary Source of Data

Collecting primary data using semi-structured and indepth interviews was undertaken. Interviews were formalized and structured using standardized questions for the respondents. Also, interviews were carried out through informal and unstructured conversations.

Questionnaire was used for structured interviews based on a predetermined and standardized or identical set of questions and responses were recorded after the questions were read to respondent. The essence of adopting this approach is to hasten the process of retrieval of questionnaire which is the major limiting factor to its use in a study of this nature. Also, semi-structured interviews were carried out during which a list of questions to be answered were drawn and response documented through note taking. The semi-structured interviews assisted to explain core issues that emerged from the response to questionnaire.

The following core questions were often asked during the semi-structured interviews:

- Has the S&T policy been a critical determinant of national development performance?
- Has the application of S&T contributed to the development of industries in Nigeria as well as increase productivity?
- How has S&T impacted on agricultural production leading to increase in food production and ensuring food security and poverty reduction?
- How has S&T policies influenced “national projects” in Nigeria?.
- What relationship exists between S&T policy institutions and the socio-economic frameworks established for national development?.
- Is a national research policy distinct from national S&T policy desirable?
- What are the major indicators for measuring the impact of S&T?
- How has patent affected technology development of the country?.
- What are the major obstacles to R&D and commercialization of R&D results.?.

Primary data were obtained through the use of questionnaires structured in four parts. Part one asked for information on institutional profiles, staff strength, staff distribution in respect of R&D activity areas, mission and vision, and mandates. Part two specifically examined the advocacy and governance of S&T and evaluation as well as monitoring of impact of S&T in addressing national needs. Part three sought for information on S&T literacy using a four-point scale to rate their opinion on societal understanding and participation on S&T activities in Nigeria. Also, two way questions, otherwise known as **Yes or No** questions were used. However, a third option was given for those who don't have an idea on the subject matter.

Part four examined the nature of R&D carried out by the RIs, highlighting the type, beneficiaries of research activities, need for a national R&D policy and perception of R&D and scientists by the society. Also, information was sought in respect of R&D capacity building, R&D breakthrough, funding structure, budget and budgetary constraints, obstacles affecting R&D generally and perception of government attitude to performance of RIs as well as the rate of communication among scientists and other stakeholders. Sample questionnaire is presented as Appendix 3.0.

Before the commencement of field work, the questionnaire was pre-tested using five RIs located in Abuja. Pilot testing of data collection instruments was carried out so as to reveal whether the instrument can reliably produce the required data and how data collection procedures can be put into operation. The responses from the RIs assisted considerably in modifying the questionnaire for final distribution and retrieval.

Competent persons were engaged to assist in the field work. Considerable use was made of staff of the Raw Materials Research and Development Council's Liaison Offices in the States of the Federation where the RIs are located, to tender and retrieve the questionnaire. The officers were well informed on issues relating to S&T development, hence they were considered very relevant to the study. Also, personal interviews were carried out with colleagues in the Federal Ministry of Science and Technology and respective research agencies.

Secondary Data

Secondary data or source of information is very vital for any research work as it will help to reconfirm or proffer answers to research questions. It is therefore, important to consider re-analyzing existing data on the subject matter of S&T development in the cause of this study. The secondary data consulted include raw data and published data. In choosing the secondary data to use, constant attention was paid to the research objectives, research questions and issues considered under the literature review on the subject matter of investigation. Literatures on S&T policy were downloaded via the internet using search engines or tools such as Yahoo, MSN, Google, etc, which assisted considerably in locating studies carried out that are relevant to the research focus.

Furthermore, some of the RIs offered extensive information on their research activities including their annual and progress reports which were quite valuable in tracking down the level of progress made over the years. Past Ministerial briefings of the Federal Ministry of Science and Technology were consulted as well as relevant published and un-published information from the Ministry.

In all cases, consideration was given to the possibility that some secondary data might lack the desired comprehensiveness. Most secondary data consulted were therefore, viewed with caution and its relevance related to meeting the objectives of the study and also answering the research questions.

3.5 **QUALITY OF RESEARCH DATA.**

In pursuance of a work of this magnitude, it is absolutely necessary to ensure that the data generated and analyzed are reliable and of the highest possible quality. It is only when this is guaranteed that the results of the analysis can be conveniently used to answer research questions and test hypotheses. Mindful of this, efforts were made to improve the quality of the measuring instrument used and ensured that they are valid and reliable.

Research design may be said to be valid if it enable a researcher elicit the correct responses from the sample subjects (Asika, 2001). Considering that the desired responses were gotten from sample population implies that the research design was valid. Also, the content validity was determined by ensuring that all the questions asked in the questionnaire, fully addressed the research questions and hypotheses. In preparing the report of the survey's findings, two objectives were considered;

- presenting the findings in a manner to minimize the possibility of erroneous or unwarranted interpretations;
- preparing the report so as to maximize the use of its findings.

For the secondary data consulted, a range of validity and reliability criteria against which the secondary data could be evaluated were considered. These criteria include, the following as reported by Saunders et al (1997):

- assessment of suitability of the secondary data source with particular emphasis on validity of measurement, coverage, including unmeasured variables , and

- evaluation of suitability of the data for analyses with particular attention to measurement, bias, validity and reliability.

Finally, the following identified threats to reliability were addressed as follows:

a. Subject error – The time of distributing the questionnaire was such that there was industrial peace in research institutions.

b. Subject bias—Steps were taken to ensure anonymity of respondents to questionnaire.

3.6 **PROCESSING OF DATA**

The data generated from the study need to be processed and analyzed to enable the researcher answer the research questions and achieve the objectives of the study. Quantitative data which are numerical data were processed and analyzed. Quantitative analysis techniques such as simple tables, bar charts, pie-charts, percentage distribution and statistical analysis for establishing relationships between variables such as chi-square test were used.

In preparing the data for analysis, consideration was given to the following as a guiding principle;

- type of data generated, highlighting the level of numerical measurement;
- format in which data will be input to the analytical software;
- need to weight cases, and
- methods to use in order to check data for errors.

In presenting data, diagrams were used to explore and understand the data. When exploring the data, sustained consideration was given to the research questions and objectives. In all cases where diagrams and tables are used, efforts were made to ensure the following:

- that they have a brief but clear and descriptive title;
- units of measurement used are clearly stated;
- sources of data used are clearly stated;
- notes to explain abbreviations and legends are made;
- the size of the sample on which the values in the table are based is stated;
- diagrams have clear axis labels;
- bars and their components are in the same logical sequence;
- tables have clear column and row headings;
- columns and rows are in a logical sequence.

The quantitative analysis was equally carried out and summaries were analyzed for trends. This enabled the researcher to establish trends and pattern of associations and relationship among variables.

3.7 **LIMITATIONS OF THE METHODOLOGY**

The study was mindful of some limitations beyond the control of the researcher as it relates to the administration and retrieval of the questionnaire and other instruments used for data collection. The sampling from the target population might not be free from errors; however, attempts were made to ensure that these errors are minimized.

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CHAPTER FOUR

PRESENTATION AND ANALYSIS OF DATA

4.1 INTRODUCTION

The chapter attempts to analyze both the quantitative and qualitative data derived from the study. The analysis took into consideration responses from the questionnaires distributed and retrieved from research institutions (RIs).

The questionnaire was designed to capture as much information as possible on general issues covering the RIs, including the year of establishment in order to determine the historical development of research institutions in Nigeria. Also, the staff strength indicating research capability and distribution of activities was determined through the questionnaire. The general issues were summed up by determining whether or not, the RIs have mission and vision and the focus of their mandate. These issues formed the background that elicited responses on questions relating to science and technology policy in Nigeria.

Several questions were asked in relation to S &T advocacy (awareness creation) as well as S&T literacy. The nature and impact of R&D being carried out were elucidated through the questionnaire. The issues of funding and budgeting as they affect R&D were considered as well as the general obstacles affecting R&D in the country. Opinions on how government sees RIs performance were sought in addition to rate of communication among scientists and the public including funding agencies.

4.2 **RESPONSES TO QUESTIONNAIRE**

The response rate was determined using simple calculations as stated below. This enabled the determination of the margin of error in the sampling process adopted.

$$\text{Response Rate} = \frac{\text{Total No. of Responses x 100}}{\text{Total No. of Sample – No Response}}$$

Given the No of sampled RIs = 25
No. of RIs that responded = 20
No. of RIs that did not respond = 4
No. of Invalid Response = 1

$$\text{Response Rate} = \frac{20 \times 100}{25-4} = \mathbf{95.2\%}$$

$$\begin{aligned} \text{Margin of Error} &= 100\% - 95.2\% \\ &= 4.8\% \\ &\simeq 5\% \end{aligned}$$

In order to determine the actual size of sample for the study, the following calculations were made.

Assumed sample size (n) = 25 RIs

Response Rate (re) = 95%

$$\text{Actual sample size (N)} = \frac{n\text{x}100}{re}$$

$$= \frac{25 \times 100}{95}$$

$$\text{Actual sample size} = 26$$

The marginal error in sampling based on sample size of 25 RIs relative to a population of 35 RIs is 71±5%. Based on the number of questionnaires received from the 20 RIs that responded out of 100 questionnaires distributed to 25 RIs, the following deduction was made:

Total no. of questionnaires retrieved = 49

Total No. distributed = 100

$$\text{Retrieval Rate} = \frac{49\text{x}100}{100} = 49\%$$

The retrieval rate of 49% was considered not poor, judging by the limitations to distribution and retrieval of questionnaires in Nigeria. The list of RIs identified, indicating their locations and primary functions as well as the functions of the Federal Ministry of Science and Technology is presented as Appendix 1.0

4.2.1 Distribution Pattern of Responses

In distributing the questionnaire, efforts were made to reach research institutions within the operational arm of Federal Ministry of Science and Technology (FMST), Federal Ministry Agriculture and Rural Development (FMARD), Federal Ministry of Environment (FME) and Federal Ministry of Health (FMH) who are the major stakeholders to S&T policy formulation and implementation. The Federal Ministry of Industry has no research institutions under it and as such, was not reflected. The analysis of the responses to the questionnaire is presented in table 4.1, while the distribution pattern of the responses is illustrated in figure 4.1.

Table 4.1 Distribution of Responses

S/N	Ministry	No. of Institutions	No. of Respondents	Percentage (%) Response
1	FMST	11	30	61.2
2.	FMARD	8	18	36.7
3	FME	1	1	2.1
	Total	**20**	**49**	**100**

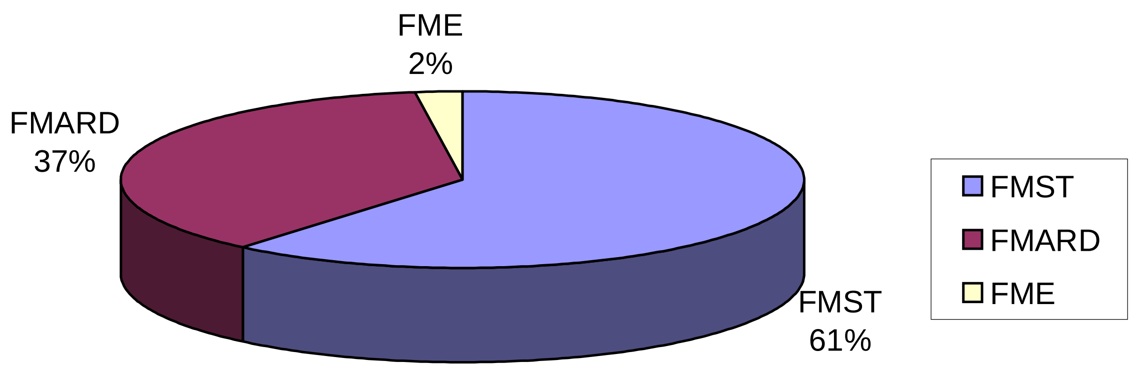
Source: Research Study, 2004

There are 30 respondents from 11 RIs under FMST that responded given a percentage response of 61.2%. The percentage response of 18 respondents from the 8 RIs under FMARD was 36.7%.

Further analysis of responses from the FMST shows that 25 respondents were from the core research institutions while 5 were from the parent ministry. From the analysis, it was obvious that the low response from the RIs under Ministry of Environment was a reflection of the number of RIs under it. There is only one research institute being supervised by the ministry.

Generally, the average response per research institutes under FMST was 3 and FMARD 2 which were considered to be fair responses. Each of the 25 RIs surveyed were given 4 questionnaires, while some returned all the four, others returned only one. Nevertheless, the responses did not in any way prejudice the findings from the study. The distribution pattern of the responses as represented in figure 4.1 is considered a fair spread covering science and technology, agricultural and environmentally related research institutions in Nigeria.

Figure 4.1 Distribution of Responses base on Ministries



4.2.2 **Evolution of Research Institutes**

In order to determine when national efforts towards the application of science and technology through research evolved in Nigeria, respondents were asked to indicate date of establishment of their institute. Their responses are presented in table 4.2.

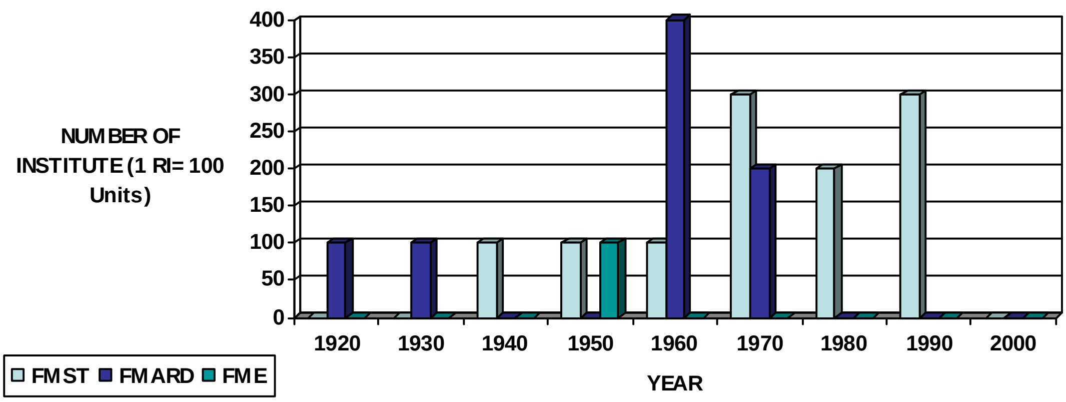
Table 4.2 Evolution of Research Institutes Based on Year of Establishment

No. of Research Institutes (RIs)				
S/N	**Year of Establishment**	**FMST RIs**	**FMARD RIs**	**FME RIs**
1	1920s	--	1	--
2	1930s	--	1	--
3	1940s	1	--	--
4	1950s	1	--	1
5	1960s	1	4	--
6	1970s	3	2	--
7	1980s	2	--	--
8	1990s	3	--	--
9	2000	NA	NA	NA
	Total	11	8	1

Source: Research Study, 2004
NA = Not Available

The oldest research institute was found under the Federal Ministry of Agriculture and Rural Development dating back to the 1920s and 30s. The highest numbers of RIs under FMARD were established in the 1960s and 1970s. For the RIs under Federal Ministry of Science and Technology, the first research institute was established in the 1940s

FIGURE 4.2 YEARS OF ESTABLISHMENT OF RIs SURVEYED



The period between 1970s and 1990s, witnessed the time when considerable number of RIs under FMST were established. For RIs under FEMARD, after the 1970s very few or no institutions were established. The only Research Institute currently under Federal Ministry of Environment, the Forestry Research Institute of Nigeria (FRIN) was established in the 1950s under Federal Ministry of Agriculture. The oldest research institute in the country was found to be over eight decades (80 years old). Within this time frame, it is expected that considerable impact of science and technology (S&T) on national development of Nigeria would have been made.

4.2.3 **Staff Strength Distribution to Determine Research Capability**

Part of the strategy of measuring the impact of S&T on national development is to determine the research capability of the research institutions. To this end, the respondents were asked to indicate the number of researchers in their institute with requisite qualifications ranging from PhD, M. Sc to B.Sc. Their responses are presented in table 4.3.

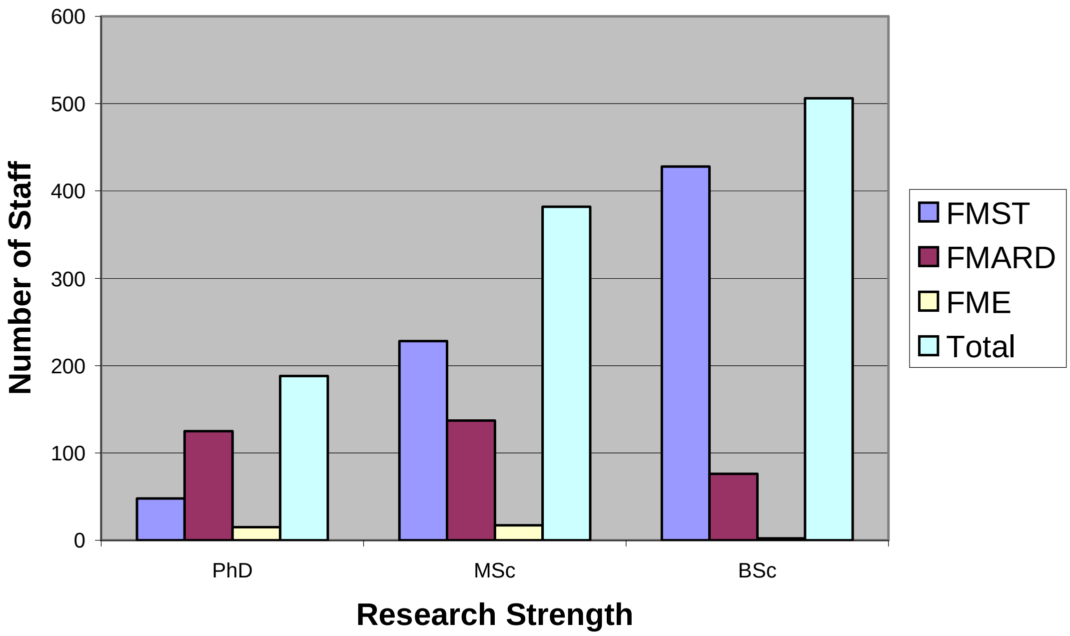
Table 4.3 Research Capability of RIs Surveyed.

Ministry					
S/N	Research Strength	FMST (11RIs)	FMARD (8RIs)	FME (1RIs)	Total
1	PhD	48	125	15	188
2	M. Sc.	228	137	17	382
3	B. Sc.	428	76	2	506
	Total	704	338	34	1076

Source: Research Study, 2004

The distribution pattern shows that PhD holders in the RIs under FMARD that responded to the study were 125, while those with
M.Sc. holders were 137. These levels of academic qualifications are considered as the research strength of any institute. Those with B.Sc are considered supportive to the other two categories of researchers.

FIGURE 4.3 Research Capability of RIs Surveyed



For the 11 RIs under FMST that responded, the distribution shows 48 PhD, 228 M. Sc. which reflected very limited research strength. The number of PhD is used mainly as an index to measure the research strength. Comparatively, the RIs under FMARD showed higher research strength judging by the number of PhD which was 66.5% as against 25.5% from RIs under FMST. The number of PhD recorded from one research institute under FME, was 15 which is about 8.0%. This was considered not bad on institutional bases.

There are more M. Sc. (59.7%), B. Sc (84.6%) in FMST than those with M. Sc (35.9%), B. Sc (15.0%) in FMARD (figure 4.3). Generally, there were more personnel with B. Sc (47.0%) than in the other two categories of academic qualifications (M. Sc. = 35.5% and PhD = 17.5%). In the research institutes studied, the number of staff with PhD was less than 20% of total research strength.

4.2.4 Staff Distribution Based on Activities

In order to delineate the research strength further, respondents were asked to mention the number of personnel involved in activities such as research, consultancy, extension and administration. Despite the number of RIs that responded from both FMST and FMARD, there were almost equal number of personnel 396 and 398 respectively involved with research. In all the institutions there were more personnel in research than those in consultancy or extension services
(Table 4.4).

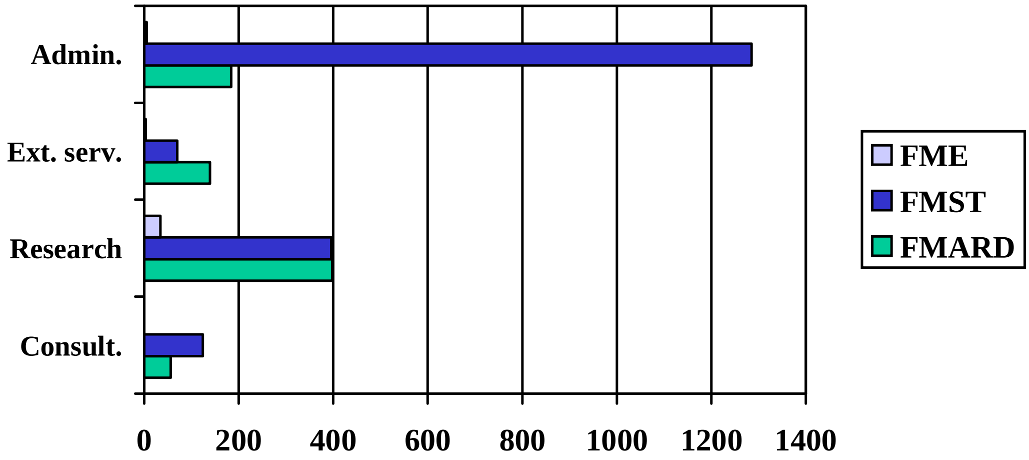
Table 4.4 Distributions of RIs Staff Based on Activities

		Ministry			
S/N	Activities	FMST	FMARD	FME	Total
1	Research	396	398	34	828
2	Consultancy	124	56	0	180
3	Extension	70	139	3	212
4	Administration	1,285	184	5	1,474
	Total	1,875	777	42	2,694

Source: Research Study, 2004

However, it is desirable to note that some of the personnel in research might also be involved with consultancy and extension services. It is also, pertinent to point out (figure 4.4) that for consultancy, more personnel were involved in FMST (68.9%) than in FMARD (31.1%). For FME, there were no indications of involvement in consultancy services by the only institution under the Ministry. May be, the mandate does not encourage consultancy services. For extension services, the converse was the case as more personnel were involved in FMARD (65.6%) than in FMST (33.0%) and FME (1.4%). For administration, RIs under FMST recorded the highest number of personnel (87.2%) compared to FMARD (12.5%) and FME (0.3%). Generally, there were more administration staff in the 20 RIs surveyed (54.7%) than in research (30.7%), extension (7.9%) and consultancy (6.7%).

Figure 4.4 Distribution of RIs Staff Based on Activities



4.3 **SCIENCE AND TECHNOLOGY POLICY**

The study attempts to assess the impact of S&T policy on national development of Nigeria. To this end, questions were posed to respondents in order to determine the level of awareness or not of the existence of a national S&T policy. Also, considering the background of the respondents as major stakeholders in the formulation and implementation of the national S&T policy, it is expected that they will be in the best position to give expert opinion about the policy and its impact on the society.

4.3.1 **S&T Advocacy**

Respondents were asked if they are aware or not of the existence of a national S&T policy in Nigeria. The responses are presented in table 4.5.

Table 4.5 Awareness of the Existence of S&T Policy in Nigeria

S/N	Response	No. of Respondents	% Respondents
1	Aware	44	95.7
2	Not Aware	1	2.2
3	No. Idea	1	2.2
	Total	46	100.0

*Source: Research study, 2004
N.R = No Response

Virtually all the respondents affirmed their awareness of the existence of a national S&T policy. It was observed that 95.6% of them stated that they are aware while 2.2% are not aware as well as 2.2% that claimed not to have any idea of the subject matter. Of the expected 49 respondents, 46 actually responded while invalid or no responses were 3. Furthermore, respondents were asked whether or not the S&T policy is accessible to them and the public. Their responses are presented in table 4.6.

Table 4.6 Accessibility of S&T Policy to the Public

S/N	Response	No. of Respondents	% Respondents
1	Yes (Accessible)	12	26.7
2	No (not Accessible)	33	73.3
		45 (NR=4)	100.0

Source: Research study, 2004
N.R = Response

Very few (26.7%) respondents affirmed that the S&T policy is accessible to them and the public. However, majority (73.3%) were of the view that even though they are aware of the existence of the policy, it is however, not accessible to them and the public in general. This finding reinforces the need for effective awareness creation on the existence of national S&T policy and of its relevance to development. Out of the 49 respondents, only 45 gave their opinion while 4 offered no opinion on the subject matter.

4.3.2 **S&T as critical determinant of development performance in Nigeria**

It is generally believed that S&T is a critical determinant of development performance of any nation. In the context of this study, this belief or opinion was subjected to test by asking respondents to comment if S&T policy has been a critical determinant of development performance in Nigeria. Their responses are presented in table 4.7

Table 4.7 S&T as Determinant of Development Performance in Nigeria.

S/N	Response	FMST	FMARD	FME	Total
1	Yes	9	9	1	19
2	No	21	8	0	29
	Total	30	*17 (NR=1)	1	48

Source: Research study, 2004

The respondents were classified according to their parent ministry, such as FMST, FMARD and FME. The total number that responded in the affirmative that S&T is a critical determinant of development performance was 19 compared to 29 that responded in the negative.

However, it is pertinent to observe that while 30% of the respondents in FMST affirmed positively that S&T policy is a critical determinant of development performance, 70% were of contrary opinion. The situation in FMARD was quite different as 52.9% affirmed positively and 47.1% offered a contrary opinion.

Comparatively, equal number of respondents (9) in FMST and FMARD agreed that S&T policy has been a critical determinant of development performance. For those with contrary opinion, 72.4% of the respondents from FMST and 27.6% from FMARD believed that S&T policy has not been a critical determinant of development performance in Nigeria.

Generally, 39.6% of the respondents agreed with the view that S&T policy has been a critical determinant of development performance while 60.4% disagreed. Their views were further subjected to chi-square test in order to validate the relationship between S&T policy and development performance. The findings were discussed in the next chapter as well as the reasons given to support their affirmation or not to the subject matter.

In an attempt to elucidate the respondents perception of the relevance of S&T to national development, they were further asked to indicate if they strongly agree or disagree to the fact that S&T policy generally aims at enhancing competitiveness of an economy as well as fostering economic growth. Their views are presented in table 4.8.

Table 4.8: Contribution of S&T Policy to Competitiveness and Economic Growth

S/N	Response	No. of Respondents	% Respondents
1	Strongly Agree	28	58.3
2	Agree	19	39.6
3	Disagree	1	2.1
4	Strongly Disagree	0	0
	Total	48 (NR=1)	100.00

Source: Research study, 2004

Of the 48 respondents, 58.3% strongly agreed while 39.6% just agreed that S&T policy contributes to competitiveness and economic growth. However, 2.1% disagreed with the view, while none of the respondents offered a strong opinion to the contrary.

To further ascertain the role played by S&T policy in national development of Nigeria looking at the time the first S&T policy was enunciated and relating it to various development programmes respondents were asked to comment whether or not they agree or disagree with the view that the policy has not played a critical role to national development. The responses are presented in table 4.9

Table 4.9: Role of S&T Policy on National Development of Nigeria

S/N	Response	FMST	FMARD	FME	Total
1	Agree	23	13	0	36
2	Disagree	6	5	1	12
3	No Idea	1	0	0	1
4	Total	30	18	1	49

Source: Research study, 2004

The respondents were very blunt in their response as 76.7% of them from FMST and 72.2% from FMARD agreed that S&T policy has not played a critical role in national development of Nigeria.

Generally, while 73.5% of all the respondents agreed, 24.5% disagreed and 2.0% were not decisive. Their responses were further subjected to chi-square test which is discussed in the next chapter alongside the reasons given to support their response.

Relating demand for innovations in industry and agriculture as factors responsible for emergence of impact-oriented S&T policy was considered in the course of this study. It was in this light that respondents were asked to comment if lack of demand for innovations in industry and agriculture was responsible for inability of S&T to impact on national development. Their responses are presented in table 4.10.

Table 4.10 Impact of lack of Demand for Innovations in Industry and Agriculture on National Development.

S/N	Response	FMST	FMARD	FME	Total
1	Yes	17	8	0	25
2	No	12	9	1	22
3	No Idea	1	1	0	2
4	Total	30	18	1	49

Source: Research Study, 2004

There was a sharp divided opinion on this subject matter in all the 20 RIs studied. For FMST, 56.7% agreed with the view that lack of demand for innovation in industry and agriculture was responsible for inability of S&T to impact on national development, while 40.% disagreed and 3.3% were not decisive.

The converse was the case with FMARD as 44.4% agreed, while 50% disagreed and 5.6% were not decisive. Comparatively, greater number of respondents (68%) from FMST agreed as against 32% from FMARD. The situation was the same with those that disagreed. Generally, however, 51.0% agreed while 44.9% disagreed and 4.1% were not decisive.

Furthermore, their responses were subjected to chi-square test to establish the relationship between societal demand for innovations and national development. The findings and discussions were presented in the next chapter.

In trying to determine the views of respondents on the impact of S&T policy in addressing societal needs, they were asked to comment on how regularly or not that the S&T policy is evaluated. Their responses are presented in table 4.11

Table 4.11: Evaluation of Impact of S&T Policy in Addressing Societal Needs

S/N	Responses	No. of Respondents	% Respondents
1	Regularly	2	4.1
2	Occasionally	19	38.8
3	Not at all	8	16.3
4	No Idea	20	40.8
	Total	49	100.00

Source: Research Study 2004

The respondents gave varying views on this subject matter with 40.8% of them not having an idea if the S&T policy was regularly evaluated or not. While 38.8% of them felt that it was occasionally evaluated, 16.3% were of the view that it is not at all evaluated while 4.1% believed that it was regularly evaluated.

4.3.3 **Societal Awareness of S&T Policy in Nigeria**

The society has been reported to have a strong influence on direction and evolution of science and technology in any nation. This influence also helps to determine the level of national development and also, sharpen the focus of S&T development. Prior to this study, there is the common belief that Nigerian society is not aware of and do not contribute to the formulation of S&T policy. It is therefore regarded that the inability of S&T to impact on national development was as a result of lack of social determinant of S&T.

In order to ascertain that the Nigerian society is not aware of and do not contribute to the formulation of S&T policy respondents were asked to respond by agreeing or disagreeing with the view. The responses are presented in table 4.12

Table 4.12: Lack of Awareness and Contribution of Nigerians to S&T Policy Formulation

S/N	Response	FMST	FMARD	FME	Total
1	Agree	20	15	1	36
2	Disagree	9	2	0	11
3	No Idea	1	1	0	2
4	Total	30	18	1	49

Source: Research Study, 2004

The analysis of the responses indicates that while 66.7% of respondents from FMST agreed, 30.0% disagreed, while 3.3% were not decisive. The same trend was observed with FMARD as 83.3% agreed, 11.1% disagreed, while 5.6% were not decisive.

Generally, 73.5% of the respondents in the 20 RIs studied agreed that the Nigerian society is not aware of and do not contribute to the formulation of S&T policy, while 22.4% disagreed and 4.1% could not make up their mind. In order to validate this finding, the responses were subjected to chi-square test. The detail analysis and decision reached were presented in the next chapter.

4.3.4 Policy Process

In order to determine the ideal policy process to be adopted in fashioning a national S&T policy framework, respondents were asked to choose among the options of minor, major and integrated policy processes. The responses are presented in table 4.13

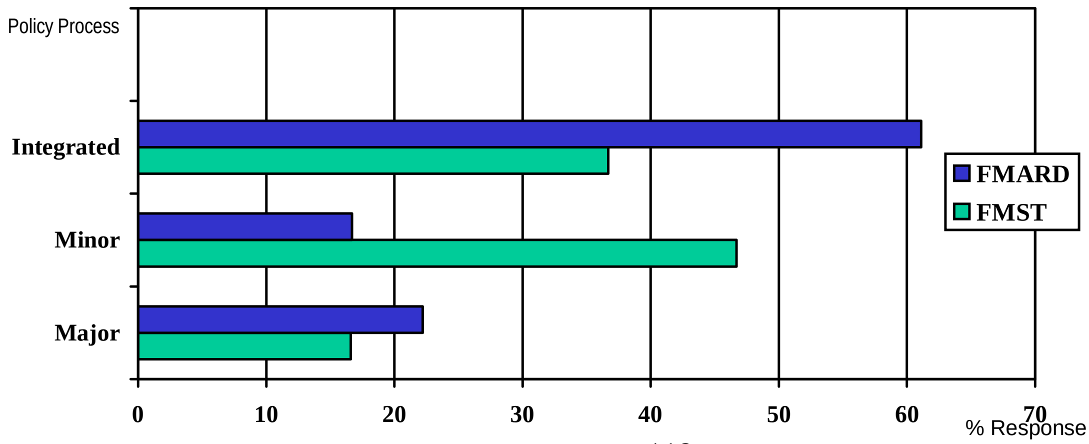
Table 4.13: Ideal Policy Process for Adoption

S/N	Policy Process	FMST	FMARD	FME	No of Respondents	% Respondents
1	Minor	14	3	1	18	36.7
2	Major	5	4	0	9	18.4
3	Integrated	11	11	0	22	44.9
		30	18	1	49	100.0

Source: Research Study, 2004

The distribution of the responses is illustrated in figure 4.5. The analysis shows that 44.9% of the respondents indicated that an integrated approach to policy process formulation is ideal. This approach implies developing new explicit strategy.

Figure 4.5 Ideal Policy Process



However, 36.7% were of the view that restructuring of existing programme or minor, policy process is ideal. Those that prefer major policy process approach by designing and implementing important new programmes were 18.4%. It is important to note that on institutional bases, those from FMST prefer minor process (46.7%) to integrated (36.7%) and major (16.6%). The converse was the case with institutions under FMARD as 61.1% favoured integrated process to major (22.2%) and minor (16.7%).

4.3.5 Collaboration between FMST and Key S&T Stakeholders

In fostering integrated approach to national development, S&T policy must have wide reaching linkages with other pertinent sectors of the economy. This demands strong collaboration between the Ministry responsible for the formulation and implementation of the policy. It is in recognition of the importance of the collaboration between Federal Ministry of Science and Technology and other stakeholders including policy makers, administrators, academicians, etc, that respondents were asked to comment on their views. Also, the respondents were requested to support their views with reasons. The responses are presented in table 4.14.

Table 4.14: Collaboration between FMST and Key S&T Stakeholders.

S/N	Statement	FMST	FMARD	FME	No of Responde	%

						Respondents
1	Agree	21	4	0	25	51.0
2	Disagree	7	4	1	12	24.5
3	No. Idea	2	10	0	12	24.5
	Total	30	18	1	49	100.0

Source: Research Study, 2004

While half of the respondents (51.0%) agreed that FMST has effectively collaborated with other key S&T stakeholders, 24.5% disagreed while 24.5% also, were not decisive. When analyzed on Ministry bases, it was obvious that majority of respondents from FMARD were very indecisive and could not agree or disagree. However, equal number (22.2%) agreed and disagreed with the view that FMST has effectively collaborated with other stakeholders. The respondents from the FMST were different in their perception of the level of collaboration between their Ministry and other stakeholders. Those who strongly feel that FMST effectively collaborated with other stakeholders were 70% while those that disagreed were 23.3% and 6.7% were not decisive. The various reasons given to support their view were discussed in the next chapter.

4.4 **SCIENCE AND TECHNOLOGY LITERACY**

Although the Nigerian nation increasingly depends on science and technology for its development, however its citizens are ill-equipped to make well informed opinions and decisions about S&T. This implies that at the heart of science and technological society which characterizes the Nigerian nation lies an unacknowledged paradox. There is an existing view that adults and children alike have a limited understanding of the essential characteristics of science and technology as well as how it influences the society and how people do influence its development. In order to ascertain the validity of the above observations, respondents were requested to express their opinion on how strongly they agree or disagree with certain statements relevant to S&T literacy. Eight valid questions were asked and the responses are presented in table 4.15.

Table 4.15: Level of Appreciation of S&T Literacy

A	**Statement**	**Poor Understanding of essential characteristics of S&T**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	0	0	0	
2	Disagree	-6	-5	0	
3	Agree	+9	+5	+1	
4	Strongly Agree	+14	+7	0	
	Net No. of Resp.	17 (N.R =1)	* 7 (N.R =1)	1	25 agreed
B	**Statement**	**Poor Understanding of influence of S&T on Society**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-2	-2	0	

2	Disagree	-4	-3	-1	
3	Agree	+9	+7	0	
4	Strongly Agree	+15	+5	0	
	Net No. of Resp.	18	7 (N.R =1)	-1	24 agreed
C	**Statement**	**S&T Policy has not recognized the need for technology literacy**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-16	-3	0	
2	Disagree	-6	-8	-1	
3	Agree	+5	+4	0	
4	Strongly Agree	+3	+1	0	
	Net No. of Resp.	-14	-6 (N.R =2)	-1	-21 disagreed
D	**Statement**	**Not well equipped to make well-informed decision on S&T**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-5	-6	-1	
2	Disagree	-3	-3	0	
3	Agree	+6	+3	0	
4	Strongly Agree	+15	+5	0	
	Net No. of Resp.	13	-1 (N.R =1)	-1	11 agreed
E	**Statement**	**Policy makers pay little attention to S&T education**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-2	-1	0	
2	Disagree	-6	0	0	
3	Agree	+9	+6	+1	
4	Strongly Agree	+13	+10	0	
	Net No. of Resp.	14	* 15 (N.R =1)	1	30 strongly agreed
F	**Statement**	**Lack of attention to technology Literacy**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-1	0	0	

2	Disagree	-10	-2	0	
3	Agree	+12	+7	+1	
4	Strongly Agree	+7	+7	0	
	Net No. of Resp.	8	12 (N.R =1)	1	21 agreed
G	**Statement**	**S&T policies are not people oriented/ market driven**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-7	0	0	
2	Disagree	-3	-2	-1	
3	Agree	+9	+14	0	
4	Strongly Agree	+11	+1	0	
	Net No. of Resp.	10	13 (N.R =1	1	22 agreed
H	**Statement**	**S&T Policies cannot guide national development efforts**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-23	-12	-1	
2	Disagree	-5	-5	0	
3	Agree	+1	0	0	
4	Strongly Agree	+1	0	0	
	Net No. of Resp.	-26	-17(N.R =1)	-1	-44 strongly disagree

Source: Research study, 2004

The analysis of the respondent's views is summarized as follows:

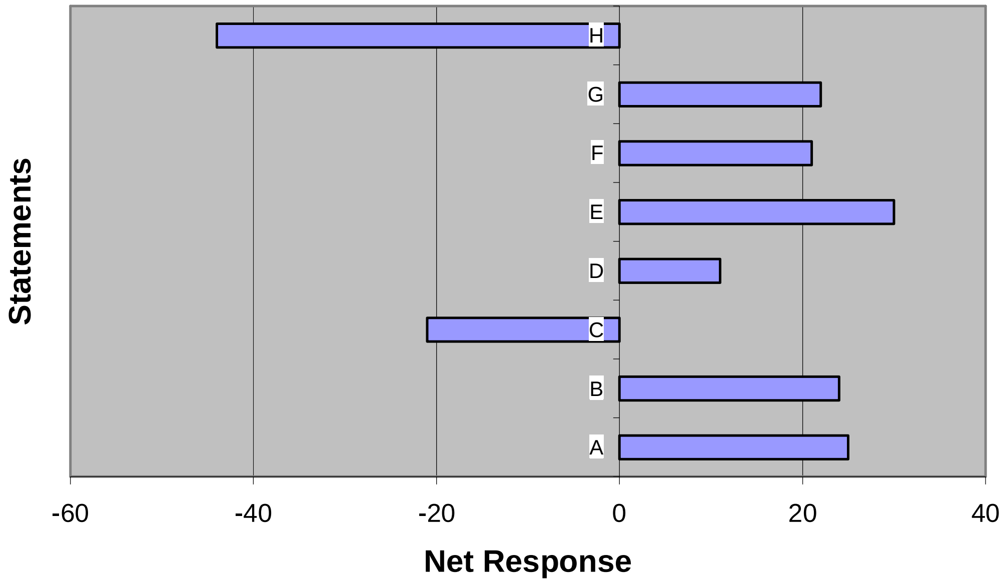
S/N	Statement	Decision
A	There is poor understanding of the essential characteristics of S&T.	25 respondents agreed positively with the statement.
B	There is poor understanding of how S&T influences the society and its development.	24 respondents agreed also with the statement
C	The S&T policy in Nigeria has not recognized the need for technological literacy.	21 respondents disagreed completely with the statement
D	Nigerians are not equipped to	11 respondents agreed with

	make well-considered decisions about S&T.	the statement. While more of the respondents from FMST agreed those from FMARD and FME disagreed.
E	Most policy makers at the Federal and State levels paid little or no attention to S&T education	30 respondents agreed with the statement.
F	There is lack of attention to technology literacy among policy makers.	21 respondents agreed with the statement.
G	S&T policies in Nigeria are not people oriented, market-driven and job-creation.	22 of the respondents agreed with the statement.
H	S&T policies cannot guide national development efforts.	44 of the respondents strongly disagreed with the statement.

- Net Response could be –ve or+ve.

For all the statements made, the greater majority of respondents agreed that there were limitations to the understanding of S&T among Nigerians. The distribution of the responses is well illustrated in figure 4.6.

FIGURE 4.6 Level of Appreciation of S&T Literacy



Furthermore, the study tried to elucidate the level of perception of policy makers on the importance of S&T to development. Respondents were asked if enough legislations on S&T education and technology literacy have been carried out by the National Assembly. It is believed that since the respondents are key internal S&T stakeholders, they must be well informed of any such legislation. Their responses are presented in table 4.16

Table 4.16: Legislation on S&T Education and Technology Literacy

S/N	Response	FMST	FMARD	FME	No. of Respondents	% Respondents
1	Yes	7	0	0	7	14.3
2	No	14	8	0	22	44.9
3	No. Idea	9	10	1	20	40.8
	Total	30	18	1	49	100.0

Source: Research Study, 2004

The analysis of the response shows that 44.9% were of the view that the National Assembly in Nigeria has not passed significant number of bills on science and technology, including S&T education and technology literacy. It is pertinent to note that 40.8% were ignorant of what the legislators were doing in respect of legislation on S&T. Those that were of the view that legislators have passed some bills on S&T are only 14.3%. To this group, were asked to indicate if any of the bills has been passed into law in the past five years.

The pattern of response also reflected the earlier observation of ignorance among the respondents as 58.1% of them were not sure. Those that were of the view that none of the bills have been passed into law were 34.9% while 7% believed that some bills have been passed into law. It is obvious that there was lack of awareness in this area as scientists and researchers seems not to know what policy makers are doing that currently affects their operational activities.

Table 4.17: Bills on S&T Passed into Law

S/N	Response	FMST	FMARD	FME	No., of Respondents	% Respondents
1	Yes	3	0	0	3	7.0
2	No	11	4	0	15	34.9
3	No. Idea	14	10	1	25	58.1
	Total	28(NR=2)	14(NR=4)	1	43	100.0

Source: Research study, 2004

In order to validate this finding, respondents were asked to assess the legislators in order to ascertain if or not they are technologically literate or lack understanding of S&T. The essence of this question is to enable the researcher find out the reason why not much legislations on S&T have been carried out. The responses are presented in table 4.18.

Table 18: Assessment of Legislator's, Technology Literacy

S/N	Level of Literacy	FMST	FMARD	FME	No., of Respondents	% Respondents
1	Technologically Literate	4	1	0	5	11.6
2	Technologically Illiterate	2	1	0	3	7.0
3	Lack understanding of S&T	22	12	1	35	81.4
	Total	28 (NR=2)	14 (NR=4)	1	43	100.0

Source: Research study, 2004

Analysis of the responses shows that 81.4% of the respondents believed that the legislators lack understanding of S&T and perhaps, that account for the limited legislation on S&T. When further asked if they were convinced that the legislators were aware of the existence of a national S&T policy, majority (54.2%) affirmed positively that the legislators were in the knowledge of the existence of S&T policy (table 4.19).

Table 4.19: Awareness of the Existence of National S&T Policy

S/N	Response	FMST	FMARD	FME	No., of Respondents	% Respondents
1	Yes	20	6	0	26	54.2
2	No	3	1	0	4	8.3
3	No. Idea	7	10	1	18	37.5
	Total	30	17(NR=1)	1	48	100.0

Respondents from FMARD (58.8%) were not sure if the legislators were aware or not and those in this category account for 37.5% of the overall number of respondents that lack idea of the issue at stake.

4.5 **NATURE OF R&D FOCUS OF RESEARCH INSTITUTES**

The study also attempts to evaluate the impact of researches carried out by research institutions in Nigeria on national development. To this end, it became necessary to primarily identify the nature of research orientation of the RIs whether they are mission oriented, scientific institutional research or purely academic research. The responses are presented in table 4.20

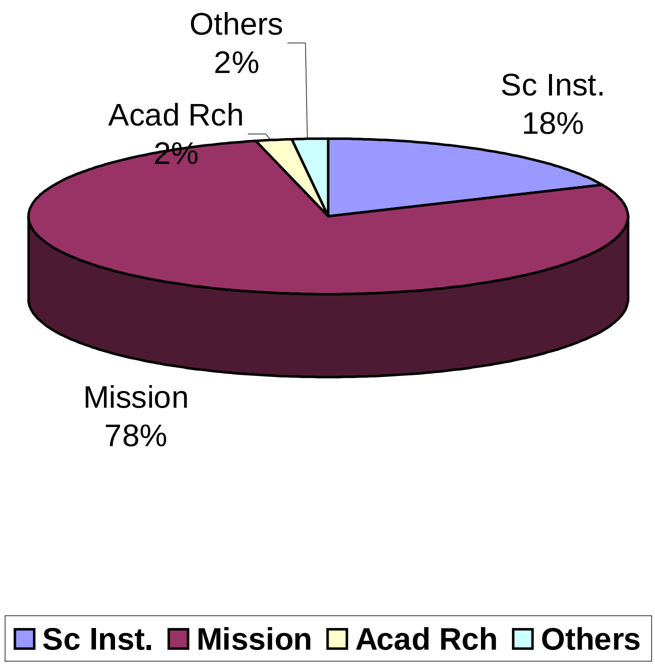
Table 4.20: Nature of Research Orientation

S/N	Research Orientation	FMST	FMARD	FME	No. of Respondents	% Respondents
1	Mission Oriented	22	15	1	38	77.6
2	Scientific Institutional Research	6	3	0	9	18.4
3	Academic Research	1	0	0	1	2.0
4	Others	1	0	0	1	2.0
	Total	30	18	1	49	100.0

Source: Research Study, 2004

The analysis as illustrated in figure 4.7 shows that virtually all the RIs (77.6%) surveyed are mission oriented institutions. This implies that they were established with specific mission and mandates in a particular area or sector of national importance.

FIGURE 4.7 Nature of Research Orientation



Those that are scientific and institutionally based are very few (18.4%). Most of them do not carry out academic research except very few (2.0%) that have academic training as integral component of their mandate.

In order to determine the nature of researches, either as applied, basic research or both, respondents were asked to indicate which of these R&D services they carry out. Their responses are presented in table 4.21

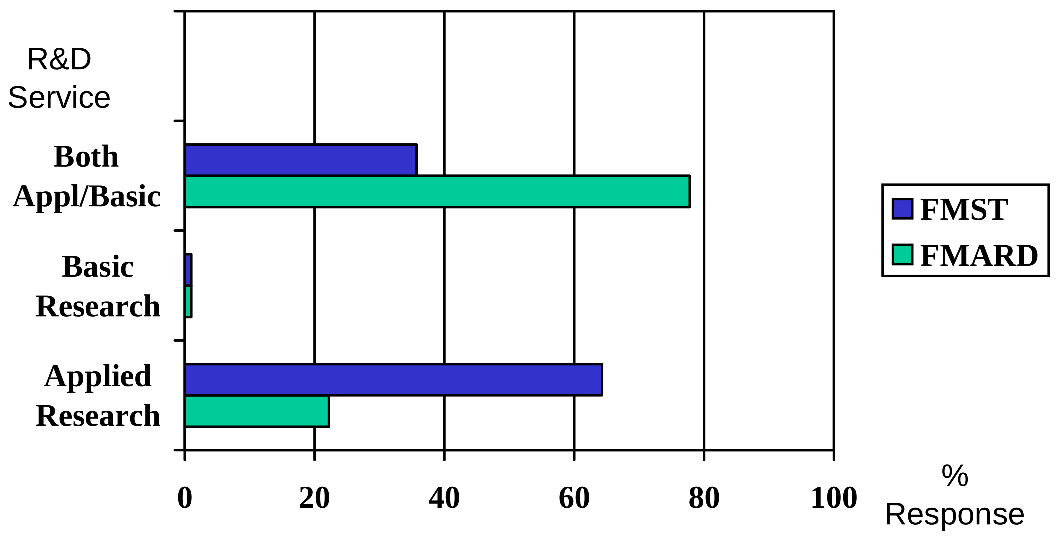
Table 4.21: Type of R&D Service that Target Market-Needs

S/N	R&D Service	FMST	FMARD	FME	No. of Respondents	% Respondents
1	Applied research	18	4	0	22	46.8
2	Basic research	0	0	0	0	0.0
3	Both	10	14	1	25	53.2
	Total	28 (NR=2)	18	1	47	100.0

Source: Research Study, 2004

The analysis is well illustrated in figure 4.8.

Figure 4.8 Types of R&D Service that Target Market Needs



Applied research (46.8%) is more prominent R&D focus than basic research (0.0%). However, 53.2% of the respondent believed that they carry out both applied and basic research. For RIs under FMST, majority of the respondents (64.3%) indicated applied research as their main focus compared to basic research. However, 35.7% were of the view that they carry out both applied and basic research. Their opinion was similar to what obtained in the RIs under FMARD (77.8%).

The respondents were further asked to identify the major beneficiaries of their research activities. Their responses are presented in table 4.22.

Figure 4.9 Beneficiaries of Research Activities

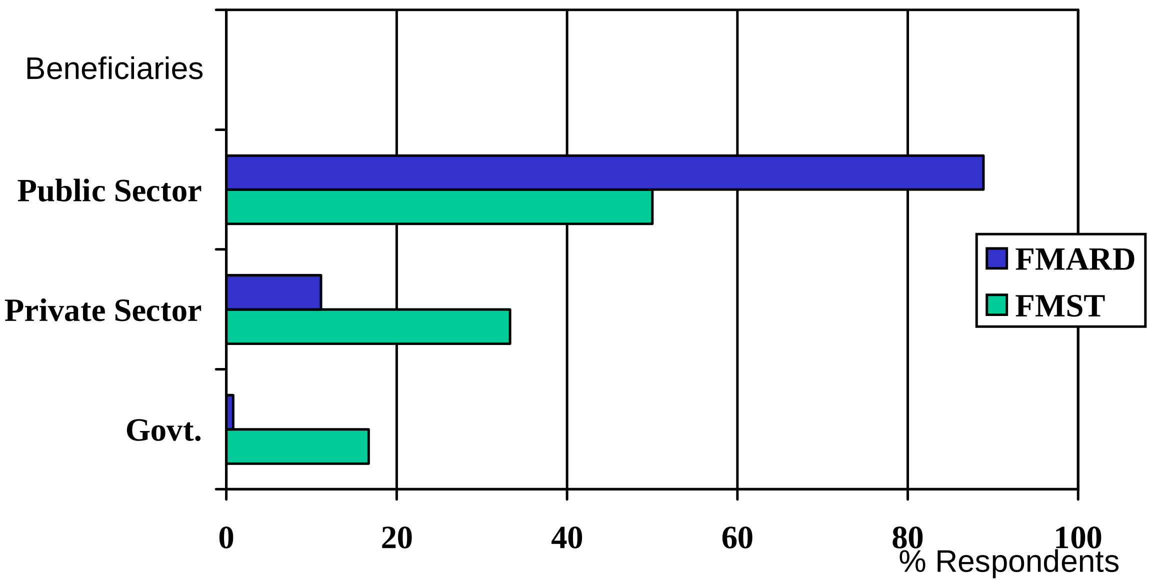


Table 4.22: Beneficiaries of Research Activities

S/N	Beneficiaries	FMST	FMARD	FME	No. of Respondents	% Respondents
1	Public sector	15	16	1	32	65.3
2	Government	5	0	0	5	10.2
3	Private Sector	10	2	0	12	24.5
	Total	30	18	1	49	100.0

Source: Research Study, 2004

The analysis (figure 4.9) of the responses indicates that the public sector (65.3%) is the major beneficiary, followed by the private sector (24.5%) and the government (10.2%). The public sector is the major beneficiary of researches carried out by RIs under FMARD (88.9%), while the private sector account for only 11.1%. However, for RIs under FMST, while the public sector account for 50%, the private sector account for 33.3% while the government account for 16.7%.

In all the RIs surveyed, there was minimal relationship with the private sector which indicates that researches carried out by them were not likely to be private-sector driven. In order to further substantiate the view that need or market-driven research is lacking in the country, respondents were asked to comment on their views.

Table 4.23 presents the responses and the analysis shows that the respondents from FMST were almost unanimous (75.0%) in their agreement to lack of need or market-driven R&D.

Table 4.23: Need or Market-Driven Research

S/N	Response	FMST	FMARD	FM E	No. of Respondents	% Respondents
1	Agree	21`	7	0	28	63.6
2	Disagree	7	8	1	16	36.4
	Total	28 (NR=2)	15 (NR=3)	1	44	100.0

Source: Research study, 2004

Respondent from FMARD that disagreed were 53.3% as against 46.7% that agreed. For all the RIs studied, 63.6% agreed while 36.4% disagreed. These findings further confirmed an earlier one that revealed lack of effective patronage and linkage between RIs and the private–sector who were considered the major beneficiaries of R&D. The reasons given by the respondents to justify their views were further discussed in the next chapter.

The desirability for a separate national R&D policy has been stressed at different fora and in many literatures on national R&D in Nigeria. The proponents argued that a National R&D policy distinct from the S&T policy will be able to strengthen R&D in the country irrespective of the implementing agency, research institution and ministry.

Even, some suggested the establishment of an “Agency” or “Council” to coordinate all R&D activities in the country. It is against this background that the respondents were requested to give their opinion whether or not a national R&D policy distinct from S&T is desirable. Table 4.24 shows the responses from the RIs surveyed.

Table 4.24: Desirability For a Separate National R&D Policy

S/N	Response	FMST	FMARD	FME	No. of Respondents	% Respondents
1	Yes	11	10	1	22	46.8
2	No	18	7	0	25	53.2
	Total	29 (NR=1)	17 (NR=1)	1	47	100.0

Source: Research study, 2004

The analysis indicates that majority of the respondents from FMARD (58.8%) agreed with the view while 41.2% disagreed. The converse was the case with respondents from FMST as 62.1% disagreed while 37.9% agreed. This is understandable, judging by the fact that they belong to the Ministry of Science and Technology. They argued that any removal of R&D policy from the national S&T policy will render such policy inconsequential. However, the aggregate response shows that 53.2% disagreed while 36.8% agreed and various reasons were given by the respondents to justify their views. These were effectively discussed in the next chapter.

4.6 **ROLE OF RESEARCH, SCIENCE AND SCIENTISTS IN A SOCIETY**

The social function of science and technology revolves round the impact research, science and scientists themselves can make on the society. To really appreciate how the researchers, scientist and policy makers perceive S&T as a veritable instrument of development, certain statements were made for their comments on whether they strongly agree or disagree. Table 4.25 present the responses to the statements and the net response or decision reached from the analysis.

Table 4.25: Role of Research, Science and Scientists in Society

A	**Statement**	**Science contributes to development**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	0	0	0	
2	Disagree	0	0	0	
3	No. Idea	0	0	0	
4	Agree	0	+2	0	
5	Strongly agreed	+30	+16	+1	
	Net no of resp.	30	18	1	49 strongly agreed
B	**Statement**	**Science knowledge is universal**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response)
1	Strongly Disagree	-2	0	0	
2	Disagree	0	-1	0	
3	No. Idea	2	5	0	
4	Agree	+3	+4	0	
5	Strongly agreed	+23	+8	1	
	Net no of resp.	24	11	1	36 strongly agreed

C	Statement	Science should firstly produce knowledge			
S/N	Response	FMST	FMARD	FM E	Decision(Net Response)
1	Strongly Disagree	-1	0	0	
2	Disagree	-5	-2	0	
3	No. Idea	3	3	0	
4	Agree	+8	+7	0	
5	Agree Strongly	+12	+6	1	
	Net no of resp.	14(NR=1)	11	+1	26 Agree
D	**Statement**	**Science should mainly lead to useful innovations**			
S/N	Response	FMST	FMARD	FM E	Decision(Net Response)
1	Strongly Disagree	-3	-0	0	
2	Disagree	-3	-7	0	
3	No. Idea	2	0	0	
4	Agree	+5	+4	0	
5	Strongly agree	+17	+7	+1	
	Net no of resp.	16	4	1	21 Agreed
E	**Statement**	**Researchers should have entrepreneurship skills**			
S/N	Response	FMST	FMARD	FM E	Decision (Net Response)
1	Strongly Disagree	-7	0	0	
2	Disagree	-2	0	0	
3	No. Idea	9	4	0	
4	Agree	+4	+9	+1	
5	Strongly agree	+8	+5	0	
	Net no of resp.	3	14	1	18 Agree
F	**Statement**	**Science is public knowledge**			
S/N	Response	FMST	FMARD	FM E	Decision(Net response)
1	Strongly Disagree	-10	-4	0	
2	Disagree	-10	-2	0	
3	No. Idea	2	2	1	
4 5	Agree Strongly agree	+4 +2	+5 +5	0 0	
	Net no of resp	14(NR=2)	14	1	-10 Disagree

G	Statement	Researchers are free to chose their research topics			
S/N	Response	FMST	FMARD	FME	Decision(Net response)
1	Strongly Disagree	-12	-7	0	
2	Disagree	-3	-4	0	
3	No. Idea	5	2	0	
4	Agree	+7	+5	+1	
5	Agree Strongly	+3	0	0	
	Net No. of resp.	5	-6	+1	-10 disagree
H	**Statement**	**Researchers should produce marketable goods**			
S/N	Response	FMST	FMARD	FME	Decision(Net response)
1	Strongly Disagree	-6	0	0	
2	Disagree	-2	-5	-1	
3	No. Idea	4	0	0	
4	Agree	4	3	0	
5	Agree Strongly	14	10	0	
	Net No. of resp	10	8	-1	17 Agreed
I	**Statement**	**Research problems are set by clients**			
S/N	Response	FMST	FMARD	FME	Decision (Net response)
I	Strongly Disagree	-4	0	0	
2	Disagree	-3	-3	0	
3	No. Idea	5	3	0	
4	Agree	+5	+2	+1	
5	Agree Strongly	+13	+10	0	
	Net No. of resp	11	9	1	21Agreed
J	**Statement**	**Research topics are set by sponsors**			
S/N	Response	FMST	FMARD	FME	Decision(Net response)
1	Strongly Disagree	-3	-4	0	
2	Disagree	-2	-1	0	
3	No. Idea	8	4	0	
4	Agree	+8	4	0	
5	Agree Strongly	+9	+5	+1	
	Net No. of resp	12	4	1	17 Agreed
K	**Statement**	**Research topics are set by parent Ministry**			

S/N	Response	FMST	FMARD	FME	Decision Net response)
1	Strongly Disagree	-7	-8	0	
2	Disagree	-3	-3	0	
3	No. Idea	7	4	1	
4	Agree	+5	+2	0	
5	Agree Strongly	+8	+1	0	
	Net No. of resp	3	-8	0	-5 disagree

Source: Research Study, 2004

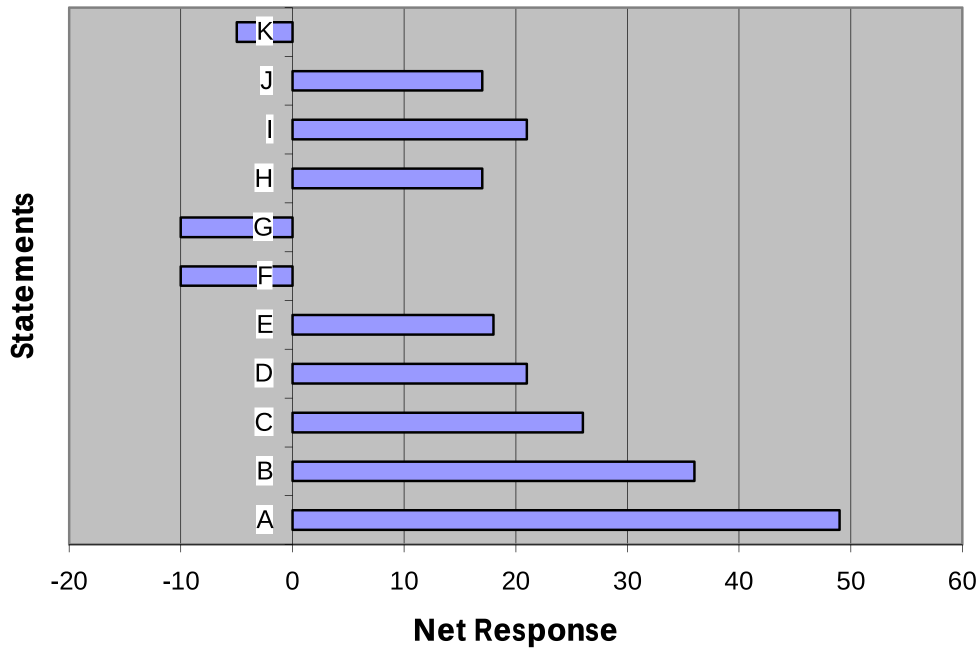
- Resp. No. 3 attract zero score in all cases

A summary of the statements and the net responses is presented below. The analysis is well illustrated in figure 4.10

Summary of Findings on Role of Research, Science and Scientists		
S/N	Statements	Net Response
A	Science contributes to development	49 respondents strongly agreed
B	Science knowledge is universal	36 respondents agreed
C	Science should firstly produce knowledge	26 respondents agreed
D	Science should mainly lead to useful innovations	21 respondents agreed
E	Researchers should have entrepreneurial skills	18 respondents agreed
F	Science is public knowledge	10 respondents disagreed
G	Researchers are free to chose their research topics	10 respondents disagreed
H	Researchers should produce marketable goods	17 respondents agreed
I	Research problems are set by clients	21 respondents agreed
K	Research topics are set by sponsors	17 respondents agreed
L	Research topics are set by parent Ministry	5 respondents disagreed

*Net Response could be +ve or –ve

FIGURE 4.10 Role of Research,Science and Scientist in Society



Analysis of the responses shows that while many of the statements were agreed to by the respondents they disagreed with the following three statements:

a. Science is a public knowledge,
b. Researchers are free to chose their research topics and
c. Research topics are set by parent ministry.

The two statements (b&c) confirm the earlier view that research topics should be determined by client based on needs. Also, that sponsors of research influence the research topics.

Among the respondents, there were some differences in their views expressed over certain statements. For instance, on the issue that “science is a public knowledge,” while 71.4% of respondents from FMST disagreed with the view, 55.6% of respondents from FMARD agreed with it. However, the net response was that 21.3% disagreed.

A similar observation was made in respect of the issue of research topics set by parent ministry. While 43.3% of respondents from FMST agreed, 61.1% of those from FMARD disagreed leading to a negative net response of 10.2% (disagreed). Even, within the Ministry, there was strong divided opinion concerning certain statements. A typical example was also on the issue of research topics set by parent ministry. For FMST, 33.3% disagreed with the view while 43.3% agreed, which was a sharp contrast.

The weaknesses often complained of concerning the operations of research institutions in the country were evaluated in order to determine the prospects of impacting on national development. Several questions relating to collaboration with productive sector, commercialization of R&D, funding, setting of targets and goals, monitoring and evaluation of R&D, mandates, remuneration, information dissemination, linkages with SMEs and exploitation of R&D results by SMEs were asked. The responses are presented in table 4.26.

Table 4.26: Assessment of Weaknesses of RIs.

A	**Statement**	**RIs do not collaborate with productive sector**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-2	0	0	
2	Disagree	-1	-4	-1	
3	No. Idea	3	4	0	
4	Agree	+10	+6	0	
5	Agree Strongly	+14	+4	0	
	Net No. of Resp.	21	6	-1	26 Agreed
B	**Statement**	**RIs lacks capacity to commercialize researches**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-8	-4	0	
2	Disagree	-2	-5	-1	
3	No. Idea	1	2	0	
4	Agree	+7	+3	0	
5	Agree Strongly	+12	+3	0	
	Net No. of Resp.	9	-3(NR=1)	-1	5 Agreed
C	**Statement**	**RIs funded by public fund are under-funded**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	0	-2	0	
2	Disagree	0	0	0	
3	No. Idea	0	0	0	
4	Agree	+2	+1	0	
5	Agree Strongly	+28	+15	+1	
	Net No. of Resp.	30	14	1	45 strongly disagree
D	**Statement**	**Target and goals are not set for performance**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-1	-1	0	
2	Disagree	-6	-5	0	
3	No. Idea	5	2	1	
4	Agree	+4	+4	0	
5	Agree Strongly	+13	+6	0	
	Net No. of Resp.	10(NR=1)	4	0	14 Agreed
E	**Statement**	**Lack of effective monitoring and evaluation**			

S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-6	0	0	
2	Disagree	-2	-1	0	
3	No. Idea	4	4	0	
4	Agree	+6	+7	+1	
5	Agree Strongly	+12	+6	0	
	Net No. of Resp.	10	12	1	23 Agreed
F	**Statement**	**RIs mandates are wide with diffused focus**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-6	-7	0	
2	Disagree	-5	-6	0	
3	No. Idea	7	0	0	
4	Agree	+5	+4	0	
5	Agree Strongly	+7	+1	+1	
	Net No. of Resp.	1	8	1	-6 disagree
G	**Statement**	**Remuneration in RIs are inadequate**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-1	-1		
2	Disagree	-3	0		
3	No. Idea	1	2		
4	Agree	+4	+2		
5	Agree Strongly	+21	+12	+1	
	Net No. of Resp.	21	13(NR=1)	1	35 strongly disagree
H	**Statement**	**RIs are weak in information dissemination**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-3	-1		
2	Disagree	-3	-1		
3	No. Idea	5	5		
4	Agree	+11	+4	+1	
5	Agree Strongly	+8	+7		
	Net No. of Resp.	13	9	1	23 Agreed
I	**Statement**	**No Linkage between RIs and SMEs**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-1	0	0	

2	Disagree	-1	0	0	
3	No. Idea	6	1	0	
4	Agree	+7	+2	0	
5	Agree Strongly	+7	+2	0	
	Net No. of Resp.	12(NR=8)	4(NR=13)	N.R=1	16 Agreed
J	**Statement**	**SMEs cannot exploit R&D due to finance**			
S/N	Response	FMST	FMARD	FME	Decision(Net Response
1	Strongly Disagree	-1	-0	0	
2	Disagree	0	-1	-1	
3	No. Idea	4	4	0	
4	Agree	+9	+4	0	
5	Agree Strongly	+16	+3	0	
	Net No. of Resp.	14	6(N.R=6)	-1	29 Agreed

Source: Research Study, 2004

- Resp. no.3 attract zero score in all cases

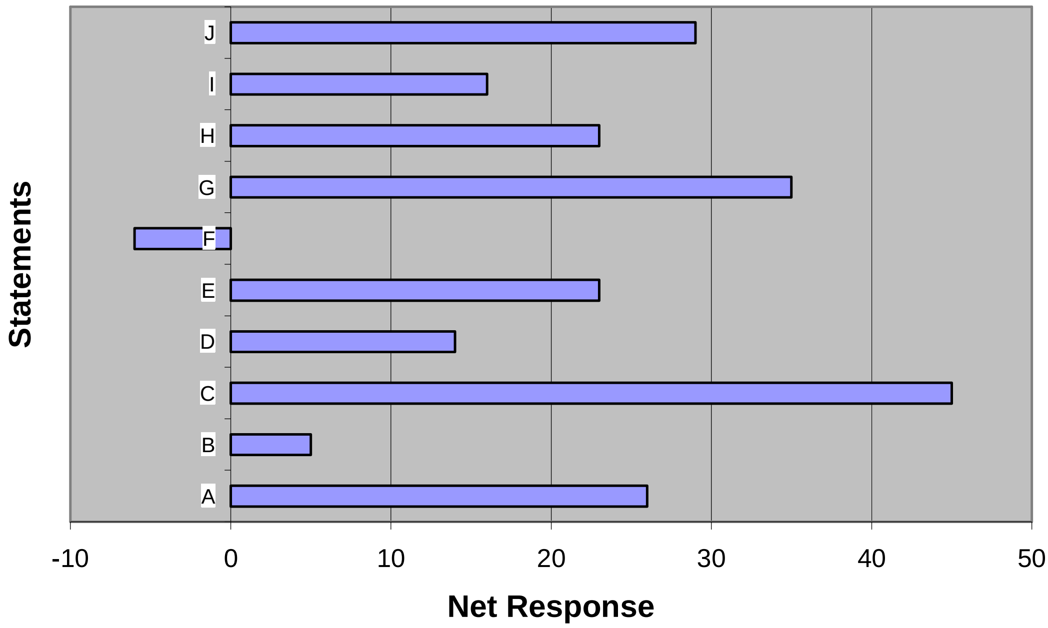
Summary of Findings on Assessment of Weaknesses of RIs		
S/N	Statements	Net Response
A	RIs do not collaborate with productive sector	26 respondents agreed
B	RIs lacks capacity to commercialize R&D results	5 respondents agreed
C	RIs are grossly under-funded by Government	45 respondents agreed strongly
D	Targets and goals are not set for performance evaluation	14 respondents agreed
E	RIs lack effective monitoring and evaluation of performance	23 respondents agreed
F	RIs mandates are wide with diffused focus	6 respondents disagreed
G	Remuneration in RIs are inadequate	35 respondents agreed strongly
H	RIs are weak in information dissemination	23 respondents agreed
I	No linkages between RIs and SMEs	16 respondents agreed
J	SMEs cannot exploit R&D results due to lack of finance and expertise	29 respondents agreed

Net response could be +ve or –ve

The summary reflecting the statements and responses is presented below.

The analysis is further illustrated in figure 4.11

FIGURE 4.11 Assessment of Weaknesses of RIs



In the analysis of the responses, the trend shows that majority of the respondents agreed with the view that RIs in Nigeria were weak to carry out the above identified functions. The only exception were they disagreed was on the issue of their mandates being wide with diffused focus, resulting in ineffectiveness. This is understandable from the emotional point of view. However, it is pertinent to point out that on the issue of mandates; opinions were divided among the respondents from different Ministries. While 36.7% disagreed with this statement in the case of FMST, 40% agreed. The outcome of the net response was influenced by responses from FMARD as 72.2% disagreed. It is important to note the strong response to issues bothering on funding of research and remuneration in RIs.

In all the Ministries, the responses were overwhelming, almost 100% in the case of poor funding. Similar observation was made in respect of remuneration. While 83.3% of respondents in FMST agreed completely that remuneration in RIs were inadequate. 82.4% of respondents in FMARD held the same view. Other issues that should be considered based on the outcome of the analysis include the following:

a. collaboration with the productive sector;
b. effective monitoring and evaluation;
c. weak information dissemination and
d. inability of SMEs to exploit R&D results.

Apart from poor funding and remunerations, these issues ranked high in the order of responses. For instance, 80% of respondents in FMST agreed that RIs do not collaborate effectively with the productive sector as well as 55.6% of respondents from FMARD.

On the issue of effective monitoring, 60% of respondents from FMST and 72.2% from FMARD agreed that there was lack of effective monitoring and evaluation of performance on continuous basis. With respect to information dissemination, the responses were almost uniform as 63.3% of those in FMST and 61.1% of those in FMARD agreed to the existence of weak information dissemination in RIs. On the issue of exploiting R&D results by SMEs the responses showed a certain pattern as the RIs under FMST deal more with SMEs than RIs under FMARD. This explains why 83.3% of respondents from FMST completely agreed that SMEs were financially weak and lack expertise to exploit R&D results relative to 58.3% of respondents from FMARD.

4.7 STRATEGIES FOR STRENGTHENING R&D CAPACITY BUILDING IN RESEARCH INSTITUTIONS

The importance attached to capacity building in R&D was realized in this study, hence the need to field questions that will elicit appropriate responses and suggestions on strategies to strengthen R&D capacity building in RIs in the country. Five core areas were identified which include the following; manpower, linkages with industry, funding, targeting of technologies as well as projects and processes, and strengthening of intellectual property right. The responses are tabulated in table 4.27

Table 4.27: Strategies for Strengthening R&D Capacity Building in RIs

S/N	Manpower	Linkage	Funding	Technologies, Project/Processes	Intellectual Property Right
1	Recruitment, training retraining should be on sustained basis.	Industries should be supportive to RIs by bringing their problems to them for solution.	Budgetary allocation to S&T should be sustainable for meaningful activities.	Technology development programmes and projects should be market-driven, people oriented, to encourage patronage.	Intellectual property right should be protected in order to strengthen R&D capability.
2	The right personnel should be recruited	Industries should endeavour to utilize on-the-shelf technologies developed by RIs.	Adequate funding of not less than 10% of fund derived from privatization of public enterprises should be made available for R&D.	Efforts must be made to promote new product/ process/innovation development among manufacturing enterprises especially SMEs through linkages with RIs.	Awareness on IPR among researchers as well as procedure for obtaining patents for innovations and viable researches should be created.
3	Motivation of personnel should be encouraged	RIs should establish technology extension services as a strategy to link	Research Tax Fund similar to Education Tax Fund	Technology adaptation should be courageously pursued.	There is need to enforce laws on IPR, if it exist.

		up with industries especially, SMEs.	should be established under transparent Trustees		
4	Federal character should not be given prominence in recruitment of personnel	The company and Allied Matters Decree should emphasize that industries should patronize local RIs.	RIs should be encouraged to establish consultancy services and internally generate revenue.	Technologies that can impact positively on the economy should be identified and targeted	Viable R&D results from RIs should be patented.
5	There should be discipline and commitment to R&D work	Collaboration and sponsorship of R&D should be encouraged by industries.	RIs should establish viable enterprises and encourage staff to retire to the business.	Incentives should be given to industries to increase local content of their production inputs and reduce import dependence.	Training of personnel on IPR should be encouraged.
6	On-the-job training especially Post Graduate studies, travel fellowships to advanced laboratories should be encouraged.	6. There is need to promote the establishment of private R&D companies or Corporate R&D institutions as well as privatize industrially related R&D institutions. 7. Consultative fora between			

		RIs and industries should be encouraged and sustained. 8. Contract research should be promoted in industry. 9. Personnel exchange programmes should be encouraged. 10. Promote industrial trouble shooting by RIs in industry. 11. Promote annual S&T fair and exhibition. 12. Regular publication and dissemination of R&D results among industries should be encouraged. 13. Industrialists should be board members of RIs in order to influence the focus of R&D. 14. Project planning and review should be jointly carried out between RIs and industries.			

4.8 **SCIENTIFIC BREAKTHROUGHS WITH IMPACT ON NATIONAL DEVELOPMENT.**

It will be recalled that the study is aimed at assessing the impact of S&T policy on national development. One of the veritable means of determining the impact of S&T on national development is to examine the various researches being conducted by RIs in order to identify those that have measurable impact. Also, various publications of research results disseminated to the public were considered as parameters for determining the impact. The issue of patented R&D results and innovations, including inventions formed part of the indicators used to gauge the impact of S&T on national development. Based on these parameters the respondents were asked to list in the order of priority, scientific breakthroughs, patented R&D results, published works in reputable journals as well as books.

Table 4.28 gives the list of scientific breakthroughs from respondents in FMST, FMARD and FME.

Table 4.28: Scientific Breakthroughs

S/N	FMST	FMARD	FME
1	Process technology for groundnut, cassava, fruit juice, etc.	1. Genetic improvement and hybrid of African cat fish.	1. Seedling production of indigenous and exotic species.
2	Dev. of interlocking block making machine of capacity	2. Dev. and patenting of fish smoking kiln.	2. Shelterbelt development for desertification control.

	300 blocks/day.		
3	Laterite grinding machine and Electro-hydraulic brick-making machine.	3. Dev. Of yam hybrids.	3. Production of ceiling boards, tiles, decorative items from wood residues.
4	Dev. of roofing tile tech and stonecrete technology.	4. Dev. of mini-sett &mini-tubers for seed yam production.	4. Grass cutter prod/edible mushroom production.
5	Dev. of fertilizer production Plant.	5. Dev. of cassava varieties and their release to farmers.	
6	Dev. of laboratory chemicals for schools.	6. Dev. of potato botanical seed for potato production.	
7	Essential oil production plant.	7. Utilization of agro-industrial by-- product for livestock feed formulation.	
8	Hydrated lime production Plant	8. Control of cassava disease (striga) using moisture and fertilizer types.	
9	Porcelain insulators production using local clay.	9. Dev. of improved maize variety.	
10	Production of candle filter for water purification.	10. Fortification of cassava with soybean for soygari.	
11	Design/production of passive/ active solar equipment for drying and power generation.	11. Industrial production of soymilk.	
12	Development of glass cutting machine.	12. Dev. of organic fertilizer.	
13	Dev. of Mellon shelling machine	13. Dev. of high yielding rubber clones (Nig. 800,900,etc)	
14	Dev. of new	14. Utilization of rubber	

	vegetable tannins for leather production.	seed oil in Glazier Putty Production.	
15	Establishment of model factories for non-metallic mineral processing.	15. Dev. of ginger splitting machine.	
16	Promotion of local fabrication of agric/mineral processing eq**uipment.**	16. Micro-propagation of oil palm. 17. Dev. of technology for modern forage production for animal feed**.**	

Source: Research Study, 2004

- Dev. = Development.

A comprehensive list of completed inventions, innovations and R&D results due for commercialization is presented in Annex 2.0

In order to validate the belief that “Patent culture in Nigeria is poor”, respondents were requested to provide information on their R&D that have been patented. From the responses, very few RIs reported that they have applied for patenting of their R&D results. The paucity of information received informed the need for personal discussions with the National Office for Technology Acquisition and Promotion (NOTAP).

From NOTAP, secondary data on names of products for which patents applications were made and granted from 1999 to 2004 is presented in table 4.29.

Table 4.29: Products Granted Patent from January 1999-August 2004

Year of Submission	Name of Product Granted Patent	Year of Approval
1999	1. Visual Breath Analyzer	2000
2000	2. Typhoid Fever Vaccine	2002
	3. Syrup Crystallizer	2002
	4. Automatic Fire Extinguisher	
	5. Automatic Labour Facilitator	
	6. SOBO-C-Drink Concentrate	
	7. STF Game	2002
	8. Wisco Toys, Helico Toys and Tokens (Pambon)	2001
	9. Automatic Car Security	2001
	10. Digital Electronic Ballot Counter Box.	2002
2001	11. Extraction of Niobium from Columbite	2001
	12. Novel Anti-snake Vaccine Discovery (COUIP) from a Vegetable Protein	2002
	13. Nutritional Supplement Drug Abuse (Dosage) formula	2001
2002	14. Amaka Capital Market Equity Sector	2002
	15. Leather Design (Adire and Ovada Leather processing Technology)	2002
	16. Imarsil and Process of Preparation	2002
2004	17. Chicken Feed Prepared with Maize Tassel	2004
	18. Simplified Humidity Chamber	2004
	19. The Mass Collection Method	2004
	20. The Multiple Collection Method	2004
	21. Phytolacca Dodecandra Ethiopian/ Zimbabwean varieties	2004
	22. Forced Convection Solar Dryer (FOMSOD 66)	
	23. Machine for Ruling e.g. Exercise Book	2004
		2004

Source: NOTAP 2004

A total of 23 products filed through NOTAP have been granted patent approval between 1999 and 2004. The various applications filed between 1999 and 2003 through NOTAP on R&D results for which approval was granted are presented in table 4.30 A, B, C.

Table 4.30: A. Patent Applications filed through NOTAP (1999-2003)

Year	Number of patent applications submitted to NOTAP	Number of patent applications filed by NOTAP at Patent Registry	Number of patent applications not accepted by NOTAP	Number of patent applications granted/ approved.
1999	2	1	1	1
2000	30	13	17	9
2001	14	6	8	3
2002	17	5	12	3
2003	4	-	4	-
Total	**67**	**25**	**42**	**16**

Source: 2004 FMST Ministerial Press Briefing.

B. Patent Applications Submitted By Sectors

Year	Electrical Eng.	Mechanical Eng.	Chem & Pharm	Agric-Agro Allied	Total
1999	-	1	1	-	2
2000	8	14	7	1	30
2001	2	3	3	4	12
2002	3	4	5	3	15
2003	2	1	5	-	8
Total	**15**	**23**	**21**	**8**	**67**

Source: 2004 FMST Ministerial Press Briefing

C. Patent Applications Granted/Approved

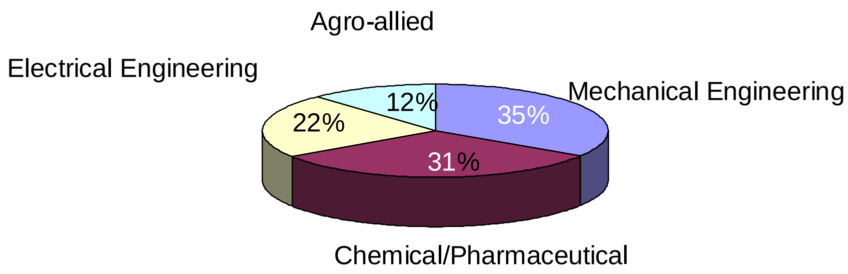
Year	Electrical Eng.	Mechanical Eng.	Chem & Pharm	Agric-Agro Allied	Total
1999	-	-	1	-	1
2000	3	2	3	I	9
2001	-	-	2	1	3
2002	-	1	-	2	3
Total	**3**	**3**	**6**	**4**	**16**

Source: 2004 FMST Ministerial Press Briefing

As at the end of 2003, 67 applications were submitted to NOTAP, 25 were accepted for filing at Patent Registry after assessment and 16 were granted approval.

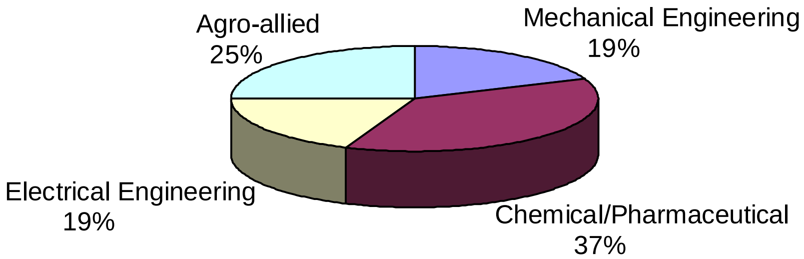
On sectoral bases the patent applications submitted within five years indicates that those from mechanical engineering had the highest (34.3%) followed by chemical and pharmaceutical (31.3%), electrical (22.4%) and 12.0% for agro-allied sector (Fig 4.12).

FIGURE 4.12 Patent Applications Submitted by Sectors



After filing, the distribution of approval shows that 37.5% of applications were approved for chemicals and pharmaceuticals, followed by agro-allied (25.0%) and 18.8% for both electrical and mechanical engineering within 4 years (figure 4.13).

FIGURE 4.13 Patent Applications Approved



4.9 **FUNDING OF R&D AND RESEARCH BUDGET**

Funding is considered very critical to impact oriented R&D. The recognition of this informed why this issue has been raised severally in the questionnaire in order to actually determine how serious it is a limiting factor to research. Primarily, attempt was made to identify the sources of research funds to RIs in Nigeria. Also, the issue of budgeting was examined in the context of budgeting process, the proposal made and the actual release made available to RIs by government.

Table 4.31 present the responses from the RIs surveyed.

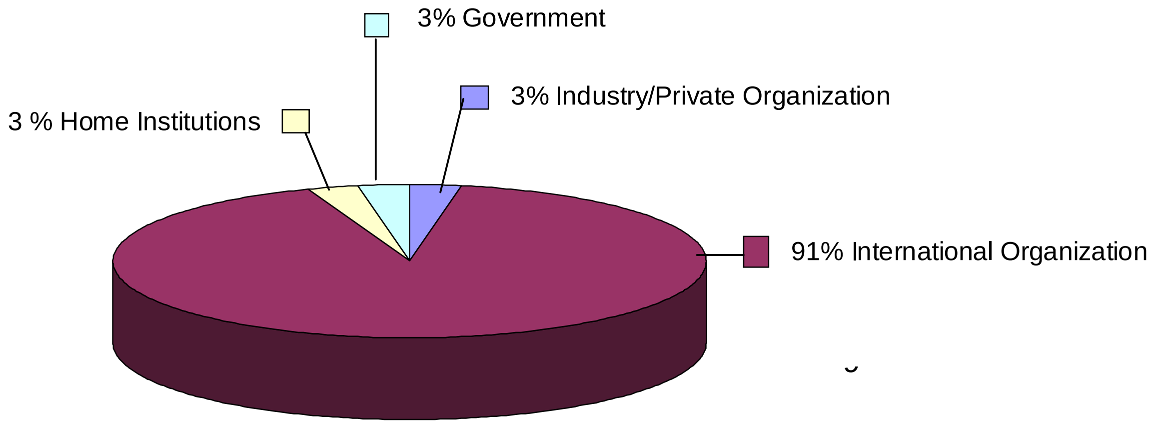
Table 4.31: Sources of Research Fund

S/N	Sources	FMST	FMARD	FME	No. of Respondents	% Respondents
	Home Institution (Internally generated))	0	1	1	1	2.8
2	Government	17	15	1	33	91.6
3.	Industry/Private Organization	1	0	0	1	2.8
4	International Organization	0	1	0	1	2.8
5	Others	0	0	0	0	0
	Total	**18** (NR=12)	**17** (NR=1)	**1**	**36**	**100.0**

Source: Research Study, 2004

The analysis showed an overwhelming response (91.6%) to the fact that government is the major source of fund. Other sources include internally generated fund (2.8%), industry (2.8%) and international organizations (2.8%). The findings are well illustrated in figure 4.14

FIGURE 4.14 Sources of Research Fund



On the issue of budget most of the respondents could not state their research budgets in the past 4 years (2000-2003) and what was actually released to them by government. For some that responded, they indicated zero release of fund from 2000-2003 despite their budget proposals. The respondents from FMARD reported that they have not received more than an average of 25% of their budgetary proposals within the period in review (2000-2003). In fact, allocation fluctuates between 12% and 25% annually. Information made available to the researcher on the issue of budgetary provision to FMST shows that in 2004, the ministry was allocated N3,352,167,903 for its recurrent expenditure as compared to a national total recurrent expenditure of N539,286,472,757. The allocation to FMST translates to 0.62% of national recurrent expenditure.

For capital expenditure the FMST received N5,701,000,000 compared to a national total capital expenditure of N349,868,371,837. This implies that the Ministry received only 1.6% of the national capital expenditure for research activities in all RIs under the Ministry as well as the projects and programmes being implemented by the Ministry itself. On the aggregate the total allocation to the Ministry comprising recurrent and capital expenditure is about 1.0% of total national budget.

4.9 OBSTACLES AFFECTING R&D AND PERFORMANCE RATING OF RESEARCH INSTITUTES BY GOVERNMENT.

Limitations posed by internal and external factors can hinder RIs from impacting on the society. In order to determine the strength of some of these factors as perceived by internal stakeholders, that is the researchers; they were asked to rate the factors as either insignificant or highly significant. Their responses are presented in table 4.32.

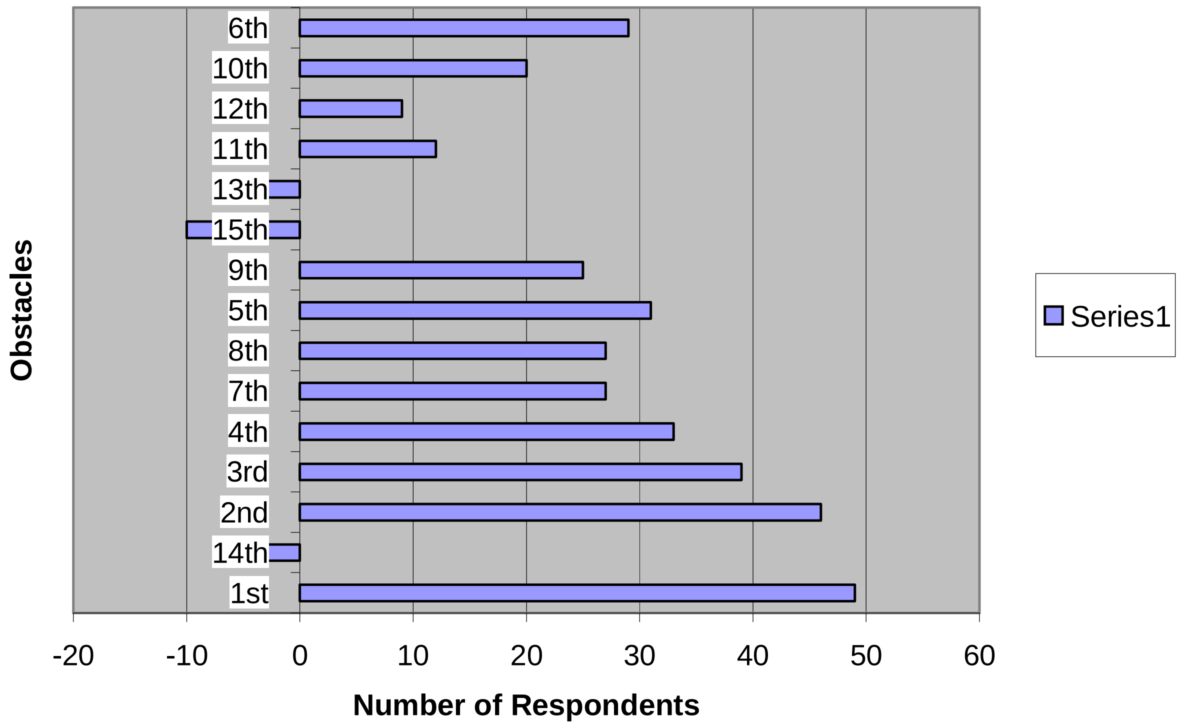
Table 4.32: Obstacles to R&D

S/N	Obstacles	FMST	FMARD	FME	No. of Respondent	Ranking
1	Poor funding	+30	+18	+1	49	1st
2	Lack of qualified staff	+6	-10	-1	-5	14th
3.	Access to equipment	+29	+16	+1	46	2nd
4	Lack of facilities (electricity/water)	+22	+16	+1	39	3rd
5	Equipment/repairs	+20	+12	+1	33	4th
6	Access to supplies	+13	+13	+1	27	7th
7	Low morale	+20	+8	-1	27	8th
8	Lack of motivation	+23	+9	-1	31	5th
9	Lack of patronage	+18	+8	-1	25	9th
10	Lack of managerial skills	+3	-12	-1	-10	15th
11	Lack of technicians	+3	-8	+1	-4	13th
12	Field work difficulties	+6	+5	+1	12	11th
13	Lack of monitoring and evaluation	+9	0	+1	9	12th
14	Access to project vehicle	+11	+8	+1	20	10th
15	Access to scientific documentation	+19	+8	+1	29	6th

Source: Research Study, 2004

Analysis shows that funding ranks the highest factor or obstacle militating against research (figure 4.15). This further confirmed all the other responses on issues concerning funding of S&T.

FIGURE 4.15 Obstacles to R&D in Nigeria



This is followed by access to research equipment and facilities such as water and electricity as well as equipment repairs. Lack of qualified staff and managerial skills were rated lowest as obstacles affecting R&D.

When asked to rate government attitude towards the performance of RIs as being very negative by strongly agree or disagree, their responses are presented in table 4.33

Table 4.33: Government Attitude to Performance of RIs

S/N	Response	FMST	FMARD	FME	No. of Respondents	% Respondents
1	Strongly Disagree	3	2	0	5	10.6
2	Disagree	9	3	1	13	27.7
3.	Agree	12	6	0	18	38.3
4	Strongly Agree	5	6	0	11	23.4
	Total	**29** (NR=1)	**17** (NR=1)	**1**	**47**	**100.0**

Source: Research Study, 2004

The analysis of the responses shows that 38.3% agreed that government feels that RIs were not performing up to expectations while 27.7% disagreed and 10.6% of the respondents strongly disagreed. On the aggregate, 61.7% agreed that government rating of RIs performance was low, while 38.3% holds a contrary view.

4.1**0 COMMUNICATION WITH SCIENTISTS AND THE PUBLIC**

The essence of communication has been emphasized as no scientific and technological progress could be achieved if research outputs are not made known to the public or end-users. Also, lack of effective communication among researchers and scientists will lead to duplication of efforts and waste of research resources.

Consequently, it was desirable to determine how effective the scientists communicate among themselves and with researchers outside the country including other critical stakeholders. The responses are presented in table 4.34.

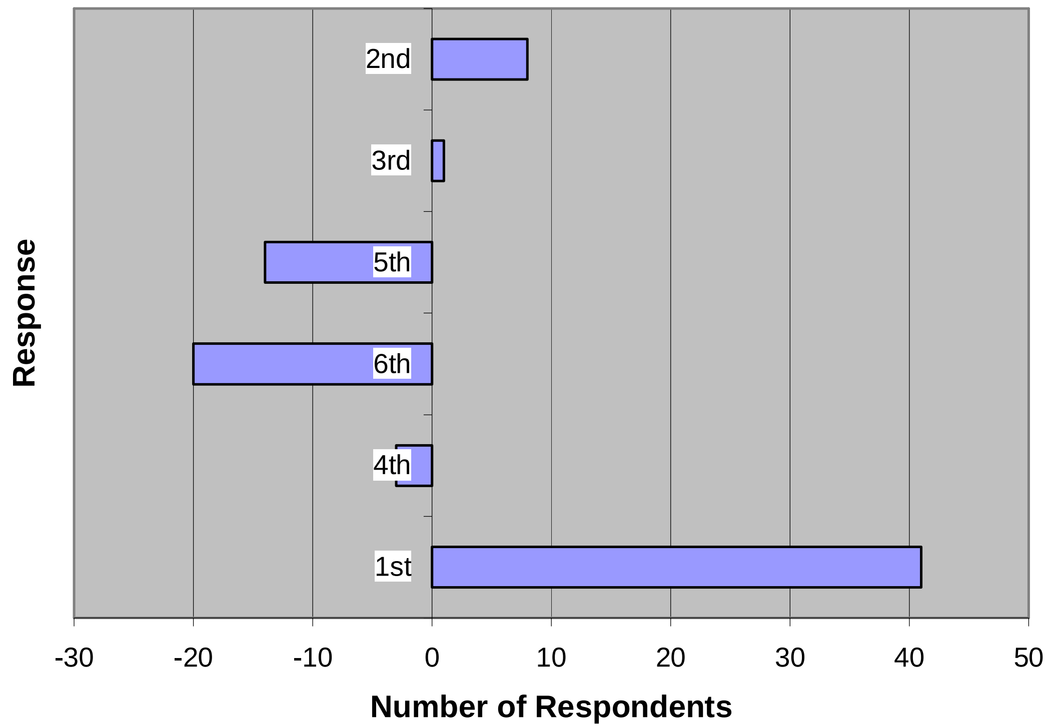
Table 4.34: Communication with Scientists and Public on R&D

S/N	Response	FMST	FMARD	FME	No. of Respondent	Ranking
1	Scientists in your institution	+24	+16	+1	41	1st
2	Scientists from other institutions in Nigeria	-7	+4	0	-3	4th
3.	Scientists from outside Nigeria	-15	-4	-1	-20	6th
4	Industries	-5	-9	0	-14	5th
5	Funding Agencies	-1	+1	+1	1	3rd
6	Private Client	+8	-1	+1	8	2nd

Source: Research Study, 2004

The analysis is well illustrated in figure 4.16.

FIGURE 4.16 **Communication with Scientists and Public on R&D**



The respondents overwhelmingly agreed that they do communicate effectively with their colleagues within their institutions. However, they were limited in communicating with scientists from other institutions in and outside Nigeria. Communication with funding agencies and private clients were effective.

CHAPTER 5

DISCUSSION OF THE RESULTS

5.1 INTRODUCTION

This chapter discusses the findings from the data analysis carried out in the preceding chapter and attempt to relate it to findings from other studies in similar areas. The underlying objective is to establish if the findings were in line with existing knowledge or provided an insight into new knowledge or opportunities that will be of interest to the society. Several issues were examined under the subject matter of this research work as they relate to impact of S&T policy to national development in Nigeria.

However, four core areas formed the focus of the discussion on the findings from the study which include the following:

- Characterization of science and technology in Nigeria, including the evolution of S&T and institutional capability for S&T activities.

- Science and technology policy, including S&T advocacy, its role as a determinant of development performance, societal awareness, policy process and institutional collaboration with S&T stakeholders.

- Science and technology literacy, including science and technology education, technology literacy and other emerging issues.

- Nature of R&D focus of science and technology research institutions, including strategies for strengthening R&D capability, identification of scientific breakthroughs, funding of R&D as well as research budget, obstacles affecting R&D and communication network among scientists in Nigeria.

5.1.1 **Responses to Questionnaire**

The analysis of the responses from the questionnaires distributed gives some level of confidence to the data generated from this study despite the obvious limitations to the study of this nature.

In order to undertake appropriate statistical analysis, a sample size of 100 questionnaires was considered reasonable and manageable. From the analysis of the responses, 95.0% level of confidence was achieved with a marginal error of 5%. This was considered similar to findings from other researchers (Saunders *et al* 1997 Ngesa *et al*, 2003).

The implication of this level of response is that there is every certainty that at least 95% of the samples would represent the characteristics of the population. It implies that the estimate for the population characteristics will be within 71±5% bearing in mind that the sampling fraction is 71.4%. The assumed sample size of 25 was not significantly different from the determined actual sample size of 26. The sample size of 25 used in the study is therefore, considered a fair representative sample size of the research institutes in Nigeria.

Also, the response rate of 49% achieved was considered to be within the threshold accepted by some researchers as valid. Response rates between 50% and 92% for questionnaire surveys have been reported as valid (Duman, 1978, Saunders *et al* 1997 and Ngesa *et al,* 2003) In a difficult environment where apathy for completing questionnaire is quite prominent, the response rate of 49% was considered reasonable and therefore, gives credibility and validity to the data used in the analysis.

5.2 **CHARACTERIZATION OF SCIENCE AND TECHNOLOGY IN NIGERIA.**

There is growing belief in Nigeria that science and technology have a role to play in national development and that this can be achieved through appropriate explicit policy. However, the nature of such policy that will bring the desired growth and development still remains contentious.

This study attempts to unravel the nature and orientation of S&T activities in the country with a view to identifying the possible impacts made on the society in the past eight decades of its evolution. The Nigerian situation in the evolution of S&T indicates an initial failure to recognize the critical role of S&T instruments to national development. The country lacked the science culture that is required to create awareness on the need to use scientific methods in economic activities.

The study identified the institutional framework for S&T development in Nigeria to include, research institutions, universities and polytechnics. Also, there is a very limited scientific research activity in the industries as well as lack of private research laboratories. Government is the major stakeholder and the public sector dictates the direction of research. The government is the major financier of S&T activities with limited or near absence of the private sector's contribution.

The contribution from non-governmental organizations has declined over the years. While the research institutes carry out mainly applied research and very limited basic research, the universities and polytechnics carry out basic research and science and technology education. Also, the government is the major source of funding for basic research. The number of research institutions in Nigeria is well over 35 including science and technology programmes and extension service institutions.

The study identified the Federal Ministry of Science and Technology, Federal Ministry of Agriculture and Rural Development, Federal Ministry of Environment, Federal Ministry of Health and Federal

Ministry of Industry and Education as the major stakeholders to S&T development in the country.

Most applied research activities take place in research institutions under Federal Ministries of S&T, agriculture, environment and health. The Federal Ministry of Science and Technology is statutorily responsible for coordinating S&T policy in all relevant areas but the funding of research through the Ministry is limited to those institutions under its jurisdiction.

It is pertinent to note that of the three tiers of government in Nigeria only the Federal Government oversees the development of S&T. The states, with the reception of a few, and local government councils have no S&T Ministries of commission and do not contribute to the funding of S&T to meet there development needs. This is an area that requires urgent attention and consideration to evenly spread scientific and technological development.

In this regard, the National Council for Science Technology Conference in Lafia, Nasarawa State of Nigeria in 2004 decided as an incentive to states that set up a Ministry of Science and Technology should be supported with computer facilities. The Raw Materials Research and Development Council was assigned the responsibility to meet this obligation.

In Brazil for instance, most states have secretaries for science and technology and legislation are implemented providing funds for research to be administered in most cases by specialized agencies (Schwartzman, 1993). The largest and oldest of these agencies, receives about 1 percent of the state revenues which in 1992 amounted to about 70 million dollars in addition to profits from its capital investments.

The National Council for Science Technology Conference in Lafia Nasarawa State of Nigeria in 2004 decided as an incentive to states that set up a Ministry of Science and Technology be supported with computer facilities.

5.2.1 Evolution of S&T in Nigeria

Some of Nigeria's scientific institutions date from the colonial era of late 19th century and early 20th century. From the research findings, the oldest research institutes dates over 80 years ago and are currently under the Federal Ministry of Agriculture and Rural Development. Also, the study revealed that the highest number of research institutes in Nigeria were established in the 1960s and 1970s.

The larger part of the current S&T capability was however built after independence between 1960 and 1990, a period characterized mainly by military rule. This trend is similar to the development pattern of S&T

in Brazil. Schwartzman (1991) reported that the greater part of the S&T capability in Brazil was built during the 1968-1980s in a period of military rule.

Three factors were identified to have contributed to the development of S&T institutions within this period. First was the concern of the military and civilian authorities with the need to build up the country's S&T competence as part of broader project of national growth and self-sufficiency.

The second, was the support received from the scientific community especially after the UNESCO Conference on Science and Technology in Africa called CASTAFRICA I and II in the 1970s.

Thirdly, the economic expansion at that time in which Nigeria's economy grew at an annual rate of about 7-10%, favoured the establishment of new institutions.

It is important to note that the S&T institutions inherited from the colonial masters and the new ones established after independence lacked the linkage with the productive sector.
This problem was reflected in the various development plans that characterized this period.

Invariably, most of the projects of scientific, technological and industrial self-sufficiency embarked during the 1st to 4th National Development Plans did not receive more than scattered support in the productive sector. In fact, they remained for the most part, restricted to special segments of the state bureaucracy and the academic community. This was the “missing link” between S&T and production in Nigeria and the difficulty was further accentuated due to lack of understanding of the effective mechanisms and policies leading to technological innovation in the productive sector. The need to strengthen the country’s basic technological infrastructure received only secondary attention in the mid-eighties.

5.2.2 Institutional Capacity for S&T Activities

The institutional capacity for S&T in the context of this study was examined from two major perspectives. First, was the staff strength distribution aimed at determining the research capability. Second, was the distribution of staff based on activities.

There is considerable installed S&T capacity in Nigeria both in terms of existing infrastructure, technical and human facilities. However, the study revealed that the capacities were very weak and seriously under-utilized.

The assessment of research strength indicated a limited number of personnel with requisite qualifications for effective research work. The greater numbers of personnel were support staff with limited research competence. In most of the research institutes, the number of staff with PhD was less than 20% of total research staff strength. The actual researchers in the 25 RIs studied constitute 30.7% of the overall R&D workforce. In a similar study carried out in some countries in sub-Saharan Africa (SSA), the general R&D workforce was 15% (Khalil, 2002).

UNESCO (1999) in a similar study in Nigeria reported that the percentage of researchers to overall R&D personnel was 10.4% while the percentage of support staff to all R&D personnel was 42.7%. This confirms the findings from this study as administrative staff constitute 54.7% of the research personnel in the RIs studied. From the research results, it was obvious that the distribution of research personnel in RIs was not favourable to effective R&D activities and therefore, hinders the quality of researches and its contribution to the development of Nigeria.

It must be borne in mind that R&D requires highly qualified and skilled personnel. Muturi (2002) observed that this caliber of skilled personnel requires substantial resources to develop and maintain and is in short supply in developing countries due to scarcity of resources.

The low level of research capacity was attributed to several factors of which the immigration of skilled researchers was significant. It has been reported that the poor state of research capacity in RIs in less developed countries was associated with immigration of skilled researchers to developed countries in search of better opportunities (Muturi, 2002, Khalil, 2002, Aredo, 2000). It has been reported that Nigeria has not less than 10,000 academics working abroad (Khalil, 2002).

It is equally estimated that about 30,000 scientists with PhD's from sub-Saharan Africa are working in the industrialized countries (Muturi, 2002, Sethi, 2000), This number was considered as the critical mass of talent that was needed to create sustainable development in SSA.

The prevailing situation in the RIs no doubt, resulted in the flight of skilled and experienced researchers from the country (**"External Brain Drain")** as well as movement to the private sector and non-research based public sector **("Internal Brain Drain").** The situation demands that the small number remaining need to be encouraged to stay if research resources are to be effectively utilized for economic and social development of the country. Fundamentally, more capacity need to be built while the existing personnel need to be trained in the art of translating R&D results into commercializable products and services.

The RIs are considered as institutional framework for transfer of viable technology for industrial production and other socio-economic activities. In order to ascertain the capacity of RIs to offer pertinent services to the society at large, the study evaluated their activities in terms of research, consultancy and extension services. The findings revealed that while more research activities were carried out, there were limited consultancy and extension services to the beneficiaries of research.

Capacity to render consultancy services among RIs was lacking despite the claim that they render such services. The major constraint was the lack of skilled personnel trained in this area. Also, the research orientation precludes entrepreneurial activities or initiatives. Generally, consultancy services rendered by some include pre-feasibility and feasibility studies preparation, market studies and reviews, equipment sourcing and brokerage services. Also, studies to determine whether or not projects were likely to be viable on the basis of a preliminary consideration of technologies, technical problems and costing were occasionally carried out.

The study confirmed the extensive extension services rendered by the agricultural research institutions relative to those from science and technology. It was established that while considerable researches goes on in the S&T research institutions, there was limited technology extension services. Technology extension services however, help research institutes to disseminate research findings and build national capacities in S&T. Extension services demand informal training of beneficiaries or client, advisory services and other support services. It also entails awareness creation, information provision, and application of technology, its trial and adoption.

Generally, industrial extension services aim at enhancing accessibility to technology and accumulation of technological capabilities (Ngesa *et al* 2003). Industrial extension service is also considered primarily as linking research and development agencies with industrial firms (Triffin, 1994). The linkage function of extension services has been emphasized for institutions considered to be “repositories of tacit knowledge such as–universities, laboratories and research institutes” (Ayiku, 1990, Desai, 1993). Extension services demand qualified personnel, equipment and facilities and financial resources which were lacking in the operating environment of local research institutions in Nigeria.

Tiffin (1994) noted that for extension services to achieve their desired goals of promoting accessibility to technology, adoption of innovations and integration of technology, they need to encourage firms to desire, receive and use technology. Extension services are particularly valuable to SMEs as most of them lack the levels of resources required to engage in their own R&D activities (Ngesa et al 2003).

On the organizational mission and vision of the RIs, it was established that most of them were set up to fulfill specific objectives arising from well defined needs. The main focus of research was in agriculture as research in industry related activities was quite limited.

The findings confirmed similar observations made on orientation of research in sub-Saharan Africa with respect to the absence of strong linkages between research and economic production. This partly explains why resources were not heavily invested in industry compared to agriculture (Khalil, 2002).

Reflecting back on the historical development of research as vividly discussed, the study confirmed the fact that, tradition of agricultural research in Nigeria traces its roots to the colonial period. Since the early 1920s when the first research institutes were established by the colonial masters, the orientation of research activities has largely been commodity-specific.

In summary, the strengths and weaknesses of S&T capacities in Nigeria show that while the general strength lie in the existence of institutional framework already established for scientific research, the major weaknesses include the following:

- lack of a comprehensive set of science and technological indicators to guide action and monitor progress;

- ineffective planning, programming, dissemination and coordinating functions of research institutions;
- poor utilization of R&D results;
- poor remuneration of scientists;
- general obsolescence of infrastructure, research facilities and other support facilities;
- limited participation of the private sector in S&T activities, and
- lack of inspiring leadership.

5.3 **SCIENCE AND TECHNOLOGY POLICY**

Successive governments in Nigeria over the years have emphasized the overwhelming significance of scientific and technological change in the development process. At various fora, government has expressed its desire to promote scientific and technological development in a bid to accelerate economic change. Science and technology policy is therefore recognized as a veritable instrument for achieving economic development if well implemented.

Policy has been defined as a "statement of the goals and objectives of an organization or a state in relation to a particular subject matter as well as description of the strategies for achieving those goals and objectivities (Salako,1999). Policy making therefore covers everything relating to the preparation and taking of decisions of concern to the state, together with the monitoring of their execution, evaluation of the results of government activities and possible feedback from the decisions taken (UNESCO, 1979).

5.3.1 **Science and Technology Advocacy**

From the study, it was discovered that prior to 1986 when the first National Policy on S&T was enunciated, scientific and technological activities were carried out implicitly without well defined national direction. It is against this background that the 1986 National Policy on S&T was established to provide the desired direction and coordination for scientific and technological activities.

The philosophy for the National Policy on S&T affirmed that it shall form the basis of Nigeria's development and shall influence the thinking and working process. However, the findings from the study show that majority of the respondents who are scientists, researchers were aware of the existence of the S&T policy but that the policy was not accessible to them and the society. This observation call to question the societal relevance of S&T.

5.3.**2 Societal Awareness of S&T Policy in Nigeria**

The term "society" refers to the larger context of a society including its needs and wants as well as its rational decision-making structures (including political, legislative, administrative and consultative) and related corrective feed-back processes (UNESCO, 1979).

It is obvious that though the national S&T policies have been explicitly formulated and its inclusion in national development plans being promoted, it was clear that such policies were still not to the knowledge of the citizenry. It can be said that the policy document was restricted, albeit, unconsciously to the federal ministry of science and technology. The greater society were not aware and do not contribute to the policy formulation process.

The study suggested the need to review the traditional processes for defining national goals, developing S&T policy and integrating it into national development plans; the administrative, scientific and political structures in which this development has taken place; the means for implementing policies and achieving objectives and finally, the standards for and method of evaluating the results of policy implementation.

The necessity for further research in this area and the need to promote new methods for generating societally relevant research was recognized from the study and recommended. The study revealed that the existing explicit S&T policies were formulated almost exclusively by government officials and research scientists and engineers which call to questions its acceptability by other stakeholders outside the S&T family.

Also, it was noted that the policies were almost exclusively concerned with technological, industrial and economic development. It is therefore clear that these factors alone were not conducive to generating policies of high “societal relevance”. The study called for a broadened involvement of the citizenry in all walks of life which should be viewed as a measure of the success of S&T policy formulation.

Also, part of the factors identified to be responsible for lack of awareness of the existence of S&T policy was the level of S&T literacy. This issue is examined in subsequent section of the report. The society no doubt, has a significant role to play in shaping the direction of S&T development. The recognition of this informed this aspect of the study to ascertain the perception of the Nigerian society of the key role of S&T to national development.

The study revealed that the Nigerian society was not aware of S&T policy and do not contribute to its formulation. Abiodun (1999) observed that the Nigerian society lacks an in-depth understanding of the role of S&T in national development plans. Coopers (1978) remarked that the level of awareness and appreciation of the importance of technology have influenced considerably the development of most societies and countries of the world.

Therefore, the perception of the influence of society on technology development gives credence to the social function of science and technology in relation to the emergence of industrialized economy (Nsa, 2003).

Considering the weighty nature of this finding, it was subjected to statistical analysis in order to validate the hypothesis stated earlier.

Testing of Hypothesis on Societal Awareness of Science and Technology Policy in Nigeria.

The data provided from the responses by the researchers interviewed in the study is presented in table 5.1. The expected frequencies of the responses computed from table 5.1 is presented in table 5.2.

Table 5.1: Observed Frequencies of Responses on Societal Awareness of Nigerians of S&T policy.

S/N	Response	FMST	FMARD	FME	Total
1	Agree	20	15	1	36
2	Disagree	9	2	0	11
3	No Idea	1	1	0	2
4	Total	30	18	1	49

To determine expected frequencies of response, the following equation is applied:

$$Eij = \frac{nixnj}{n}$$

n = 49, i=row total, j=column total

Table 5.2: Expected Frequencies of Responses on Societal Awareness of Nigerians of S&T policy

S/N	Response	FMST	FMARD	FME
.	Agree	$\frac{36x30}{49}$ (22.04)	$\frac{36x18}{49}$ (13.22)	$\frac{36x1}{49}$ (0.73)
2	Disagree	$\frac{11x30}{49}$ (6.73)	$\frac{11x18}{49}$ (4.04)	$\frac{11x1}{49}$ (0.22)
3	No. Idea	$\frac{2x30}{49}$ (1.22)	$\frac{2 x18}{49}$ (0.73)	$\frac{2x1}{49}$ (0.04)

Source: Research study, 2004

HYPOTHESIS I

Ho: The Nigerian society is not aware of and do not contribute to the formulation of S&T policy.

H_I: The Nigerian society is aware of and do contribute to the formulation of S&T policy.

To test the hypothesis, the following chi-square equation is applied:

$$X^2 = \sum_{J=i}^{nc} \frac{(\text{observed} - \text{Expected})^2}{\text{Expected}}$$

	FMST		FMARD		FME
A. Agree	$\frac{(20-22.04)^2}{22.04}$	+	$\frac{(15-13.22)^2}{13.22}$	+	$\frac{(1-0.73)^2}{0.73}$
	(0.189)		**(0.240)**		**(0.100)**
B. Disagree	$\frac{(9-6.73)^2}{6.73}$	+	$\frac{(2-4.04)^2}{4.04}$	+	$\frac{(0-022)^2}{0.22}$
	(0.766)		**(1.030)**		**(0.220)**
C. No Idea	$\frac{(1-1.22)^2}{1.22}$	+	$\frac{(1-0.73)^2}{0.73}$	+	$\frac{(0-0.04)^2}{0.04}$
	(0.040)		**(0.100)**		**(0.040)**

X^2 cal= 0.189+0.240+0.100+0.766+1.030+0.220+
0.040+0.100+0.040

X^2 cal = 2.725

Decision Rule

Reject Ho at 0.05, if the computed value of X^2 is greater than X^2 tabulated at (r-1) (c-1) degree of freedom (d.f)

R=3, c=3, d.f = (3-1)(3-1) = 4
X^2 tab 0.05 (d.f=4) = 9.488

Since X^2 calculated (2.725) was less than X^2 tabulated (9.488) we accept the hypothesis at 0.05 level of significance. The statistical test of the hypothesis further confirmed the finding that the Nigeria society was not aware of and do not contribute to the formulation of S&T policy.

5.3.3 Science and Technology as Critical Determinants of Development Performance in Nigeria.

A wide variety of different policies have been pursued in an effort to foster technological development with the aim of accelerating the pace of economic development (Westphal, 2002). In assessing the impact of S&T policies on national development the questions to ask include, has S&T policy been a critical determinant of development performance?, if so, in what way and for what reasons?; what are the elements of an effective science and technology strategy and how are they best translated into operational policies?.

These questions were partially answered through the findings from the study. With particular reference to Nigeria, it is believed that science and technology have not been critical determinants of development performance. The finding was further subjected to statistical analysis in order to validate the hypothesis stated in respect of S&T as determinants of development performance.

Testing of Hypothesis on Science and Technology as Determinants of Development Performance in Nigeria.

The data from the respondents represent the observed frequencies of responses and are presented in table 5.3. From this data, the expected frequencies of responses were computed as presented in table 5.4.

Table 5.3 Observed Frequencies of Responses on S&T as Determinant of Development Performance.

S/N	Response	FMST	FMARD	FME	Total
1	Yes	9	9	1	19
2	No	21	8	0	29
	Total	30	17 (NR=1)	1	48

Source: Research study, 2004 N.R = No response.

To determine the expected frequencies, the following equation was applied:

$$E_{ij} = \frac{n_i x n_j}{n}, \quad \text{where } n\ 48,\ I = \text{row total } j = \text{column total}$$

Table 5.4 Expected Frequencies of Responses on S&T as Determinant of Development Performance

S/N	Response	FMST	FMARD	FME
1	Yes	$\frac{19x30}{48}$ (11.88)	$\frac{19x17}{48}$ (6.73)	$\frac{19x1}{48}$ (0.40)
2	No	$\frac{29x30}{48}$ (18.13)	$\frac{29x17}{48}$ (10.27)	$\frac{29x1}{48}$ (0.60)

Source: Research study, 2004

HYPOTHESIS 2

Ho: Science and technology policy has not been a critical determinant of development performance in Nigeria.

H_1: Science and technology policy has been a critical determinant of development performance in Nigeria.

To test the hypothesis, the following chi-square equation was applied.

$$X^2 = \sum_{J=I}^{nc} \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

	FMST		FMARD		FME
A. Yes =	$\frac{(9-11.88)^2}{11.88}$	+	$\frac{(9-6.73)^2}{6.73}$	+	$\frac{(1-0.40)^2}{0.40}$
	(0.70)		**(0.77)**		**(0.9)**
B. No =	$\frac{(21-18.13)^2}{18.13}$	+	$\frac{(8-10.27)^2}{10.27}$	+	$\frac{(0-0.60)^2}{0.60}$
	(0.45)		**(0.50)**		**(0.60)**

X^2 cal = 0.70+0.77+0.9+0.45+0.50+0.60
= 3.92

Decision Rule

Reject Ho at 0.05 if the computed value of X^2 is greater than the tabulated value of X^2 (0.95) at (r-I) (c. I)degree of freedom.
r=2, c=3
Degree of freedom) (d. f)= (2-1)(3-1) =2
X^2 tabulated (d. f=2) =5.991

Since X^2 calculated (3.92) was less than X^2 tabulated (5.991) we accept the hypothesis that “Science and Technology policy has not been a critical determinant of development performance in Nigeria at 0.05 levels of significance.

This invariably confirmed statistically, the validity of the finding. Various reasons were given to support the view that S&T policy is not a critical determinant of development in Nigeria. The major reasons given include the following:

- Political considerations are determinants of development performance rather than S&T policy.
- There is no support for S&T policy and its popularization for impact on national development to be felt.
- The emphasis on consumption and importation of goods rather than production based on technology has alienated S&T from the development process.
- Science and technology policy is on paper as its implementation has not made any meaningful impact on development.
- Development is influenced by budget and budgetary allocations to S&T have not reflected critically its priority position in the development agenda of the country.
- Government does not give priority to S&T and past development plans have excluded S&T policy.
- The perceived stakeholders, both the public and private sector; lack awareness of S&T policy and therefore, could not influence development planning process.

- Dependency on importation of technology and human capital for national projects made national S&T policy inconsequential.

- Science and technology policy has not empowered small and medium enterprises (SMEs) considered as the engine of growth and development.

Further on this issue while it was established that S&T contributes to competitiveness and economic growth, however, its role in national development in Nigeria was not clear. Most of the respondents were of the opinion that S&T policy has not played the desired role in national development. Their response was further subjected to statistical analysis using chi-square test in order to validate the hypothesis.

Testing of Hypothesis on Role of S&T policy on National Development of Nigeria.

The data derived from the analysis to the response represent the observed frequencies (Table 5.5). From this data, the expected frequencies were computed (Table 5.6).

Table 5.5 Observed Frequencies of Responses on role of S&T Policy on National Development of Nigeria.

S/N	Response	FMST	FMARD	FME	Total
1	Agree	23	13	0	36
2	Disagree	6	5	1	12
3	No Idea	1	0	0	1
4	Total	30	18	1	49

Source: Research Study, 2004

To determine the expected frequencies, the following equation was applied:

$$Eij = \frac{nixnj}{n}$$

n = 49, i = row total, j = column total

Table 5.6 Expected Frequencies of Responses on Role of S&T Policy on National Development of Nigeria

S/N	Response	FMST	FMARD	FME
1	Agree	$\frac{36x30}{49}$ (22.04)	$\frac{36x18}{49}$ (13.22)	$\frac{36x1}{49}$ (0.73)
2	Disagree	$\frac{12x30}{49}$ (7.35)	$\frac{12x18}{49}$ (4.41)	$\frac{12x1}{49}$ (0.24)
3	No. Idea	$\frac{1x30}{49}$ (0.61)	$\frac{1 x18}{49}$ (0.37)	$\frac{2x1}{49}$ (0.02)

Source: Research Study, 2004

HYPOTHESIS 3

Ho: Science and technology policy has not played a critical role in national development of Nigeria

H_I: Science and technology policy has played a critical role in national development of Nigeria.

To test the hypothesis, the following equation is applied:

$$X^2 = \sum_{J=I}^{nc} \frac{(Observed - Expected)^2}{Expected}$$

	FMST		FMARD		FME
A. Agree	$\frac{(23-22.04)^2}{22.04}$	+	$\frac{(13-13.22)^2}{13.22}$	+	$\frac{(1-0.73)^2}{0.73}$
	(0.042)		**(0-004)**		**(0.730)**
B. Disagree	$\frac{(6-7.35)^2}{7.35}$	+	$\frac{(5-4.41)^2}{4.41}$	+	$\frac{(1-0.24)^2}{0.24}$
	(0.248)		**(0.079)**		**(2.407)**
C. No Idea	$\frac{(1-0.61)^2}{0.61}$	+	$\frac{(0-0.37)^2}{0.37}$	+	$\frac{(0-0.02)^2}{0.02}$
	(0.249)		**(0.370)**		**(0.020)**

X^2 cal= 0.042+0.004+0.730+0.248+0.079+2.407+ 249+0.370+0.020
= 4.149

Decision Rule

Reject Ho at 0.05 if the computed value of X^2 is greater than X^2 tabulated at (r-1) (c-1) degree of freedom (d.f).
r = 3, c = 3
d.f = (3-1) (3-1) = 4
At X^2 0.05 (d.f =4) = 9.488

Since X^2 calculated (4.149) was less than X^2 tabulated (9.488) we accept the hypothesis that "Science and technology policy has not played a critical role in national development of Nigeria" at 0.05 level of significance.

The statistical analysis confirmed the finding on the role of S&T policy on national development of Nigeria. The reasons given by respondents to support their opinion on the subject include the following:

- Science and technology have been relegated to the background over the years in relation to allocation of resources for development.

- National projects embarked on during the various phases of the development plan did not consider building technological capacities.

- Lack of technological infrastructure limited the role of S&T in the national development of Nigeria.

- Poor governance and its negative impact on S&T policy affected national development.

- Lack of commitment and will power on the part of policy implementors as S&T policy lacked continuity in its implementation.

- Poor investment capability on S&T.

- Research and development outputs are not properly utilized leading to low industrial output.

- There is no linkage between research institutes and industry which affected wealth creation.

- The continued importation of finished products and spare parts reflects a weak S&T structure which hinders national development.

- Lack of national framework of indicators for measuring S&T capacities which affects determination of progress made.

- Poor S&T policy planning process and lack of need-driven S&T policy.

- Very weak linkage between S&T policy and industrial policy.

The demand for innovations in industry and agriculture was considered as critical factor for emergence of impact-oriented S&T policy. Westphal (2002) observed that the essentiality of early agricultural development has fundamental implications for overall science and technology development strategy.

The findings from the study confirm the statement that lack of demand for innovations in industry and agriculture is not safety responsible for inability of S&T to impact on national development. Although innovation acts as a pull and push factor that drives demand for S&T, there are other factors that influence the impact of S&T on development.

Testing of Hypothesis on Impact of Demand for Innovations in Industry and Agriculture on National Development.

The data derived from the analysis to the response represent the observed frequencies (Table 5.7). From this data, the expected frequencies are computed (Table 5.8).

Table 5.7 Observed Frequencies of Responses on Impact of Lack of Demand for Innovation in Industry and Agriculture on National Development.

S/N	Response	FMST	FMARD	FME	Total
1	Yes	17	8	0	25
2	No	12	9	1	22
3	No Idea	1	1	0	2
4	Total	30	18	1	49

Source: Research Study, 2004

To determine the expected frequencies, the equation stated

below was applied.

$$Eij = \frac{ni \times nj}{n}$$

n = 49, i = row total, j = column total

Table 5.8 Expected Frequencies of Responses on Impact of Lack of Demand for Innovations in Industry and Agriculture on National Development.

S/N	Response	FMST	FMARD	FME
1	Yes	$\frac{25x30}{49}$ (15.31)	$\frac{25x18}{49}$ (9.184)	$\frac{25x1}{49}$ (0.510)
2	No	$\frac{22x30}{49}$ (13.47)	$\frac{22x18}{49}$ (8.08)	$\frac{22x1}{49}$ (0.45)
3	No. Idea	$\frac{2x30}{49}$ (1.22)	$\frac{2 x18}{49}$ (0.73)	$\frac{2x1}{49}$ (0.04)

Source: Research Study, 2004

HYPOTHESIS 4

Ho: Lack of demand for innovations in industry and agriculture is not responsible for inability of S&T to impact on national development

H_1: Lack of demand for innovations in industry and agriculture is responsible for inability of S&T to impact on national development.

To test the hypothesis, the equation stated hereunder was applied.

$$X^2 = \sum_{J=I}^{nc} \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

	FMST		FMARD		FME
A. Yes =	$\frac{(12-15.31)^2}{15.31}$	+	$\frac{(8-9.184)^2}{9.184}$	+	$\frac{(8-0.510)^2}{0.510}$
	(0.187)		**(1.402)**		**(0.570)**
B. No =	$\frac{(12-13.47)^2}{13.47}$	+	$\frac{(9-8.08)^2}{8.08}$	+	$\frac{(1-0.45)^2}{0.45}$
	(0.160)		**(0.105)**		**(0.672)**
C. No idea	$\frac{(1-1.22)^2}{1.22}$	+	$\frac{(1-0.73)^2}{0.73}$	+	$\frac{(0.0.04)^2}{0.04}$
	(0.040)		**(0.010)**		**(0.040)**

X^2 calculated = 1.437 + 3.683 + 0.470 + 1.483 + 0.100 + 0.040
= 7.213

Decision Rule

Reject Ho at 0.05 if the computed value of X^2 calculated is greater than X^2 tabulated at (r-1) (c-1) degree of freedom (d.f).
R= 3, c = 3
d.f = (3-1) (3-1) = 4
X^2 tabulated 0.05 (d.f = 4) = 9.488

Since X^2 calculated (3.126) was less than X^2 tabulated (9.488), we accept the hypothesis at 0.05 levels of significance that lack of demand for innovations in industry and agriculture is not responsible for inability of S&T to impact on national development.

It is pertinent to note from this finding that while it was expected that lack of demand for innovation in industry and agriculture is responsible for inability of S&T to impact on national development, the converse was the case. This implies that though innovation is a necessary factor for S&T development, it is not the most critical factor as some other factors contribute towards ensuring that S&T impact on development.

5.3.4 **Policy Process**

In Nigeria, over the years, several policies covering different sectors of the economy have been established to guide the development process. Emovon (1999) observed that science and technology policy which aimed at directing and coordinating R&D towards meeting the needs of the society especially in the field of agriculture, industry, health, etc, has had chequered history of evolution.

He further argued that without a solid S&T policy, industrial policy will be nothing but the promotion of commerce. Industrial policy, he observed, requires increased productivity predicated on intensive research into local raw materials as input to manufacturing and the acquisition of engineering design, fabrication skills as well as adaptation of modern technologies and machinery.

Ohaba (2001) informed that policy formulation has been recognized as a veritable component of organizational decision-making process. He further stated that a good policy framework must therefore have a vision and mission as well as a research philosophy or orientation.

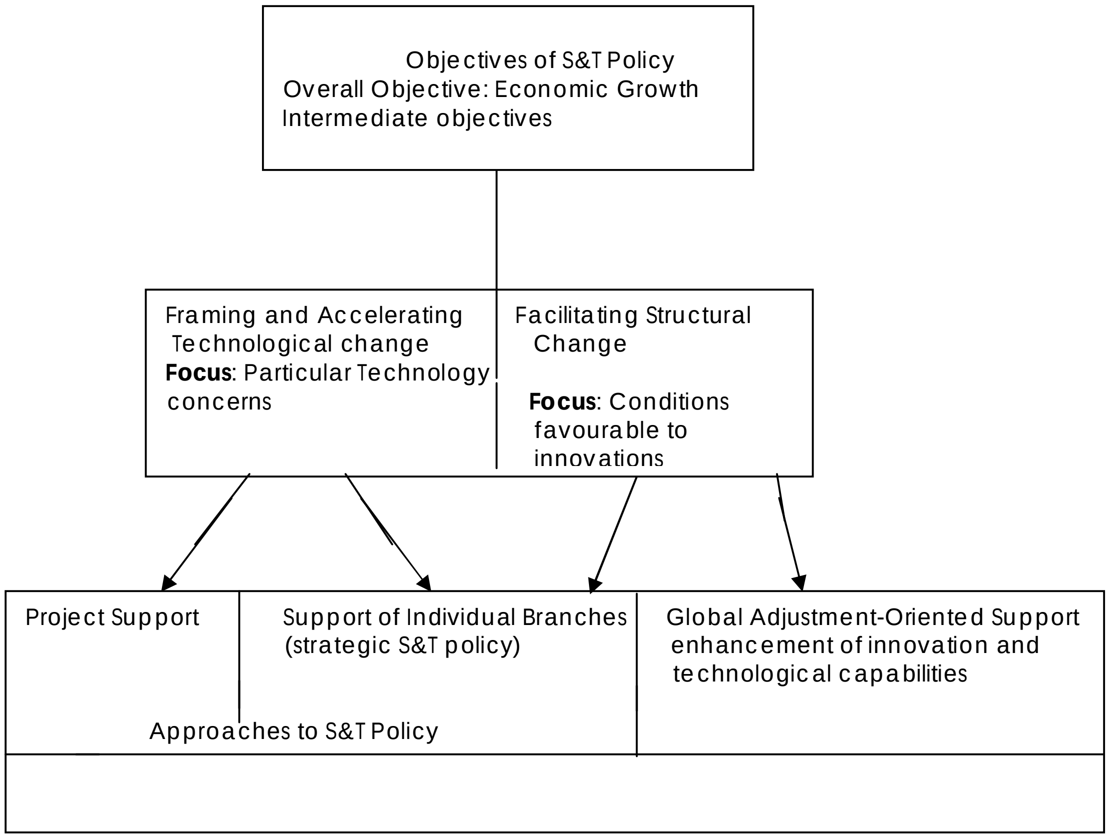
The study identified three policy processes and evaluated them to determine the ideal policy process for adoption in formulating a national S&T policy framework. The three policy processes were minor, major and integrated policy processes. The findings indicate that integrated policy process was more preferred, which implies developing new explicit policy strategy. However, minor policy process which entails restructuring of existing programme was equally desirable. Policies should be dynamic and should be reviewed and modified as newer opportunities and challenges manifest (Nsa). Also, policies must have objectives which will give insight into the anticipated achievements in their implementation (Nsa, 2003).

In reviewing the 2003 National S&T policy document, two intermediate objectives of S&T policy were identified which may be essentially pursued by the following three distinct approaches:

- promotion of individual projects,
- support of particular branches of S&T and
- global adjustment-oriented support.

These approaches are illustrated in figure 5.1

Figure 5.1: Objectives of and Approaches to S&T Policy



Source: Adapted from Ahrens (2002).

While the overall objective is economic growth, the intermediate objectives are framing and accelerating technological change and facilitating structural change.

The national S&T policy of Nigeria enunciated in 2003 took into consideration the three distinct approaches as some specific individual project such as the satellite (space) project was embarked on while support was given to information technology and biotechnology development through the establishment of institutional frameworks for implementation of policies in these areas.

In pursuant of the implementation of the 2003 S&T policy, concerted efforts were made to build national technological capabilities and enhancement of innovation conditions. For instance, in implementing the space programme, government trained Nigerian scientists and engineers to acquire capability to manage the satellite system. These scientists were involved in the design and building of all the subsystems of the Nigeria Sat-I micro – satellite.

Consequently, a team of skilled space scientists and engineers which formed the nucleus of Nigeria space capacity building for subsequent generations of satellites was developed. It is obvious that the design of a national S&T policy will often result in a policy mix reflecting diverse objectives and interests. Ahrens (2002) suggested that in order to ensure the coherence, consistence and efficiency of technology policies, policy makers are advised to adhere to the following principles designed to strengthen the competitiveness of economies.

a. The concept of network development and competence centres aimed at increasing the efficiency of national innovation systems. The concept implies that each organization of a country’s innovation system may become part of a competence centre that links innovative enterprises, research organizations and government agencies to form what is called the “triple helix”. This new type of cooperation between government, academia and industry combines cooperative elements of economic and political exchange with efficient competitive processes. The concept requires stakeholders who interact independently within a given institutional framework.

b. The principle of “learning research organization” which emphasizes the need for a substantial degree of organizational and managerial flexibility in order to process gained experiences and new information and meet the changing research objectives that evolved in the course of economic development.

c. The principle of competition requires that government establish a market-oriented regulatory and legal framework to enhance competition among the organizations of the innovative system. Competition is very critical in period of scarce public resources used to support various stakeholders of the innovation system. The existence of sufficiently flexible network structures comprising government agencies, research organizations and private enterprises is imperative for national development.

d. The principle of lean research organizations seek to avoid bureaucratic rigidities, especially time-consuming administrative procedures which hinder the fast achievement, utilization and commercial exploitation of research results. Research organizations are self-organizing entities that should not be evaluated according to formally correct administration procedures but according to their research performance (Witt, 1997).

e. The principle of continuous evaluation holds that no organization should survive if it does not succeed in the market or lacks scientific technological reputation.

The principle calls for restructuring of the existing S&T infrastructure especially the institutional framework to make them more competitive in an emerging and dynamic global environment.

Having considered the importance of policy objectives in policy formulation, it is desirable to elucidate further the findings from this study in respect of the policy process. Three phases of policy process were identified from the critique on national S&T policy formulation. These include the following:

- strategy formulation
- programme identification and design
- programme implementation and assessment.

The findings were line with policy processes reported by Bartzokas and Teubal (2002).

Table 5.9: S&T Policy Process-Phases (productive sector directed)

S/N	Phase	Objective	Tasks-activity	Outcome
1	Upstream-Strategy Formulation	Formulate an Explicit Strategy	Search, Research & Interaction (Stakeholders and experts), generating vision/strategy	Set of priorities in science and technology and for the productive sector
2	Downstream-program identification and Design	Design of an important new program	Identifying the set of programs; preliminary design; trial implementation, trial design.	A set of programmes and programme designs which “fit” priorities.
3	Downstream programme implementation; Assessment	Successful implementation and learning	Full implementation; operational adjustments research on impacts and on success/failure factors.	Contribution to productive sector restructuring; New information about ” Policy Needs”

Source: Adapted from Bartzokas and Teubal, 2002

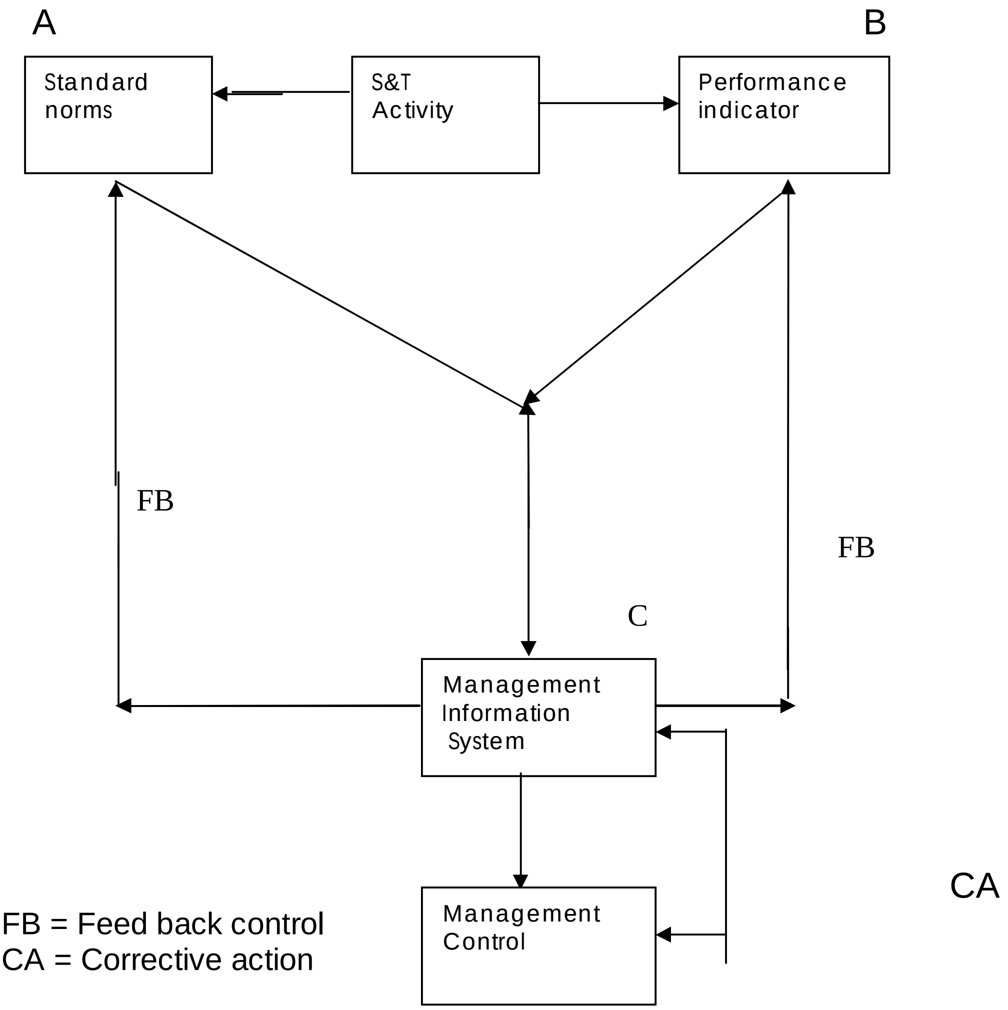
Table 5.9 shows a number of steps or activities that lead to policy formulation and implementation. There are three phases in policy process design which include the upstream-strategy formulation, downstream programme identification and design and downstream programme implementation assessment. The formulation process entails activities such as research and interaction with stakeholders and experts thereby generating a vision and strategy to achieve the vision. The vision and strategy are translated into set of priorities.

The next phase is to identify programmes which would promote the set priorities and design of these programmes. The final phase entails the implementation of the programmes and impact assessment. The feedback from the impact assessment may influence both priorities and specific programme design. S&T policy must be dynamic and should take into consideration the changing frontiers of S&T within and outside the country.

The control theory can be applied in the explanation of policy process formulation. The design of the policy process should endeavour to encorporate a feedback control mechanism so as to ensure that minor, major or integrated policy processes can be considered as the need arises.

The control theory is based on a constant comparison between the established norms by which S&T activities should be performed and performance indicators which actually show how the same activities are carried out or the impact it made. The model of control theory approach is illustrated in figure 5.2

Figure 5.2: Model of Control Theory Approach to S&T Policy.



FB = Feed back control
CA = Corrective action

The special features of the model include:

i) Standard norm for activity (A)
ii) performance indicator for activity (B)
iii) Management Information System (c) to report on the feed back (FB) which is a function of (i) and (ii); and
iv) Management control to take corrective action (CA) which in turn is a function of (iii).

This implies that the model anticipates that a continual effort should be made to keep track of the performance indicators for S&T policy activities which are used for constant comparison with the standard norms established for the same activities. With this model, the implementation of S&T policy could be monitored to ensure that it is on track. It is expected that over the time, the performance of S&T policy could be evaluated.

It will be recalled that three basic types of policy process were identified which include, minor, major and integrated processes.

Table 5.10: Type of Policy Process

Type of Policy Process	Objective	Phases Involved
Minor	Restructuring of Existing Program	3
Major	Design and Implementation of Important New Program	2to3
Integrated	A New Explicit Strategy; A Reconfiguration Program Portfolio and Implementation	Many different combinations

Source: Adapted from Bartzokas and Teubal, 2002
2 = Downstream Programme Identification and Design
3 = Downstream Programme Implementation and Assessement

A minor policy process involves programme implementation and feedback. It concerns a programme already being implemented over which new decisions have to be made about budgets, structure of incentives and other matters of implementation (Bartzokas and Teubal, (2002). Often, the outcome would be changes in program implementation and possibly, minor changes in program design. Minor policy process therefore, deals exclusively with downstream phases of the policy, especially the program implementation phase. The minor policy process repeats itself as part of program implementation.

The integrated policy process involves all three phases of upstream and downstream phases. Integrated policy process is informed by radical changes in the environment facing a country and information acquired in respect of the changes (Bartzokas and Teubal, 2002). The 1986 national science and technology policy was formulated and implemented for a very long time with minor and major policy changes. However, in 2003 an integrated policy process was adopted based on changes in the S&T environment. The resulting new S&T policy had a wider scope and include areas such as biotechnology, information technology, space technology, etc, hitherto, not covered by the 1986 S&T policy document.

The radical change in the S&T environment resulted to a new vision and strategy with emerging new priorities. These new priorities led to policy activity in both downstream phases; the design of new programs and their implementation. The classical examples include, the information and communication technology (ICT) programme, biotechnology programme and the space technology programme.

The Nigeria Sat-1 was launched within a period the 2003 S&T policy was formulated. The satellite which is an Earth Observation Micro-Satellite was successfully launched on 27th September, 2003 in Plesetsk, Russia (FMST, Ministerial Press briefing, 2004). Also, in promoting ICT the Federal Ministry of Science and Technology launched in March 2003, the Mobile Internet Unit used as an IT training and cyber centre.

The internet access was achieved with the aid of a VSAT (Very Small Aperture Terminal) equipped with a 1.2m dish mounted on the roof of a bus. Also, the establishment of Bioresources Development Centre at Odi, Bayelsa State for the purpose of developing the rich bioresources of the Niger-Delta region is one of the programmes that emerged from the new policy initiatives of FMST.

It is obvious from the examples cited that the integrated approach adopted in the formulation of 2003 S&T policy resulted in a new portfolio of programmes (and institutions) involving a subset of new programmes of various kinds, both horizontal and targeted programmes. There is no doubt that radical changes in the environment such as IT revolution, space research, necessitated a shift towards an integrated policy process rather than a continuation of the prevailing minor policy processes associated with the operations of 1986 S&T policy.

5.3**.5 Collaboration between FMST and Key Stakeholders**

The study established the importance of collaboration between the various stakeholders responsible for S&T policy formulation and implementation. The whole essence of studying this aspect is to establish the relationship between governance and S&T policy formulation and implementation. The stakeholders identified in the collaborative efforts at formulating and implementing S&T policy include the FMST, policy makers as well as legislators, administrators, academicians, organized private sector, etc.

While it was established that the Federal Ministry of Science and Technology effectively collaborated with other stakeholders, some issues emerged which were emphasized by the respondents
(Table 5.11).

Table 5.11: Reasons For and Against the Effectiveness of Collaboration between FMST and Key Stakeholders

S/N	Support	Against
1	FMST has been pursuing collaborative programmes as one of its core mandates, irrespective of initial poor response from opinion moulders.	1.Bureaucracy has often weighed down FMST and as such cannot collaborate with other stakeholders effectively.
2.	FMST and its agencies have sponsored considerable number of researches in Universities.	2. Current efforts in reaching out are not effective as interaction with other stakeholders is not impressive.
3	Stakeholders' committee meetings, round table discussions and conferences are often organized by the ministry.	3, Institutional linkages of FMST are constrained by poor funding and therefore cannot be effective.
4	Collaboration has been achieved through trade fairs, exhibition, seminars and workshops.	4. FMST lacks the fund, will and requisite orientation for effective collaboration.
5.	Science summits are organized periodically.	5. The Ministry lack skilled personnel, especially scientists that can initiate positive collaborative programmes.
6	FMST has always encouraged linkages with the private sector entrepreneurs through its agencies such as RMRDC, NOTAP, etc	6. There has been very limited coordination of National R&D activities by FMST, due to ineffective collaboration.
7	FMST has collaborated with various ministries such as Education; on science education, Health; on HIV/AIDs, Power and Steel on production of electric insulators for NEPA, Environment and Agriculture on Nigerian Satellite (ST-I)	7. Poor communication network of its programmes apart from the usual Ministerial Press Briefings.
		8. The Ministry do not appoint industrialists as Chairmen and Board members of parastatals under it.

Source: Research Study, 2004

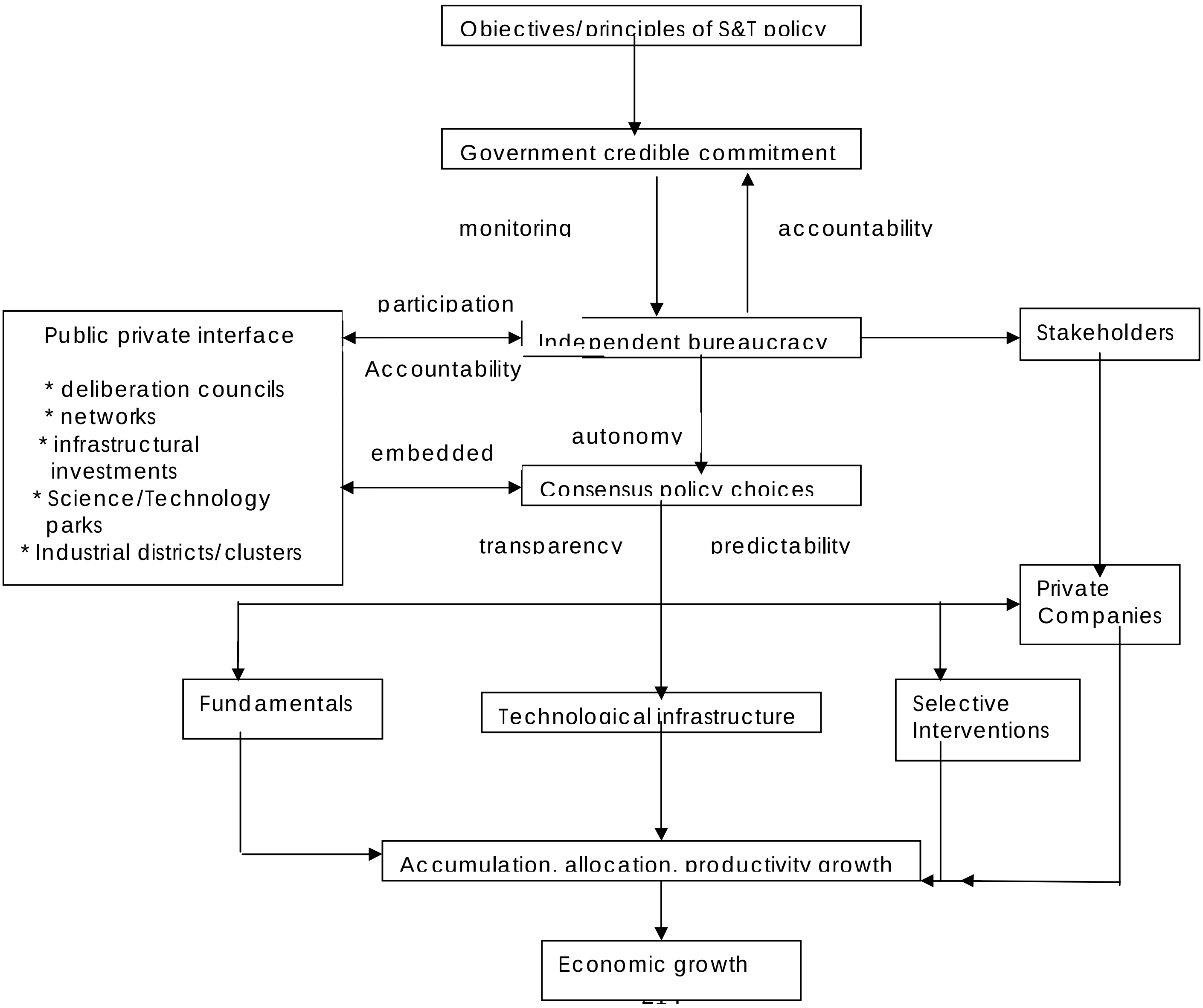
The impact of any policy whether S&T policy, industrial policy or trade policy depends on the commitment of government (Ahrens, 2002). Credible political commitment to the implementation of a policy framework is influenced by the sincerity, capability and sustainability condition of government. If a government for instance, is able to implement reform policies and there is lack of sincerity or truthfulness on the part of political decision makers who support reforms by words and not by deed, it is sufficient to lead to policy failure. Even when sincerity of purpose is established and government lacks the capability of technical implementation and of forming appropriate legislative and enforcement coalition, the reforms are likely to fail.

Lastly, if the major stakeholders (political actors) are sincere and capable, policy reforms will still fail if they cannot be sustained over time. These three conditions are individually and collectively sufficient to make political commitments assured.

Effective governance structures determine to a greater extent the successful implementation of national policies. There has been a growing awareness that the quality of a country's governance structure is a key determinant to its ability to pursue sustainable economic and social development. Governance in the context of this study is taken to mean "the capacity of the institutional environment to implement and enforce public policies and to improve private–sector coordination"

(Ahrens, 2002). The perceived structures for effective governance conducive to technological development of Nigeria as conceptualized in this study is illustrated in Figure 5.3

Figure 5.3: Governance and Science and Technology Policy: A Conceptual Framework



The figure shows the interaction of different key stakeholders within a specific set of institutions favouring consensus, participatory and accountable policy making based on transparent and predictable rules. These allow for different policy choices that help exploit latent potentials of S&T.

Implementing S&T policy not only requires clear objectives and credible commitment on part of the government but equally important, is a competent and meritocratic bureaucracy that is closely related to the private sector.

5.4 **SCIENCE AND TECHNOLOGY LITERACY**

The study assessed the perception of level of literacy of the Nigerian society as it relates to science and technology. The findings show that greater majority of respondents agreed to the fact that there are limitations to the understanding of S&T among Nigerians, including policy-makers/legislators. These findings corroborate that of Young *et al* (2002). In their study on S&T literacy among the American people, they observed that the American nation increasingly depends on technology and is adopting new technologies at a breath-taking pace, however, its citizens are not equipped to make well considered decisions or to think critically about technology".

They concluded that “as a society” they are not technologically literate. This is similar to the finding from this study as respondents agreed to the statement that Nigerians are ill-equipped to make well-informed decisions or opinions on S&T. Evidences abound of the daily application of S&T in our social lives, but the society is still ignorant of how it works, the implication of its use or even where it comes from. The foundation for S&T literacy is lacking as the nature of education system in Nigeria has not given prominence to science and technology education.

In a recent study carried out by the Federal Ministry of Education in collaboration with UNESCO, it was found that in the year 2000, for the 40 universities in the country, the total enrolment was 201,825 or 46.5% for science and technology education as against 232,046 or 53.5% for arts and humanities (Federal Ministry of Education, 2003). This was quite below the prescribed admission ratio of 60% for science and technology and 40% for arts and humanities-based programmes.

The study concluded that literacy education in Nigeria has a firm grip on social consciousness and control of resources in the society compared with science and technology education. Furthermore, the report observed that in every society where literacy education ideology is strongly held, science and technology education tend not to develop to meet national expectations.

This situation is however, not peculiar to Nigeria alone. Young et al (2002) noted that in the United States, neither the educational system nor its policy making apparatus has recognized the importance of technological literacy. Furthermore, most policy makers at the federal and state levels have paid little or no attention to S&T education or technological literacy.

The analysis from this study revealed that most of the respondents were of the opinion that the National Assembly in Nigeria has not passed significant number of bills on S&T including S&T education and technology literacy. Furthermore, there was no evidence to suggest that legislators and their staff have considerable understanding of science and technology. Infact 81.4% of the respondents believed that the legislators lack understanding of S&T and perhaps, it account for the limited legislation on S&T. This implies that despite the fact that national and state legislators often find themselves grappling with policy issues that requires an understanding of technology, they lack the basic knowledge.

It is important to note that S&T literacy like literacy in many aspects of life is expected to provide people with the basic knowledge and tools to participate intelligently and thoughtfully on global issues around them. It is therefore, in recognition of this disconnect between S&T reality and public understanding that the study is emphasizing on the need to set things right. This requires the cooperation of all including schools of education, engineering, science teachers, developers of curriculum and instructional materials, federal and state policy makers, industry and non-industry supporters of educational reform and S&T centres and institutions.

5.5 **NATURE OF R&D ORIENTATION**

The nature of research orientation is considered fundamental to the determination of impact of S&T to national development. The study identified three research orientations of the research institutes in Nigeria which include, mission-oriented research, scientific institutional research and academic research. The analysis of the responses from the research institutes surveyed shows that majority of them were established with specific mission and mandates to carry out research in a particular area or sector of national importance.

However, some are scientific institutionally based and carry out both applied and basic research. Very few combine applied research and academic research. These are those that have training units as component of their overall mandate. Technology development starts with basic research and progress through applied research before experimental development into prototypes or pilot plants for commercialization (Muturi, 2002).

The findings from the study indicated that applied research is the major focus of R&D activities of the research institutions. Majority of the respondents especially from agricultural RIs believed that they carry out both applied and basic researches. This is understandable judging by the fact that the distinction between the two is very narrow. Basic research is a precursor to applied research. In essence, it forms the basis for applied research, leading to commercialization of research results.

Muturi (2002) observed that both basic and applied researches are normally complementary. Infact, he opined that applied scientific research is an extension of basic research whereby effort is made towards establishing application of results of basic research in solving particular problems. Frippiat (2002) also noted that basic research is an academic research providing fundamental knowledge. While applied research is an extension of basic science leading to production. It is a type of research specially aimed at industrial production and creating significant impact on national development process.

Furthermore, it was established that the major beneficiaries of R&D activities in Nigeria is the public, especially the farmers who are in direct contact with the agricultural research institutions. Apart from the public, the private sector do benefit minimally from the researches carried out by RIs in the country, especially entrepreneurs and small and medium enterprises (SMEs).

The government utilizes very limited products of researches carried out by the RIs. The government patronage is not significant compared to that of the public and the private sector. In some developed and developing countries, government is the major beneficiary of R&D. For instance, in the United States, the Defence Department sponsors considerable number of R&D for the benefit of government and the society at large.

Skolnikoff (1993) noted the continued US government support for S&T in the face of growing budgetary problems and uncertainly of economic returns. He attributed it to the deeply held conviction established during and after the World War II that support for S&T will eventually benefit government in the development of superior weapons as well as improved medical care or high productivity in agriculture to ensure food security.

Schwartzman (1993) noted that the economic and military importance attached to S&T in Brazil informed government strong patronage of R&D activities. He informed that the military doctrine of technological development in the 1970s was a driving force for Brazil’s technological development in the field of space research (including the development of rockets and satellite), atomic submarine and construction of military airplanes.

Also, India is currently a space power nation with the capability to build rockets and launch its own satellites as a result of government commitment to S&T development through research.

5.5.1 **Need for Market-Driven Research**

The various phases of growth from basic research to production of goods are expected to respond to market needs. It has been reported that in developed countries, government support hundreds of R&D projects and the industry up to the applied research stage to ascertain their future potential (Prasad, 2002). Prasad (2002) argued that it is often the researches with market potential that are further pursued through the phases of full technology development and production.

The study confirmed the lack of need or market-driven research in the country. In all the research institutes surveyed there was minimal relationship or linkage with the private sector which indicated that researches carried out by them were unlikely to be private-sector driven. Various reasons were given by the respondents to support their view that market-driven R&D is lacking in the country. The reasons in support and against given by the respondents are presented in table 5.12.

Table 5.12: Reasons in Support For or Against the Lack of Market-Driven Research in Nigeria.

S/N	Agree	Disagree
1	Need assessment before embarking on research is not always carried out.	1. Market-driven R&D exists, however industrialists are more interested in imported technologies.
2.	Research projects are often determined by management of the organization or leader of research team.	2. Available market-driven R&D products are not being patronized by entrepreneurs for fear that they may not be technically feasible and economically viable.
3	Training of researchers lacked challenges of market-driven research.	3. Poor funding of R&D and the dependence of multi-national companies (MNCs) on R&D carried broad affected the development of viable market-driven R&D products.
4	There is lack of awareness among researchers of the benefits of market-driven R&D.	4. Need-driven R&D has been successfully implemented in the field of agriculture as majority of the farmers have benefited from improved crop varieties and farming techniques.
5.	The process of developing market-driven R&D is not understood by researchers.	
6	Researchers are not resourceful in designing appropriate project concepts that will target market needs.	
7	In establishing the RIs there is no philosophy for market-driven R&D and commercialization of R&D	

	results as justified by their mandates?	
8	The absence of research industry linkage is a demotivation to the emergence of market-driven R&D.	
9	There are no committed efforts by Government to make local entrepreneurs utilize research results thereby stimulating the growth of market-driven R&D.	
10	R&D findings are not readily available to SMEs and often, they (SMEs) cannot pay for consultation fees.	
11	Lack of infrastructure in engineering made R&D not market-driven.	
12	Lack of coordinating unit in RIs with qualified personnel to determine R&D market exists.	
13	Most R&D do not get to pilot plant stage due to poor funding and lack of skill to translate laboratory research to commercial production.	
14	Many research outputs are poorly conceived and do not attract entrepreneurs.	
15.	Lack of communication between researchers and industries.	
16	Lack of contract research between RIs and industries aimed at addressing specific problems	

17	Funding of R&D activities is seen as consumption rather than an investment.	
18	S&T policy lacks commercial orientation.	

Source: Research Study, 2004

From all the reasons given, it is very obvious that lack of enabling environment that promote R&D support, risk-financing and entrepreneurial system contributed to the situation where industry and R&D institutions operate at cross purposes instead of functioning as partners in facing development challenges.

5.5.2 **The Need for Separate National R&D Policy**

The need for a national R&D policy distinct from the S&T policy has been proposed. Oke (1999) associated the lack of a defined guideline in terms of National Research Policy to be responsible for the non-performing state of research institutions in Nigeria. He observed that the starting point for the establishment of RIs ought to have been rooted in a well-articulated national research policy, policy guidelines and national goals as well as objectives and strategies to serve as a blueprint.

It was observed that the current 2003 S&T policy took into consideration the issues observed by Oke (1999). The policy document proposed the establishment of a body for central coordination of national R&D activities as lack of proper coordination was instrumental to the weak contribution of S&T to national development (FMST, Ministerial Press Briefing 2004). The body is to be called National Research and Development Coordination Council (NRDCC) and to be chaired by Mr. President.

Based on the analysis of the responses from the survey carried out on RIs, it was obvious that a "National Research Policy" though desirable, however, should not be distinct from the national S&T policy. The reasons in support for and against a National R&D policy distinct from national S&T policy are presented in table 5.13.

Table 5.13: Reasons For National R&D Policy Distinct From S&T Policy.

S/N	Reasons For	Reasons Against
1.	To emphasize the philosophy of commercialization of R&D and wealth creation.	1. A distinct R&D policy will be an overlap as such a policy is an integral part of S&T policy.
2	For effective coverage of all R&D activities irrespective of the implementing agencies or Ministry.	2. S&T policy document should be all-embracing including all issues on R&D and its implementation.
3	R&D policy will address specific R&D requirements as against broad based approach of S&T policy.	3. A separate national R&D policy will thin out the already meager resources allocated to funding of S&T.

4	Distinct national R&D policy will be properly implemented, monitored and adequately funded.	4. A distinct national R&D policy will increase the bureaucratic structure that needs restructuring for effectiveness.
5	National R&D policy will foster effective linkage with all stakeholders to respond to S&T needs.	
6	National R&D policy will unify all the activities of RIs including those outside FMST.	
7	National R&D policy will be able to establish national indicators for effective monitoring and evaluation of the impact of research activities.	
8	An institutional framework similar to National University Communication should be established to manage R&D while FMST concentrate on policy issues.	

Source: Research Study,2004

5.5.3 **Role of Research, science and scientist in National Development**

The study highlighted the role and responsibility of scientists and scientific community in the rational and effective use of the limited available resources in setting up coherent cooperative programmes for the integration of science and technology into national development plans. The need to establish stronger links between researchers and users of research as well as popularization of S&T was also recognized. The study established the following:

a. The universality of science and its contribution to knowledge.

b. That science should lead to useful innovations and development of entrepreneurial skills.

c. Researchers should be encouraged to produce marketable goods.

d. Research problems requiring solution should be influenced by clients needs while research topic should be influenced by sponsors of research.

The study revealed a limited appreciation of the value of R&D by the society and government which in turn affected research orientation. Consequently, instead of increasing the R&D efforts to solve pressing national problems, such efforts were reduced especially as economic conditions became quite unfavourable.

5.5.4 **Nature of R&D capacities**

An assessment of the R&D capacities in Nigeria was partially carried out in the study. The assessment of R&D capacities was carried out in order to determine the strength and weaknesses of the S&T capacity in the country. The study established that R&D capacities in Nigeria exist in the universities and research institutes only, as there were no private R&D laboratories and industry neither carry out R&D locally or sponsor R&D.

The existing capacities were weak and cannot serve as delivery systems for national development. It was noted that existing capacity as an area of strength in terms of the institutional framework for R&D. However, this capacity was under-utilized. The under-utilization was associated with poor incentives and more importantly, with the poor remuneration of researchers. Furthermore, lack of requisite research facilities and input materials contributed to the poor state of R&D activities.

It is pertinent to note that much of the researches carried out in the country were by public institutions. Moreover, most of the researchers were civil servants and were therefore, subject to low wages and unattractive remunerations. Low wages implies that the researchers were not adequately empowered to work hard and be productive

(Khalil, 2002). Invariably, there was very little to show in the way of result even for the meager resources deployed to support research in these institutions.

The following factors were identified to characterize the weakness of research institutions in the country.

- Research institutions do not collaborate with the productive sector.
- The research institutions lack the capacity to commercialize R&D results.
- They were grossly under-funded by government and remuneration for researchers is inadequate.
- Targets and goals were not clearly set for performance evaluation.
- There was lack of effective monitoring and evaluation of performance.
- Research institutions experience limitations in disseminating information on their activities.
- There was virtually no effective linkages between research institutions and small and medium enterprises(SMEs).
- SMEs were not empowered to exploit R&D results due to lack of finance and expertise.

These issues are further elaborated on as it relates to the following subject matter, S&T infrastructure, financing of R&D and evaluation of R&D.

5.5.5 **Science and Technology Infrastructure**

Apart from the regulatory and policy environment, “a country’s S&T infrastructure is of critical importance to national development (Ahrens, 2002). The S&T infrastructure include the educational system, private and public research institutions, the network of technological and scientific associations and its legal institutions such as intellectual property right as well as contract laws which provide incentives to develop and exchange technologies.

From the research findings, the existence of science and technological infrastructure in Nigeria was established. However, the capability of this infrastructure to act as a delivery system for innovative activity that will eventually take place within firms in order to achieve technological progress and economic performance is in doubt due to obvious reasons stated previously. Also, there is no strong linkage between the educational system, research organizations and the private sector for exchange of technological information.

It must be appreciated that science and technological infrastructure backs up technological efforts of private firms by providing standards, information, scientific knowledge and facilities which cannot be established and operated by individual firms (Ergas, 1987, Lall, 1992 and Evenson and Westphal, 1995).

Successful technology transfer and the development of indigenous technological capabilities demand technological literacy of internal stakeholders, the minimum amount of which depends on the stage of national development. This, demands the utmost development of a long- term national strategy of human resource development and continuous investment in the country's educational system. Considering the low level of technological development of Nigeria, improvements in primary and secondary education including vocational training are very critical.

A key issue relating to the science and technological infrastructure is the establishment of public R&D institutions. The study established the failure of private sector to capture the gains from R&D which implied that the social reforms may well exceed potential private returns. This, however, was not the case in Nigeria. Though the major beneficiary of R&D according to the research findings was the public, however, the social returns were limited, fragmented and cannot be measured with certainty.

This finding implied that there was a need to step up action to create the desired awareness of the benefits of research to the society. To this end, circumstances therefore exist especially in the field of basic research to justify and necessitate government action in financing, organizing and encouraging R&D activities.

Even, if potential gains from R&D abound, but the benefiting industry consists only of small and medium enterprises (SMEs), government intervention is still imperative. The study equally established the fact that the SMEs were unable to benefit from local R&D activities because they do not have the means (capital base) to invest in the development of R&D results with an uncertain outcome in terms of market acceptability. This finding confirmed similar findings reported by some researchers (Ahrens, 2002 and Lau, 1997).

Lau (1997) noted that for government-financed R&D, the problem of utilizing R&D results was more critical when the direction of research was not relatively well known and the necessary linkage with the market was not there. He therefore, concluded that concentrating resources in a single direction may become costly and if the research direction was not sufficiently clear, diversification of resources will be a more useful strategy.

Ahrens (2002) further advised that in order to address the problem of government-sponsored R&D, it is of essence to ensure that it meets the needs of its clients. He argued that reinventing technology usually does not pay. In order to be productive, research organizations need to build on existing technologies and available channels of international technology transfer.

The essential elements of technological development capability as identified from the study are presented in table 5.13.

Table 5.13: Essential Elements for Technological Development Capability/Capacity Building

Element	**Primary Source of Element**	**Suggested Future Policies and Directions**
I. Manpower Scientists, Engineers, Technologists, Technicians with practical skills	• Science and Technology teaching institutions; • Technical Training Institutions; • Skills Development Centres.	• Strengthening and deepening scientific culture, scientific methodology and the intrinsic intellectual value of the disciplines; • Training as a practical means of sustaining economic growth; • Training in the new and emerging S&T disciplines. • Growth points in S&T disciplines.
II. Scientific and Technological Knowledge	* Scientific and Technological Training and Research Institutions; * R&D Centres etc.	To emphasize:- • Purposeful and targeted research; • Improved agricultural productivity; • Improved industrial manufacturing process;

		• Improved Technical Services to the economy; • Improved investment of resources in R&D work.
III. Technical Facilities for technology development capability building: • Engineering materials, • Chemical materials, • Power Equipment, • Scientific and control instruments and electronic equipment; • Engineering accessories; • Engineering tools.	From industrialized countries with capacity to manufacture and produce these essential equipment and materials.	Initially by: • Direct purchase from industrialized manufacturing countries of these facilities; Foreign technology investments in the economy, while the capability is built domestically to mass produce these items.

Source: Adapted from Oragwu, 2002.

N.B

(i) The constructive and systematic interaction of Elements I, II and III in the process of production of goods and services results in technological development and innovation capability;

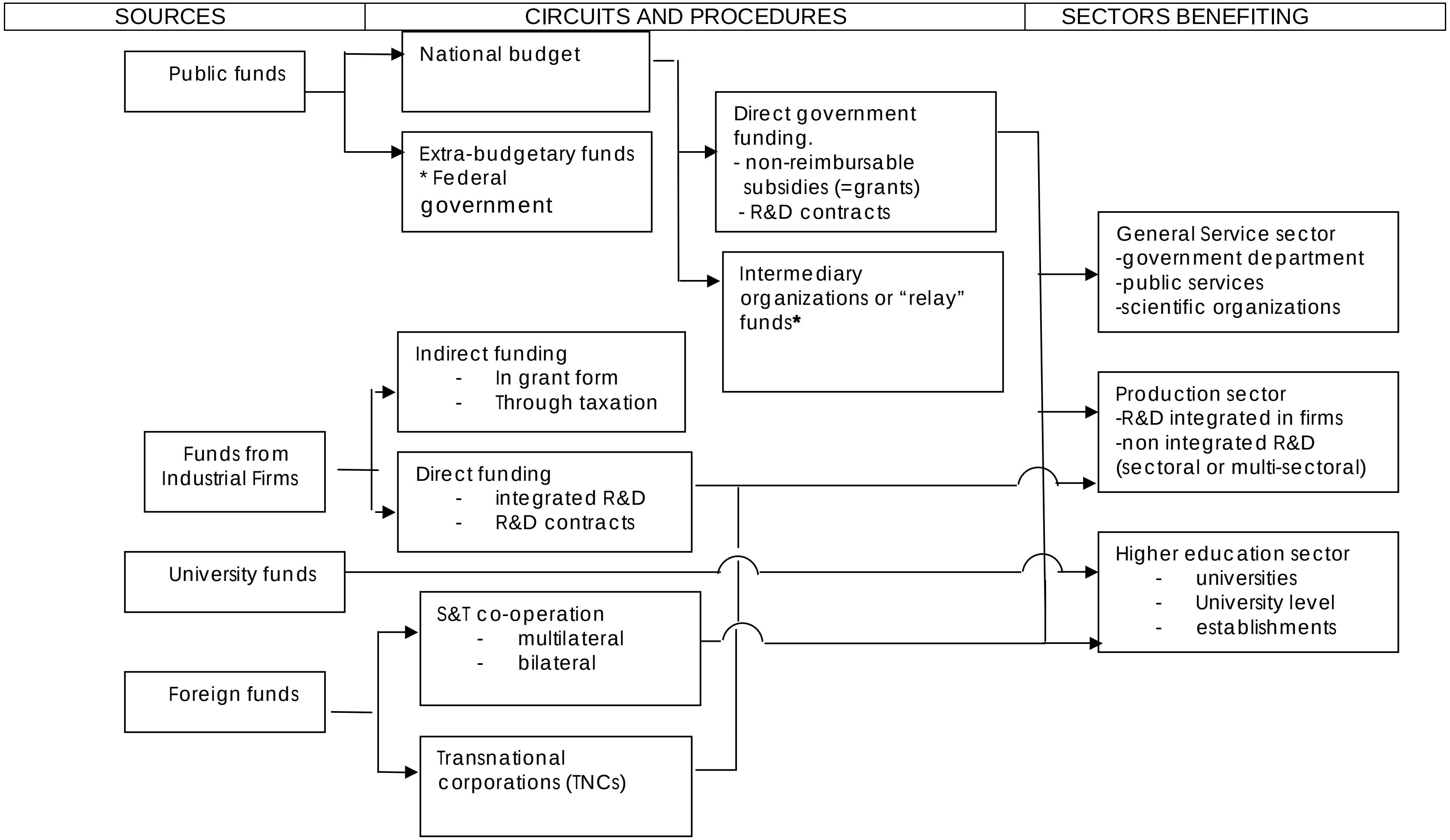
(ii) The application of the acquired capability/capacity in industrial manufacturing of goods of global competitiveness leads to technological /industrial transformation of the relevant society.

Evenson and Westphal (1995) were of the view that adaptive industrial research needs to be undertaken in relative close proximity to experiences that were gained in production processes. For this reason, they suggested that public R&D efforts should be embedded in innovative production works linking research laboratories, industry and possibly universities and government agencies.

5.5.6 F**unding R&D and Research Budget**

The study established the critical role of effective and sustainable funding of R&D to national development. In all relevant issues relating to financing R&D the limitation of funds were highlighted as the most critical. However, the study discovered that government was the major source of funding for research. Other limited sources of funding identified include internally generated fund, industry/private organization and international organizations. The current and possible sources of fund are illustrated in figure 5.4.

Figure 5. 4: Current and Possible Sources of S&T Funding in Nigeria



* Very limited or not in existence.

Nsa (2003) observed that the level of performance of RIs could be attributed to the level of funding and its judicious use. He further noted that the ownership structure of RIs determines considerably the nature of funding and orientation of research.

This view was further collaborated by WAITRO study on research and technology organizations (RTOs) in which it was reported that research organizations that receive more than half of their money directly from industry or in a manner that its use is controlled by industry becomes industry-focused (WAITRO, 1999).

However, if government fund research organizations and industry has no significant influence on the works conducted by them, they are not likely to be valued by industry. This factor perhaps explains the limited research industry relationship or linkage.

Nsa (2003) in his study of financial management of research and technology organizations in Nigeria noted that with the current funding pattern where government is the main source of funding, that such funding was not sustainable. The limitation to funding comes from lack of appreciation of the benefits of R&D to national development by government. With budgetary constraints, the funding of R&D becomes restricted. It is in this prevailing circumstance that the benefits of publicly funded R&D become eroded and is even challenged.

It must be appreciated that the highest proportions of S&T activities were carried out by public institutions which invariably demands that it should be considered under national budget.

The national budget therefore emerged as one of the essential instrument of government S&T policy. Unfortunately, the conventional budgeting procedures have been recognized as not permissive of the explicit and appropriate identification of funds allocated to S&T in national budgets (UNESCO, 1979).

Therefore, it is almost impossible to analyze the amount, distribution and purpose of such funds and this accordingly precludes any evaluation of their relationship to national development goals. Boer (2002) noted that the main financial metric for measuring R&D which is the annual budget is a tool considered basically inadequate to evaluate investment.

National budget in the past two decades as revealed from the study had not favoured S&T activities for it to deliver the expected socio-economic development impact. The limited commitment of government to the funding of S&T created a further dis-incentive on the part of the private sector to finance R&D as government has failed in its pivotal role.

Furthermore, the shortcomings of private sector funding of R&D especially as it relates to concern on return on investments, long-term nature of R&D, limitation of financing capacities of firms, implies that government should continue to play the leading role. It is pertinent to reiterate that one of the functions of S&T funding by government is to make the return on S&T activities credible enough for it to attract capital from industry and even foreign funds.

In most discussions on funding of S&T, especially R&D, the need to justify the money expended ranks paramount. The argument that R&D fund is rather a consumption than an investment has informed the little or no serious attention given to it by government. Therefore, the desire for economic returns to R&D needs to be appraised conscientiously. The question that should be answered is "should economic pay--off be the basis for R&D investigations"?. If so, then an economic return on investment should be expected so that proper cost benefit analysis can be made and compared with alternative expenditures (Skolnikoff, 1993).

However, return on investment in research has been reported to be peculiarly difficult to measure (Skolnikoff) 1993).

Mc Daugal *et al* (1996) observed that government research budget are more of a convenient slush fund than a strategic investment. Oragwu (2000) commenting on the current budget practice of research institutes in Nigeria noted that the civil service approach to the design and implementation of R&D programme budget often fail to set up quantifiable and measurable goals.

Since government still remain the major source of funding for S&T, it is obvious that irrespective of the percentage of national S&T expenditure financed by it, the S&T policy should ensure that funds allocated for R&D are judiciously applied so as to have maximum multiplier effect. This will serve as a justification for allocation of financial resources to S&T arising out of national budget preparation procedures.

In addressing the issue of limited funding for R&D, some researchers are of the view that to improve the performance of public research institutes, public support may be adequately based on a scheme of gradually declining subsidies (Evenson and Ranis, 1990). They suggested that research institutes should face competition with respect to public and private sector research funds.

The study finally identified special funding schemes for financing R&D to include the following:

a. Establishment of private funding foundations. Private funding foundations promoting R&D are likely to be effective mechanism for funding scientific research.
b. Establishment of national or sectoral research council and fund in view of the magnitude of the emerging needs generated by increase in public funding of S&T.

c. Establishment of special funds such as “Technical and Economic Development Fund”. This is a special fund usually formed from the proceeds of an industrial turnover tax and the amount involved allocated to joint R&D programmes of common social importance for a particular sector of national activity. Also, part of the proceeds from privatization of public enterprises can be channeled to such special fund.

d. Establishment of venture capital fund for commercialization of viable research results.

It must be appreciated that lack of measurable impact of funds allocated to R&D activities in the country has equally contributed to the limited funds made available by government. Government has expressed concerned over the huge public money expended on R&D over the years for which the value obtained still remained unclear. Traditional R&D management approach focused on measuring effort-based inputs such as level of spending and number of people involved in R&D rather than results and commercial applications (Nsa, 2003).

Nsa (2003) observed that most government R&D expenditures were made without defined priorities or objective strategies against which performance can be evaluated. Consequently, the long-term socio-economic and result-based indicators have largely been ignored.

5.5.7 R&D Evaluation

As national resources continue to be limited and government is finding it difficult to finance all its social development programmes, there is a growing interest in the ways in which national development goals are defined. The role of S&T in addressing national development problems need to be clearly defined and the output of financial investments on R&D be assured to further attract government financial commitment. This situation entails the need to rank R&D projects in terms of priorities for resource allocation.

However, this desire to get R&D activities properly focused is constrained by lack of indicators that will enable R&D to be evaluated. Certain indices such as R&D efficiency, effectiveness and productivity have been proposed as desirable for evaluation of R&D. While the efficiency is a concept intrinsic to S&T which measures how far resources invested in R&D have been productive within reasonable time limits (ie input/output ratios), effectiveness is a concept extrinsic to S&T which measures the output of R&D both qualitatively and quantitatively against the socio-economic goals or objectives pursued.

R&D productivity emphasizes on effective manpower resource utilization and profitability which conveys the essence of economic returns on investment. The importance of R&D evaluation cannot be overemphasized and should be conducted regularly. R&D evaluations are expected to be carried out at different levels both nationally and at the institutional levels, as well as across scientific areas. It should be carried out before (ex-ante), during, and after (ex-post factor). The evaluation should be specific with respect to the following issues:

- the output of the activity as it relates to research product (scientific knowledge) and experimental development product (technological innovation which calls for different considerations.
- the missions of the research institutions; and
- the ultimate national goals.

R&D evaluation therefore, must take into consideration of not only the scientific merit, but also, the societal utility with less emphasis on purely economic benefits.

The study established that national science policy makers lack evaluation methods for ongoing and terminated R&D. In this connection, the study noted that it makes little sense to restrict R&D evaluation to the immediate results of research, whether these results consist of new knowledge or of new products or processes. In other words, what effective R&D management should really seek is as follows:

- an evaluation of the degree to which research results were utilized in the productive sectors of the economy; and
- an evaluation of the impact of the utilization of R&D results on the achievement of national development goals, in different spheres of national life and at different levels of human activity.

5.5.8 **Status of S&T Indicators in Nigeria**

The attempt to determine the status of S&T capacities in Nigeria in terms of type, level, quality and quantity was constrained by lack of national framework of indicators for measuring S&T capacities. Government departments in charge of collecting, compiling and classifying national statistical information have not identified the most basic indicators. Consequently, measuring the progress and status of S&T has been constrained by lack of suitable indicators (Khalil, 2002 p.4).

Table 5.14: Nature and Status of Science and Technology Measurement Activities in Nigeria

S/N	Measurement	Objectives	Status
1	Institutional level analysis	* collection and publication of key indicators for internal monitoring budgeting and planning.	* Most public RIs record their activities in the annual report; however, there is no national format or standard for measurement of performance based on key S&T indicators. * Measurement activities for public research have not been regularized on

			an annual basis.
2	Inter-institution comparisons	* Inter-institution comparisons to reflect specific measurements on the basis of projects undertaken.	* This has not been carried out in Nigeria.
3	Industry and national level analysis.	* Provision of national data and statistics through surveys. * Standardized definitions need to be established. * Findings from the survey can provide input to national S&T policy making process	* Industrial research at national level analysis has not been carried out. * Fragmented information indicates no industry level R&D being carried out. * There is need to establish this based on statistical analysis.

Source: Research Study, 2004

It was found that the country lacked the framework or tradition for grouping the S&T measures in terms of input and output indicators. Furthermore, the absence of systematic framework of data collection and formatting has made it difficult for multi-level comparisons to be made. This finding lead to the conclusion that the absence of key indicators in the country's S&T system has compromised the development of national S&T capacities as it relates to the following:

- failure to incorporate S&T indicators in the socio-economic planning process;

- failure to develop an integrated planning framework;

- inability to influence S&T practice and policy;
- poor understanding of the factors influencing S&T development; and
- inability to appreciate the implications of unplanned S&T activities.

This development has resulted in the failure to evaluate the level and quality of scientific and technical information; national capabilities to manage R&D and its commercialization, including promoting reverse engineering. It also, militated against the evaluation of science and technology gaps and the levels of production in national economies. The study discovered the existence of information for development of S&T indicators in the country; however, the information was scattered and not compiled, standardized and systematized. These findings confirmed a similar report by Khalil (2002) on sub-Saharan Africa (SSA). Furthermore, the study revealed that data on S&T indicators such as output of basic research, applied research, development of innovations and production activities were available on institutional basis but not collated and systematized to give a national data or information.

Furthermore, intermediate outputs such as patents and publications were measured, but such measures were not made available to the public. Invariably, such outputs have little to do with ultimate utility and benefits arising from them. The study discovered that available patents in Nigeria did not translate to technological transfer or acquisition. This corroborates with the view expressed by some researchers that transfer or non-transfer of technology takes place not because of the patent itself, but because of other prevailing conditions that create an incentive for productive activities (Vaitsos, 1978). They argued that patent licences which are so often considered vehicles of technology transfer were in most cases nothing more than import permits given under certain conditions.

5.5.9 **Communication with Scientists and the public**

The study established the difficulties experienced by local scientists in communicating with others both within and outside the country. However, communication among scientists within a particular institution was much easier. It will be recalled that over the last decade before the emergence of information and communication technology, linkages with researchers abroad has declined considerably apart from a minute number of selected cases.

Linkages and collaborations between researchers have been poor and so, had international networking (Khalil, 2002).

International exchange programmes, sabbatical engagement and short-term career enhancement award have diminished or completely been abolished. Participation in fellowships and international symposia and conferences has almost been phased out. Lack of funds has been advanced as the main reason for this decline as government budgets cannot cover travels for international conferences.

Many RIs surveyed have not been able to keep abreast with professional scientific and technological developments elsewhere because membership to international organizations and subscription to reputable journals have fallen drastically. Aredo (2000) confirmed in a similar study that on an average bases, less than 1% of researchers in sub-Saharan Africa are capable of sustaining regular professional contacts with peers elsewhere. Also, he observed that African researchers have not been able to consistently link up with their peers abroad using electronic mail because of the cost implications

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CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 **SUMMARY OF FINDINGS**

Governments in Nigeria over the years have emphasized the overwhelming significance of science and technology in the development process. In various national policy documents, government has expressed its desire to promote scientific and technological development with the prime aim of accelerating economic development and enhance the welfare of the citizenry. Based on this recognition as well as the fundamental aspiration for national development, the country embarked on series of new S&T initiatives strongly supported with the promotion of R&D programmes in the public sector.

These efforts were varied both in extent, scope and emphasis. Within this framework therefore, Nigeria's S&T research capacities emerged with numerous success stories as well as failures and constraints. All these offered vital lessons of experience and policy concern.

This study is therefore predicated on the need to assess the impact of national S&T policy on development of the country. The summary of findings from the study is presented based on the following subject headings:

- Characterization of S&T in Nigeria,
- Science and technology policy issues,
- Science and technology literacy, and
- Nature of R&D orientation of S&T research institutions.

6.1.1 **Characterization of S&T in Nigeria**

Evidence from literature studies and analysis of findings from this study revealed as follows:

- Nigerian situation in the evolution of S&T indicates an initial failure to recognize the critical role of S&T instruments to national development.

- The country lacked the science culture that is required to create awareness on the need to use scientific methods in economic activities.

- The institutional frameworks for S&T development in Nigeria include research institutions, universities and polytechnics. Also, scientific research activities in the industries were limited and there was no private commercial R&D laboratory.

- Although, the oldest research institutes in Nigeria were over 80 years, the larger part of the current S&T capability was however, built after independence, between 1960 and 1990. This was a period characterized mainly by military rule in Nigeria. The peak periods in the establishment of research institutions in Nigeria were in the 1960s and 1970s.

- The Government is the major stakeholder and financier of S&T activities with limited or no support from the private sector.

- The study revealed that the S&T institutions inherited from the colonial master and the new ones established thereafter, lacked the necessary linkage with the productive sector. This problem reflected in the various development plans embarked after independence.

- The study confirmed the considerable installed S&T capacity in Nigeria both in terms of existing infrastructure, technical facilities and human resources. The S&T institutions were however, weak to serve as delivery system for national development. Their mandates have for long been on generalities and short on specifics.

- The assessment of research strength indicated that personnel with requisite qualifications for effective research work, especially those with PhDs were limited. There were more support staff in the employment of S&T institutions than researchers. External and internal "brain drain" was advanced as reasons for the depletion of qualified personnel, especially those with higher academic research standing.

- The findings from the study established that while more research activities were executed in the RIs, consultancy and extension services were sparingly carried out to the benefit of the society. More extension services were rendered by agricultural research institutions while technology extension services were hardly rendered by research institutes under S&T ministry.

- The capacity to render consultancy and technology extension services among RIs was lacking due, primarily to limited skilled personnel trained in these areas.

- Scientific and technological researches in Nigeria have demonstrated a pronounced bias towards agriculture. The bias was also characterized by a narrow diversity of specialization that inclined more to food crops. It was not clear what criteria that were used to pursue research at the on-set, however, preliminary evidence from the study suggests the influence of the colonial evolutionary nature of R&D and perhaps, the issue of food security as well as foreign exchange earnings from expert of agro-commodities.

6.1.2 **Science and Technology Policy**

- The first explicit national policy on science and technology was formulated in 1986. The philosophy for the national policy on S&T affirmed that it shall form the basis of Nigeria's development and shall influence the thinking and working process.

- There is limited awareness of the existence of national S&T policy even among scientist and researchers in the country. Even, those who were aware stated that the policy was not accessible to them and the public. This was considered a limiting factor to the social function of S&T. The society was not aware and do not contribute to the policy formulation process.

- The study revealed that the current explicit S&T policies were formulated almost exclusively by government officials and research scientists and engineers, which calls to question its overall acceptability by other stakeholders including the private sector.

- It was established that science and technology policies have not been a critical determinant of development performance in Nigeria.

- The contribution of S&T to competitiveness and economic growth of the country was established. However, its role in national development is not clear and cannot be quantified in absolute terms.

- The study indicated that lack of demand for innovation in industry and agriculture was not responsible for inability of S&T to impact on national development. This implies that though innovation is a necessary factor that stimulate S&T development, it is however, not the most critical factor as some other factors do contribute to ensure that it impact on development.

- Three policy processes were identified that influenced national S&T policy formulation which include minor, major and integrated policy processes. The findings indicated that integrated policy process is preferred which entails developing new explicit policy strategy after a certain period of time.

- The review of 2003 national S&T policy document identified two intermediate objectives of the policy which were framing and accelerating technological change and facilitating structural change. The overall objective was to achieve economic growth. The intermediate objectives could be pursued by:

    a. promoting individual projects,

    b. supporting particular branches of S&T and,

    c. global adjustment-oriented support.

The 2003 S&T policy took into consideration the above three distinct approaches in establishing specific individual project like the space (satellite) project while ICT and biotechnology were part of the strategic S&T policy.

- The issue of national project and building of national technological capabilities were being addressed through the implementation of 2003 S&T policy. The training of Nigerian scientists and engineers to acquire capability to launch and manage the space satellite system is a classical example.

- Also, three phases of policy process were identified from the critique on national S&T policy formulation which include; strategy formulation, programme identification and design, programme implementation and assessment. These phases must be supported by impact assessment which will form part of the feedback control mechanism.

- The study also, revealed the concern expressed on the issue of governance and S&T policy. The emphasis was on commitment to policy implementation in addition to transparency, accountability and sustainability. The collaboration between the various stakeholders responsible for S&T policy formulation and implementation requires commitment to achieve the desired success.

6.1.3 **Science and Technology Literacy**

The level of S&T literacy has been associated with the understanding and appreciation of S&T activities. The study made the following findings as they relate to S&T literacy.

- There were limitations to the understanding of S&T among Nigerians including policy makers as well as legislators.

- The Nigerian society was aware of the daily application of S&T in their social lives but ignorant of how it works and its implication to national development.

- The foundation for S&T literacy was lacking due mainly to the educational system in Nigeria which failed to give prominence to science and technology education.

- The admission ratio for science and technology programmes to the Nigerian universities favoured the humanities-based programmes than S&T based programmes. This implies that literary education has a firm grip on social consciousness and control of resources in the society compared with science and technology education.

- The findings from the study indicated that the legislators at both federal and state levels have not passed significant number of bills on S&T including S&T education.

- This situation was attributed to lack of understanding or failure to appreciate the importance of science and technology in societal development.

6.1.4 **Nature of R&D Orientation**

- The study identified three research orientations to include mission oriented research, scientific institutional research and academic research. Most of the RIs studied were established with specific mission and mandates to carry out applied research in a particular area or sector of the national economy. Some however, were institutionally based and carry out both applied and basic research.

- The major beneficiaries of R&D activities in Nigeria were the public, especially the farmers who were in direct contact with the agricultural research institutions. Also, the private sector minimally benefits from the researches carried out, especially entrepreneurs and SMEs. Government patronage of research was insignificant despite being the main financier of R&D activities.

- The study revealed that there was minimal relationship or linkage between research institutions and the private sector. This implies that most of the researches carried out by the RIs were not likely to be private-sector driven. From the various reasons given to justify why local R&D was not market-driven, it was obvious that lack of enabling environment that promotes R&D support, risk financing and entrepreneurial system contributed to the disconnect of R&D institutions from industry instead of their functioning as partners in facing development challenges.

- The need for a national research policy was expressed, however, such a policy should not be distinct from the national S&T policy.

- The study established the following fundamental issues:

    i. the universal nature of science and its contribution to knowledge;

    ii. the need for science to lead to useful innovations and development of entrepreneurial skills among scientists.

    iii. researchers should be encouraged to produce marketable goals.

    iv. research problems requiring solution should be influenced by clients needs while research topics should be influence d by sponsors and guided by societal needs.

- There is limited appreciation of the value of R&D by the society and government as evidence abound in the limited resources allocated to R&D.

- There is under-utilization of existing research capacities in Nigeria which is associated with poor incentives and more importantly, poor remuneration of researchers. Also, lack of requisite research facilities and input materials contributed to the poor state of R&D activities in the country.

- The factors identified to have characterized the weaknesses of research institutions in the country include among others lack of collaboration with the private sector, inability to commercialize R&D results, gross under-funding, targets and goals not properly set for performance evaluation, lack of effective monitoring and evaluation and poor dissemination of information on research activities.

- The strategies for strengthening R&D capacity building include, manpower development through proper recruitment of qualified and skilled personnel, training and retraining, and motivation of staff, establishing stronger linkages between RIs and industry as well as the greater society, proper and sustainable funding of R&D, promotion of technologies, projects and processes including reverse engineering and promotion of intellectual property rights.

- Significant numbers of scientific breakthroughs were identified but most of them were yet to be commercialized.

- The study recognized the role of government budget as a policy instrument for development of S&T. This was informed by the fact that the highest proportions of S&T activities were carried out by public intuitions which demands its inclusion in the national budget. National budget unfortunately, has not favoured S&T as the Federal Ministry of Science and Technology has never received more than 1.0% of the total national budget in the past 4 years.

- The study identified the following special funding schemes for financing R&D:

    i. Establishment of Private Funding Foundations.

    ii. Establishment of National or Sectoral Research Council Fund.

    iii. Establishment of Special Fund such as “Technical and Economic Development Fund”.

    iv. Establishment of Venture Capital Scheme.

Also, it was discovered that lack of measurable impact of funds allocated to R&D activities equally contributed to the limited fund released by government. Four criteria for R&D impact assessment were developed to include:

- R&D output as it relates to development of fundamental knowledge;

- R&D output as it relates to technology development.

- Output as it relates to development of scientific and technical human capital.

- Output in terms of published articles and patents.

- Evaluation of R&D was not effective due primarily to lack of the political will and more significantly, to lack of indicators to measure R&D impact. The study established that S&T policy makers lack evaluation methods for on-going and terminated R&D. In fact, there was no national format or standard for measurement of performance based on Key S&T indicators.

- However, there were indications of the existence of information for development of S&T indicators in the country. This information were currently scattered and not compiled, standardized and systematized.

- The available patents in Nigeria did not translate to technological transfer or acquisition. Knowledge of intellectual property rights among researchers/scientists was very limited.

- Communication between scientists in the country and those outside was quite difficult due to budgetary constraints. Poor funding has limited international exchange programmes, sabbatical engagement and short-term career enhancement, including participation at international seminars and conferences.

- Research institutions in the country have not been able to keep abreast with professional scientific and technological developments elsewhere because membership to international organizations and subscription to reputable journals have declined considerably.

6.2 CONCLUSIONS AND RECOMMENDATIONS

The main thrust of this study apart from measuring the impact of S&T policy on national development, is to emphasize on the need to move the country from the previous mode of scientific and technological development into a new frontier more adequate to the current and future realities.

Science and technology are today more important than ever for Nigeria, if it is to raise the standards of living of its people, consolidate a modern economy and participates as a significant partner in the global arena. This implies that the economy must be modernized and be competitive.

In this regards, a new policy paradigm anchored on the following precepts is proposed, “to stimulate the freedom, initiative and creativity of the researcher, while establishing strong links between their work and the requirements of the economy, the educational system and of society as a whole; and to make Nigerian science and technology truly international while strengthening the country’s educational and S&T capabilities”

To achieve these, requires a competitive environment based on public incentives and private opportunities that rewards achievements and provides adequate resources to R&D in order to pursue strategic goals. The new policy initiative should among other issues, address the following key points:

- to increase the linkages between applied and academic research with the productive sector, and to increase their share in the national effort for scientific and technological development. This requires a significant increase in private investments in R&D;

- to promote research and development through the application of appropriate system of rewards and incentives for scientists, appropriate career structures and increased public support for S&T;

- to invest considerably in the development of innovative capabilities of the productive system through incentives, extension services and strengthening of the national infrastructure for S&T;

- to make government agencies for science and technology more flexible and predisposed to peer review procedures in order to track the impact of S&T activities.

- to encourage and stimulate S&T institutions as well as research groups to search for opportunities for collaborative research and partnerships from different sources including the private sector, non-governmental organizations so as to reduce the dependence on government.

The study on the impact of S&T policy on national development would have been an easy one if comprehensive national framework of S&T indicators and measures are in place and operational. This made the assessment of the impact very difficult and moreover, there are no indigenous capabilities to monitor trends in performance. The lack of quantitative measures gives an incomplete picture of existing S&T

capacities in Nigeria. Therefore, it is obvious that Nigeria is relatively handicapped given the poor identification and delineation of S&T measurement activities. Furthermore, the country lacks the tradition of grouping S&T measures in terms of input and output indicators. The absence of a systematic framework for data collection and formatting made it difficult for multilevel comparisons.

The study recognized the importance of availability of reliable and up-to-date data on S&T resources for the purposes of planning. Also, the need to undertake on a continuous basis surveys of the scientific and technological potential to enable accurate conclusions to be drawn concerning S&T resources that exist and those needed to meet development requirements is very imperative. The planning process of S&T should be strengthened by ensuring the participation of specialists from all relevant sectors in order to obtain comprehensive and adequate plans.

The issue of S&T literacy deserves serious consideration in the new S&T policy paradigm. The hallmark of S&T literacy in Nigeria therefore, demands that the society should;

a. recognize S&T in its many forms and also understand that the line between science and technology is very thin. This will lead to the realization that technology permeates modern society;

b. recognize that technology influences changes in the society and has done so throughout history. Through S&T today the world has been made “smaller” and eventually a “global village”. Also, life expectancy has been extended through developments in S&T.

c. recognize that society shapes technology as much as technology shapes society; and

d. appreciate that key people in successful technological innovation are not only scientists, engineers and technologists. Even, business men, bankers, judges, environmentalists, politicians and government bureaucrats are key stakeholders.

In order to improve on S&T literacy, the foundation has to be laid and this must begin from the schools. Pupils and students must be provided with early and regular contact with technology. Exposing these groups to technological concepts and hands-on design-related activities is the most likely way to help them acquire the desired knowledge, ways of thinking and acting and capabilities consistent with S&T literacy.

The study identified three key obstacles that have hindered S&T development in Nigeria which include; cultural obstacles and those connected with the production system as well as institutional obstacles. The cultural obstacles implies the influence of societal values, habits and customs. These factors determine resistance or support to change. The difficultly of incorporating S&T in the social structure is a manifestation of an aversion to change. Poverty is also identified as another cultural obstacle to development of S&T.

The characteristics of the production system in Nigeria showed a dual model of underdevelopment:

a. a traditionally agrarian sector which is socially, economically and technologically backward.

b. a modern sector, predominantly urban, relatively industrialized with social and cultural codes similar to developed countries.

This production system tends to hinder the creation of S&T capacity. The institutional obstacles affecting S&T development in the country arise from organizational defects, lack of resources, inefficiency of government agencies as well as the private sector groups concerned with the formulation and implementation of S&T policy.

POLICY RECOMMENDATIONS

1. Science and technology policies are needed to make Nigeria refocus its industrial development process so as to make it more competitive. It is therefore, recommended that government should consider adopting a pragmatic approach to redirect the country's S&T policies in line with the new economic realities. To this end, the policies should aim at reorganization and technological modernization of the industrial sector using

appropriate sectoral policies. Support for R&D activities should be selective and clearly be associated with broader processes of innovation based on the transfer, diffusion and absorption of technological competence.

2. It is obvious that many RIs in the country are becoming irrelevant due to lack of resources and flight of existing pool of scientific competence. In this regard, appropriate measures should be put in place as a matter of urgency in order to deter this process. It is recommended that government should guarantee a stable, predictable and sustainable flux of resources to S&T agencies to enable them perform their statutory functions. Apart from providing the needed resources, it is recommended that concerted efforts should be made to support the most qualified RIs and groups in their ability to keep their best researchers. This will help to stem down both external and internal "brain drain".

   The RIs should be provided with basis equipment and infrastructure to enhance research activities. A program should be initiated that should compensate for oscillations in salaries, guarantee resources for current expenditures and provide means for the acquisition and modernization of scientific equipment. A network of research laboratories should be established for the purpose of embarking on high-level collaborative research.

3. It has been emphasized the importance of both basic and applied research to the socio-economic development of the country. Therefore, it is necessary to develop a three-pronged policy for S&T development with clearly distinguished support mechanisms for basic science, applied science, extension services and education.

   Basic science has the fundamental role to play in enhancing the quality of higher education for scientists, engineers and the society at large. The universities must be empowered to develop explicit links between their graduate and undergraduate programs, support intellectual and financial investments for the development of materials for science teaching as well as research work. Fellowship programs abroad should be revitalized and strengthened. Fellowships should be awarded with a clear perspective of returning to productive work in Nigeria.

   On the other hand, applied research should be strongly supported and evaluated in terms of its short-term scientific and medium or long-term practical results. Lack of appropriate evaluation procedures makes applied R&D runs the risk of being expensive and of doubtful technical and commercial viability. RIs and their projects should be subject to joint evaluations by peer review and policy oriented authorities and be required to compete for research support outside their agencies.

4. Government should begin to place greater emphasis on achieving value-for money in its expenditure on research. This demands an increase in the government activities on R&D evaluation. Assessment should be based not only on the value of research output and whether adequate in–house mechanisms are put in place for monitoring and evaluation but to the continuing “mission relevance” of research institutions.

   Consequently, there is an urgent need to set up a National Committee on Guidelines for Research Evaluation. This will help to promote the introduction of techniques for formal assessment of R&D within government programmes and laboratories.

5. Research should be market-driven. Industrially focused research should demand an understanding between the key stakeholders including industries, RIs and funding agencies. Targets should be set by these stakeholders. The fact that research is initiated in the context of agreed strategic industrial and technological objectives implies that it is generally accepted and that evaluation can often be limited to appraisal of technical performance.

6. Government should encourage the use of publications, citation analysis and patents as indicators of research outputs and technological excellence, especially in relation to the contributions made by research institutions to long-term government-funded research projects where the technological impacts are diffused and economic returns are difficult to predict.

7. On issue of human resource development, policies for science and technology are not expected to succeed without profound transformations in the educational system. This entails increased access to educational opportunities, quality improvement of basic and secondary education,
strengthening of technical education and diversification and better use of public resources in higher education.

   Nigeria has maintained a wide gulf between education for the academic professions, including engineering and middle-level professional training. It should be appreciated that the knowledge intensive basis of modern industry and services requires the development of general skills for the technician. To this end, it is recommended that post secondary technical education should be expanded and developed with close links to industry.

Also, it is absolutely desirable to establish a “programme of policy studies in science and technology within the institutional operating framework of Federal Ministry of Science and Technology with the prime objective of developing a policy research capability within the ministry.

8. There is need to strengthen infrastructure for information and knowledge dissemination. In this regard, new and systematic procedures need to be developed to incorporate technology into the industrial process with greater emphasis on the development and dissemination of norms and standards as well as information and procedures for technology transfer and quality improvement. The dissemination of information on R&D should be encouraged by:

- strengthening national libraries specializing in S&T;
- strengthening national information and documentation and dissemination of bibliographical and non-bibliographical information on S&T;
- encouraging the National Information Technology Development Agency (NITDA) to develope and maintain national scientific and technological database; and
- strengthening NITDA to design national scientific and technological information system and networks which should be inter-connected to other information hubs through wide area network (WAN).

9. Government should embark on institutional reforms of the science and technology system. The agencies for S&T in Nigeria are considered less efficient and highly plagued with problems of political patronage and bureaucratic formalism, considering their civil service nature. This demands that the agencies should be made smaller, more flexible and more efficient. This recommendation has become imperative as these agencies experiences funding limitations.

They do not know how much money they will receive at any given time and their decisions are often based on expectations that are often not fulfilled. Consequently, they have not established adequate procedures to receive proposals in constant values and as such, protect their research grants from inflation. Invariably, they suffer limitation in the sense that when the projects are finally approved their value would have significantly reduced than when they were presented and still lower, when the fund is eventually received and expended.

Furthermore, the research system should be restructured through proper and effective evaluation in order to meet the technological needs of the country as well as ensure support for basic research, applied research, large and small research grants, fellowship and training programmes as well as scientific information. A federal agency to provide long-term, sizeable grants for institutions and cooperative projects in form of a Research Council is advocated. Also, there is a need to develop an effective system for planning, managing and evaluation of research intended to make incremental contributions to S&T. Peer review procedures should be strengthened by the federal government and made free from pressures of institutional interest groups.

10. Collaboration between Federal Ministry of Science and Technology and other ministries such as agriculture, education, environment, industry, health as well as finance and foreign affairs is recommended. The essence is to stimulate the necessary reforms in other branches of the federal government so as to maintain the quality and autonomy of research in both the research institutions under these ministries and federal universities.

    For the foreign affairs ministry, the collaboration is desirable in order to keep the channels open for international cooperation between Nigeria and international agencies and institutions and the international scientific community.

The issue of proper funding of S&T activities has been overemphasized and the Federal Ministry of Science and Technology should explore ways and means of getting the ministry of finance improve on budgetary provision. In this regard, the legislative arms of the government should be enlightened and lobbied on the potentials and benefits of sustainable funding of S&T. Also, concerted efforts should be made to promote venture capital scheme and specialized funding schemes to bring the benefits of research to the society.

11. Government should pursue goal-oriented national projects and also promote through such projects, technology capability building. There is need to adopt well-identified projects linking science, technology and the productive sector with the primary aim of strengthening specific fields and research orientations. Scientific R&D should take place in a highly internationalized and competitive environment for resources, prestige and recognition, and the leading scientists should also be entrepreneurs of this knowledge enterprise.

Finally, the recognition that economic growth and competition must now have a central position in the formulation of S&T policies is the driving force for national development. The desire to commercialize S&T is assuming wider dimensions globally. Developed nations have shown commitment to embrace commercially-oriented S&T policies and as such, have provided the platform for development of commercial technology as well as the diffusion of technology and strengthening of industrial capacity to absorb technology information. Nigeria need not and should not be left out in the emerging global realities on the application of S&T to national development.

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Appendix I: .A. LIST OF MAJOR RESEARCH AND TECHNOLOGY ORGANISATIONS IN NIGERIA

S/N	Name of Institution	Location	Functions
	A. <u>Science and Technology</u>		
1.	Federal Institute of Industrial Research Oshodi (FIIRO), Lagos.	Lagos	Research and development into food processing, agro allied, textiles pulp and paper, design and fabrication of prototypes micro-electronics and information services
2.	National Office for Technology Acquisition and Promotion (NOTAP), Abuja	Abuja	Vetting registration and monitoring technology transfer agreements, documentation innovations and inventions and promotion of intellectual property rights.
3.	National Research Institute for Chemical Technology (NARICT) Zaria	Zaria	Research into industrial chemicals, polymers and plastics, hides and skins including leather and leather products
4.	Nigerian Building and Road Research Institute (NBRRI) Abuja	Abuja	Research into engineering materials and the use of local materials and methods in road and building construction.
5.	Project Development Institute (PRODA), Enugu	Enugu	Research into engineering design and fabrication,

			ceramic products, electrical and electronics products; energy, including coal
6.	Raw Materials Research and Development Council (RMRDC), Abuja	Abuja	Support and expedite industrial development and self reliance through the maximum utilisation of local raw materials as inputs for the industries.
7.	Nigerian Institute for Trypanosomiasis Research (NITR), Kaduna	Kaduna	Research into tsetse and simulum flies and diagnostic methods on the control of onchoereciasis and trypanosomiasis.
8.	National Agency for Science, and Engineering Infrastructure (NASENI), Abuja	Abuja	Research into engineering infrastructure development
9.	Nigerian Stored Products Research Institute (NSPRS), Ilorin	Ilorin	Research into stored and preservation systems for agricultural produce.
10.	Scientific Equipment Development Institute	Enugu & Minna	Equipment development, glass wares fabrication.
11.	Technology Business Incubators.	Aba, Nnewi, Lagos & Kano.	Incubating small business in order to commercialize research results, inventions and process innovations.
12.	Regional Program for Technology Management	Lagos	Human resource development in Technology management

13.	National Centre for Technology Management B. **Agricultural Sciences**	Ile-Ife	Training of Technology Managers.
14.	Agricultural Extension and liaison Services (AERLS).	Zaria	Overall planning and coordination of all agricultural extension; specialist support activities in crops, livestock, fisheries, forestry irrigation, agric engineering and food technology, collation and dissemination of agric. innovations to states extension services.
15.	Cocoa Research Institute of Nigeria (CRIN) Onigambari	Ibadan	Research in cocoa, kola cashew, coffee and tea.
16.	Forestry Research Institute of Nigeria (FRIN)	Ibadan	Research into natural forests, plantations, wood products and wild life.
17.	Institute for Agricultural Research (IAR)	Zaria	Research into (a) genetic improvement of sorghum, groundnut, cowpea, cotton and sunflower, (b) farming systems research and extension covering Northwestern Nigeria.
18.	National Animal Production Research Institute (NAPRI)	Zaria	Research into cattle, goats' sheep and poultry as well as into animal feeds and exotic breeds.

19.	Institute for Agricultural Research and Training (IAR &T)	Ibadan	Research into maize, kenaf, jute and soil sciences.
20.	Lake Chad Research Institute (LCRI)	Maidu-guri	Variety improvement of wheat and barley. Improvement of farming systems and all agricultural crops.
21.	National Institute for Freshwater Fisheries Research (NIFFR)	New Bussa	Research into fresh water fisheries and other aquatic resources in rivers, natural and man-made lakes.
22.	National Root Crops Research Institute (NRCRI)	Umudike	Research into yams, cassava, cocoyam, Irish Potatoes and ginger. (b) farming systems research and extension covering the South-Eastern Agricultural zone.
23.	National Veterinary Research Institute (NVRI)	VOM, Jos	Research into livestock diseases and their control including the production of vaccines and sera.
24.	Nigeria Institute for Oceanography and Marine Research (NIOMR),	Lagos	Research into the geographical phenomena of the Nigerian ocean bed and the contiguous landmass, research on marine and brackish water fisheries and oceanography.
25.	Nigerian Institute for Oil Palm	Benin	Research into oil palm

	Research (NIFOR)		coconut, raffia palm and ornamental palms and dates
26.	Rubber Research Institute of Nigeria (RRIN)	Benin	Research into natural rubber and its by products.
27.	National Horticultural Research Institute (NIHORT)	Ibadan	Research into fruits vegetables, their processing and preservation and development of indigenous ornamentals.
28	National Cereals Research Institute (NCRI)	Bida	Research into rice, soyabeans, beniseed and sugar cane.

B. RESEARCH AND DEVELOPMENT AGENCIES / PROJECTS

1. African Regional Centre for Engineering **Design and Manufacturing** (ARCEDEM), Ibadan.
2. Centre for the Adaptation of Technology (CAT), Awka
3. Energy Commission of Nigerian (ECN), Lagos
4. Hydraulics Equipment Development Institute (HEDI), Kano
5. National Agency for Science and Engineering Infrastructure (NASENI), Lagos.
6. National Centre for Genetic research and Biotechnology (NACGRAB), Moor Plantation, Ibadan.
7. National Centre for Remote Sensing (NCRS), Jos
8. National Centre for Technology Management NACETEM), Ile-Ife

9. Regional Centre for Technology Management (RECTEM), Lagos

10. Scientific Equipment Development Institute (SEDI-E), Enugu

11. Scientific Equipment Development Institute (SEDI-M), Minna

12. Sheda Science and Technology complex (SHESTCO),Abuja

13. Technology Business Incubator Centre, Aba

14. Technology Business Incubator Centre, Kano

15. Technology Business Incubator Centre, Lagos.

C. RESEARCH AND DEVELOPMENT TRAINING INSTITUTIONS

1. * College of Animal Health and Husbandry, VOM (NVRI)
2. * College of Chemical and Leather Technology, zaria (NARICT)
3. * Federal Fisheries School, Lagos (NIOMR)
4. * Federal Freshwater Fisheries School, Baga, Maiduguri (LCRI)
5. * Federal Freshwater Fisheries School, New Bussa (NIFFR)
6. * Federal Mechanization School, Afaka (FRIN)
7. * Federal School of Agriculture, Umudike (NRCRI)
8. * Federal School of Forestry, Jos (FRIN)
9. * Federal School of Wildlife Management, New Bussa (FRIN)
10. *School of Agriculture, Akure (LAR&T)
11. *School of Agriculture, Moor Plantation, Ibadan (LAR&T)

12. *School of Animal Health and Husbandry, Ibadan (LAR&T)

13. *School of Forestry, Ibadan (FRIN)

14. *School of Medical Laboratory Technology, Vom (NIYR).
    - **Not under FMST.**

D. FEDERAL MINISTRY OF SCIENCE AND TECHNOLOGY

FUNCTIONS AND MANDATE

i. Formulation, monitoring and review of the National Policy on Science and Technology;

ii. Promotion and administration of technology transfer programmes;

iii. Promotion and co-ordination of scientific and technological research and development activities and technological innovation in agricultural, industrial, communications, electronics, medical, pharmaceutical, road and building energy research and the basic sciences;

iv. Promotion and co-ordination of scientific and technological innovation, development, assessment, adaptation and production, including the development of scientific and technological infrastructure;

v. Co-ordination and supervision of the research and development efforts of all the national research institutes and agencies, and the development and production activities of the national infrastructure development complexes;

vi. Establishing, promoting and maintaining federal-state linkages in science and technology;

vii. Establishing and maintaining relations with scientific, technical and technological bodies and agencies of the O.A.U., the United Nation's Agencies, the Commonwealth secretariat and its Agencies, the ECOWAS, as well as other regional bodies and bilateral and multilateral arrangements through active contributions to and national representation in these bodies agencies and organizations.

Appendix II: IMPACT-ORIENTED RESEARCH RESULTS AND INVENTIONS

A	ASSOCIATION OF INVENTIONS/RESEARCHERS			
S/N	Name of Researcher	Address	Project	Project Status
1	Aloysius Ohanuwa	No. 72 Yalode Street, Barracks Bus Stop, Ajegunle Lagos.	Wine Making machine	Completed/awaiting commercialization
2	Chinedum Micah Njoku	C. Micah Intern. Co. Tech. Business Incub. Centre, Aba Tel: 082-225320, 227622	• Developed soy-chips • Soy-corn flakes • Soy-meat pie	"
3	Ifeanyi G. Muokwue	No. 11, Abeje Street, Off Aduke Street, ECN Bus stop, Ojo Rod Lagos	• Production of carbon black from waste tyre • Production of liquid starch from neem plants (CMC) • Kerosine pressing iron • Automatic remote gun firing 5,000 bullet • Home cooking machine • Automatic gate with inbuilt camera	"
4	Elijah N. Oluikpe	Elinuol & Co. Nig. Ltd., Faulks Rd. Aba	• Alkyd Resin • Surfactants • Foam suppressants	"
5	Jude Ulibueze	No.33 Rufai Street Olowojenye Bus stop, Ajegunle Lagos	• Foam making machine	"
6	Mr. Innocent Okongwu	Isu-Umuaba Village, Oba, Idemili South LGA Anambra State	• High blood pressure syrup	"
7	Ndememoh Okon	Ikot Ubok Udom, Odot Sub-post, NSIT ATAI, Akwa Ibom State	• Manufacture of paints using 100% local content	"
8			• Banana Resources- wine, banana sugar, vinegar	"
9	Anthony Olwale Ajakaiye	WALLEX Prod. Plot 8, Ulor Street, Ire-Akari Estate, Isolo, Lagos	• Digital Satellite Radio Telecommunication system (Concept)	"
10	Engr. Okorie E. Ukonu	Emec Eng. Works, 1, Osoba Avenue Ipaja Town, Lagos	• Geomantic Mathematical Calculator as an aid for	"

			the teaching and learning of mathematics in Nigerian Schools and Colleges	
11	Mr. John Ositadinma	14 Rukyat Bamire close Ojo Alaba, Lagos	• Carbon black making machine	“
12	Mr. Lazarus O. Okoli	Bio Medicine Prison Barracks Kiri-kiri, Apapa, Lagos	• Gas pressing iron	“
13	Mr. Oluchi C, Meaku	No. 5 Salako St. Mushin, 114 opp. F29, oshodi main mkt, Lagos, Tel:01-4528149	• Automatic voltage monitor • Telephone Interaction • 250w-500w DC to AC • Siren Alarm/Door Bell • Security Light	“
14	Obioha O. C. Onuha	12 Boundary Rd Ajegunle, Lagos	Electric Industrial Steam pressing Machine	“
15	Mr. John Ositadinma	14 Rukyat Bamire Close Ojo Alaba, Lagos	• Gum Arabic melting machine • Carbon Black making machine	“
16	Sansea Ltd.,	7A Kolawole Ashimi Rd. Ogudu GRA Ojota, Lagos	• Farming and extraction of citronella oil • Farming and extraction of lemongrass oil	“
17	Udeme S. Akpimoh	EsaUso Metal Works, Ikot Ubokudom Ngit Atai LGA, Akwa-Ibom	• Oil Palm digester for crushing of oil palm fruits for oil • Manual press for oil palm fruits • Cassava grating machine	“
18	Dr. Eghosa Igbinosa	No.11 Osunde Street, Upper Sokponba Rd, Benine City	• Manual soap tableting machine for small scale industries	“
19	Dr. P. O. Idemudia	5, Iriagen Avenue, Off Goodwill Rd, Benin City	• Design and manufacture of Environmental Cleaning Kit	“
20	CEO	Nosmek Eng. Akwa-Ibom State	• Spent Lubrication Oil	“
21	CEO	Ekanem Brothers Akwa-Ibom State	• Automatic voltage regularor (AVR)	“

22	Dum Mwidum	Logistics Section, Radio Rivers, PMB 5170, Pot Harcourt	• Electro-Mechanical Traffic Lights	“
22	Coolgo Tech. Coy	20 Oleh Rd. IRRI, Isoko South LGA Delta State.	• Manufacturing of Automotive Rebouring Machine	“
22	Sigma Technical Agencies Ltd.	218 Trans-Amadi Layout Port-Harcourt.	• On-line testing and calibration of relief valves	“
23	Banji Siak Camera Tech.	8, Akode Street, off Memumu Aremu St. P.O. Box 8043, Surulere Lagos. Tel. 01-836281	• Bascalite Photographic studio lighting	“
B		RESEARCH INSTITUTIONS		
	CRIN	Cocoa Research Institute of Nigeria (CRIN), Ibadan		
24 25	Cocoa Research Institute of Nigeria (CRIN) FIIRO	CRIN Federal Institute of Industrial Research, Oshodi (FIIRO), P.M.B 21023, Ikeja, 01-523205 Ext. 151	• Soap from palm/cocoa waste for domestic and industrial washing • Wine made from cocoa for human consumption • Technology of processing and utilization of unfermented oil-palm sap • Design, Dev. And Fabrication of 60kg/hr groundnut roaster • Design, Deve. And fabrication of par boiler equipment for instant yam flour project • Design and dev. Of a reactor for adhesive from cassava starch • The technology for canning local cow peas(but the adequacy of sterilization remains to be fully justified • Apparatus for the stabilization of wines and fruit juice • Equipment for stabilizing wines and juice by cooling	“

			• Local plant fibres for the production of weaving yarns • Machinery and equipment for the production of wood pulp • Utilization of wood wastes for the production of particle boards and fibre-boards • Organonosly pulping of some Nigerian woods • Retting of some local plant fibres for the production of eaving yarns. • Treated botled palm wine toi extend shelf life • Maize flour/girls-Pulverised maize grain. • Benniseed oil-extracted oil from Benniseed • Mechanized mass production of fufu, yam cassava flour • Vinegar-Liguid preservative for fruit and vegetable • Soy ogi-soya bean flour as baby food • Baby hair pomade cream • Sorghum malt for breweries and beverages • Poultry feed for animal production • Induced breeding of clarias- to achieve all season breeding of fish fingerlings • Design and fabrication of flavour distillation apparatus • Design and fabrication	

			of essential oil distillation still for leafy aromatic plant materials.	
26	FRIN	Forestry Research Institute of Nigeria, Ibadan	• Roofing titles-concrete sheets • Sawdust/cement roofing sheets for roofing, ceiling and flooring • Treated electric wooden poles for electricity transmission	
27	Institute for Agricultural Research, Samaru, Zaria-Kaduna- State	Institute for Agricultural Research (IAR) Samaru, PMB 1044, Zaria, Kaduna State 069-55071-4 “	• Development of a range of animal drawn implements • Portable solar energy • Motorize maize sheller dehusker • Motorize cowpea sheller • Motorize multi-crop thresher • Animal drawn emcot rotary weeder • Manually operated milk churner • IAR bicycle cart-special cart mounted on two bicycle wheels for farm produce transporting • Rope-wick herbicide applicator-dispenser for pest control • Manual maize sheller-metal sheet frames & housing, manually operated for maize grain extraction • Land leveler (Animal Drawn) – Blade fixed to a hopper for leveling tiled soil • Mechanical thresher/sheller-device to thresh and shell grains • Solar Drier-compact	

			drier made of glass miled steel and wood • Manual operated ground meter shroud sprayer for spraying equipment • Sorghum thresher-electrically powered rotating cylinder with crossbars for sorghum processing • Groundnut thresher-engine powered rotating metal cylinder with blades • Manual grain mill-consists of rotor fixed screen and power unit • Oxen drawn lawn mower-rotating drum with cutting edge for lawn mowing • Manual fruit picker-A bag fixed to an oval ring • Milk churner device for milking cow	
28	NIFOR	Nigerian Institute for Oil Palm Research, Benin City	• Motorized nuts fibre separator • An appropriate technology for the extraction of coconut and palm kernel oil • Palm waste briquette • Palm waste briquette stove	
29	(IITA), Ibadan	International Institute for Tropical Agriculture	• Hand hoe-push and pull mechnical machine for weeding and hoeling crops • Groundnut sheller mechanically operated concave hopper for removal of groundnut shell • Modified wheel barrow	

			to transport farm produce • Motor cycle equipped with side cart for local transport • Chopping machine to chip yam/ cassava etc • Device to facilitate fermentation of tubers • Mechanical thresher sheller to thresh & shell grains • Grain sorter/cleaner-vibrating device with varying sizes of stiffer • Grinder (wet/dry) power driven mechanical device to grind food stuff • Dryer/storage bin-Cylinderical type • Sickle-Manually operated harvester • Knapsack type-manually operated harvester • Huller and Decorticator-Machine for descaling grains and fruits e.g. rice cowpea and soyabeans • Garri fryer-Drum like pots with burners attached • Garri frying machine with accessories	
30	Lake Chad Research Institute-Maiduguri-Borno State	Lake Chad Research Institute-Maiduguri-Borno State PMB 1293 Maiduguri 07-231188	• Threshing machine for wheat barley, rice and millet • Breeding early maturity high yielding millet varieties resistant to stigma • A heat tolerant wheat variety LACRI WHIT-1 yielding 4-5t/ha was released to farmers in	

			1998. • Two improved millet varieties, GB 8735 and SOSAT-C88, with potential yields of 2.3t/ha and early maturing (60-80 days) were developed • Multipurpose threshing machine • Breeder seed production	
31	NCAM	National Centre for Agricultural Mechanization, Ilorin	• Manual cassava lifter-U-shaped frame equipment for cassava harvesting • Par boiler- boiler comprising oil drum divided into soaking and steaming chambers for parboiling of rice • Manual seed planter for planting crops • Hand hoe-push and pull mechanical machine for weeding and hoeing crops • Biogas digester- A drum with inlet and outlet pipes utilization of energy for cooking • Manual maize sheller-metal sheet frame and housing manually operated for maize grain extraction • Groundnut sheller mechanically operated concave hoper for removal of groundnut shell • Pedal operator cassava grater • Solar drier-compact drier made of glass mild steel and wood for compact drier made of	

			glass mild steel and wood • Multi purpose low cost spraying device for fertilizer • Multi purpose manual seed planter	
32	IARS	Institute of Agricultural Research, Samaru	• Industrial laundry equipment	
33	NCRI	National Cereal Research Institute, Badegi	• Brown Sugar Processing plant • Par boiler- boiler comprising oil drum divided into soaking and steaming chambers for parboiling of rice, mini sugar processing plant centrifuge- electrical operated rotary-for laboratory production	
34	National Horticultural Research Institute (N.H.R.I.) – Ibadan – Oyo State	National Horticultural Research Institute (NHRI), PMB. 5432, Idi-Ishin, Ibadan 02-2412230	• Availability of improved tomato seeds (varieties) • Availability of improved pepper varieties • Biological control of rastiococcus invaders, using G. tebygi • Control of tomato wit disease using integrated approach • Indexing of pests/diseases of horticultural crops • Cultural control of nematode pests using sequential crop rotation • Fruit for concentrate- extracted fruit for beverage industry • Plantain wine • Split citrus and plantain propagation-technique for citrus and plantain plant reproduction • Baby food-cereal based	

			weaning food • Improved Budded plantain material • Improved small scale orchard-plantain for variety of fruits for production	
35	National Research Institute for Chemical Technology (NARICT), Zaria – Kaduna State	National Research Institute for Chemical Technology (NARICT), PMB. 1052, Zaria. 069-50510, 34503	• Pilot scale production of pancreatic/fungal composite bate for use in leather manufacture • Extraction and utilization of Cissus aralioides in the bating and deliming process of leather manufacture • Multi-purpose dryer • Ventilated collapsible fruit crates • Evaporative coolers • Plastic crates • Solar trays • A rectangular vertical kiln and the firing devices • Refractory bricks for kiln construction • Hydrated lime plant • Design of burner systems for firing local kilns using various fuels	
36	National Root Crops Research Institute (N.R.C.R.I) – Umudike – Abia State	National Root Crops Research Institute (NRCRI), PMB 7006, Umudike, Umuahia, Abia State	• Cassava peeling tool • Cassava bicycle grater • Boom sprayer • Ginger splitting machine • Ginger dryer	
37	Nigeria Institute for Oceanography and Marine Research, Lagos (NIOMR)	Nigeria Institute for Oceanography and Marine Research Lagos (NIOMR)	• Container for fingerlings-Insulator fibre glass tanks for transport of fingerlings • Fish canning for human consumption • Improved beach sieve net-fish trap for fish production • Processed fish	

			products-fish mince, fish cake and fish savage • Gas smoking kiln made of mild steel panel with angle bar for fish smoking.	
38	Nigeria Institute for fresh water fisheries research Kanji Lake (NIFFR)	Nigeria Institute for Fresh Water Fisheries Research Kanji Lake (NIFFR)	• Fish feed-fish growth feed • Gas smoking kiln made of mild steel panel with angel bar for fish smoking	
39	NBRRI)	Nigeria Building & Road Research Institute (NBBRI)	• Fibre cement roofing sheets • Device for fastening string for building construction • Roofing titles- concrete sheets • Concrete block moulding machine • Brick kiln-coal fried brick kiln for making burnt bricks • Bick kiln –coal fired brick for making burnt bricks • Stabilized bricks production • Mador tiles (roofing tiles) production machine • Burnt bricks production machine • Lime kiln for lime production • Sky luminance for lighting device for building site	
40	Nigerian Stored Products Research Institute (N.S.P.R.I.) Ilorin-Kwara State	Nigerian Stored Products Research Institute – KM 3, ASA – Dam Rd PMB 1489, Ilorin.	• Inert atmosphere silo storage • Domestic storage techniques (Hermetic) • Multipurpose dryer • Technology for cassava cuttings	

			• Storage of cassava roots in boxes and trenches • Ventilated collapsible fruit crates • Evaporative coolers • Vegetable baskets solar trays	
41	Project Development Institute Enugu (PRODA)	PRODA	• Industrial gas burner-perforated metal pipe burners for garri fryers/gas cookers • Crucible pot for oil fired furnace-clay graphite crucible for melting steel and metal scrabs. • Carbon brushes-black of compacted solid mass of metallic and non -metallic powder • Gravity die-casting engine piston produced by die casting process for 4 stroke engine and GHP plants • Cottage pottery plants • China wares for table wares and house decorations • Plaster of paris for treatment of fractures in hospitals • Microchip computer for industrial process control • pelleting machine to produce fish feed in pellet • Oil fired tilting furnace heat resistant melting pot with tilting mechanism for melting ferrous and non ferrous metals • Porcelain-electrical insulating device for	

			power transmission • Hammer mill-metal for grinding of grains • Ceramic ball-mill machine with 750kg capacity for milling of feldspar for ceramic industry	
42	Rubber Research Institute of Nigeria Benin-City-Edo State	Rubber Research Institute of Nigeria (RRIN) KM 19, Benin-Sapele Rd, PMB 1049, Benin-City. 052-254792	• Development of high yielding rubber clones called NIG 800 series clones • Development of spacing techniques for rubber cropping systems • Development of basic agronomic practices for intercropping pleurotus tuber regium, an edible mushroom, with mature rubber • Strand selection and polybag production of the edible mushroom • Pleurotus tuber-regium, as an intercrop with mature rubber • Construction of a low-cost mushroom production unit for use under mature rubber • Large scale production of two popular local edible mushrooms pleurotus, tuber-regium and lentinus squarrosuium • Large scale production of the medicinal scletotia of pleurotus tuber regium • Mixed farming with farm, Animals and mini-live-stock snails, honey bee grass cutter etc.) after canopy closure	

			• Integrated snail farming in mature rubber (an aspect of mini-live-stock development as sustainable agric) • Integrated bee-keeping in mature rubber (mini-livestock development in sustainable agric business) • Intercropping of young rubber with food cross-cowpea, soyabean, yam, maize, melon • Grass cutter farming technology • Snail farming technology • Bee-keeping technology • Studies on effluent from rubber processing factories • Quality assurance of Nigerian natural rubber • Extraction and analysis of rubber seed oil • Refining of rubber seed oil • Optimum storage conditions for rubber seed oil • Preparation and analysis of rubber seed oil-modified alkyd resins • Molecular weight characterization and estimation of dilute solution viscosity parameters of rubber seed oil-modified alkyd resins • Water-soluble rubber seed oil alkyd resins • Production of rubber seed oil	

			• Utilization of rubber seed oil and its derivatives as processing aids for natural rubber • Special chemicals developed for leather treatment • Sopa, shampoo and body cream for body care from rubber seed oil • Paints and wood varnishes from rubber latex • Alkyd resins from rubber seed oil for cosmetic, soap • Putty-malleable substance made from rubber for sealing leakages • Technique for faster graving of rubber	
43	Centre for Adaptation of Technology (CAT) Awka	Awka Anambra State	• Gordian Automatic Voltage Regulator • Industrial Camera • Digital Information Display • Solar Powered Inverter • Software Development • Printed Circuit Board • Plate Maker	
44	GOMELA ELECT. IND. NIG.	Technology Business Incubation Centre, Federal Ministry of Science and Technology, Aba. 082-227622; 225320	• Hair dryer for use by beauty saloon operators • Electric kettle for domestic and small scale industrial uses • Ring boiler for domestic and small scale industrial uses	
45	C. MICAH INTERNATIONAL COY.	Technology Business Incubation Centre, Federal Minstry of Science and Technology, Aba. 082-225320, 227622	• Automatic control electric oven for domestic and industrial uses • Electric stove.	

			• Developed Soy-chip • Soy-corn flakes • Soy-meat pie	
46	Gelaz Vent. Nig. Ltd.	ATBIC/FMST, Aba, Abia State	• High quality kiln scouring powder	
47	The Technology People	Technology Business Incubation Centre, P.O. Box 11787, Farm Centre, Kano, 668169, 668063	• Vacuum filling machine (liquid) and powder filling machine • Kaolin sterilizer with temperature control (pharmaceutical) • Polythene shrinking machine and polythene scaling machine • Bottle sterilizing oven with temperature control and Homogenisen • Domestic ovens (Gas and Electricity) and grinding machines	
48	Hattara Ceramics	Technology Business Incubation Centre, P.O. Box 11787, Farm Centre, Kano, 668169, 668063	• Kick-wheel • Kiln	
49	Maicingum Genery Enterprises	Technology Business Incubation Centre, P.O. Box 11787, Farm Centre, Kano, 668169, 668063	• Bone Crusher • Soap Cutter • Fire Blower	
50	Kobby Manuel Nig. Limited	Unit A4, Technology Business Incubation Centre, Federal Ministry of Science and Technology, Aba, 082-229953, 2244339	• Production of PKO with higher percentage content of fatty acid	
51	Oshatuya Ass. Nig. Ltd	Halleluya House Opp.Sch. of Handicapped via WAEC office Ibadan, Tel: 02-8104477	• Dayo Gasified Kerosene Cooke (N. Pressure, No ick)	
52	Engr. Salaiman Famro	21 Reservation Rd, GRA Ilorin Kwara State.	• Sulamro Drying System	
53	Emos & Sons Ent. Nig.	Opara & Uzaime, Etsako West, Edo State.	• Beekeeping for training and research • Developed citrus farm for Bee farm and Honey Production	

Appendix III: QUESTIONNAIRE

This Questionnaire is aimed at collecting data for the purpose of appraising the impact of Science and Technology Policy and R&D on National Development in Nigeria.

This research work is purely an academic exercise and all information provided will be treated with strict confidentiality.

Kindly respond as vividly as possible to the following questions.

1.0 **GENERAL**

1.1 Name of Organization...

Address...

Date of Establishment...

Name of Supervising Ministry...

....

....

1.2 Staff Strength: Please indicate the number of researchers in your establishment as indicated below:

a. With PhD...

b. With M.Sc..

c. With B.Sc...

1.3 How many of your staff are into the following activities:

a. Research...

b. Consultancy...

c. Extension……………………………………………………………………………

d. Administration…………………………………………………………………….

1.4 Please, state briefly your organizational mission and vision:

a. Mission…………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

b. Vision……………………………………………………………………………….

……………………………………………………………………………………….

……………………………………………………………………………………….

1.5 Kindly state briefly your core mandates:

……………………………………………………………………………………….

……………………………………………………………………………………….

………………………………………………………………………………………

2.0 SCIENCE AND TECHNOLOGY POLICY (S&T)

2.1 Please indicate if you are aware or not of the existence of an Science and Technology (S&T) Policy in Nigeria.

a. Aware
b. Not Aware
c. No Idea

2.2 If you are aware, is it readily accessible to you and the public?

a. Yes ☐ b. No ☐

2.3 In my opinion, S&T Policy has been a critical determinant of development performance in Nigeria:

a. Yes ☐ b. No ☐

2.4 Kindly support your response to Question 2.3 with reasons.

………………………………………………………………………………………….

………………………………………………………………………………………….

………………………………………………………………………………………….

2.5 S&T Policy generally aims at enhancing competitiveness of an economy and at fostering economic growth. Kindly indicate if you

a. Strongly agree ☐ b. Agree ☐

c. Disagree ☐ d. Strongly disagree ☐

2.6 Science and technology policy has not played a critical role in national development of Nigeria.

a. Agree ☐ b. Disagree ☐ c. No idea ☐

2.7 Kindly state your reasons to support your response above (2.6)

………………………………………………………………………………………….

………………………………………………………………………………………….

………………………………………………………………………………………….

2.8 The Nigerian society is not aware of and do not contribute to the formulation of S&T policy.

a. Agree ☐ b. Disagree ☐ c. No idea ☐

2.9 Lack of demand for innovations in industry and agriculture is responsible for inability of S&T to impact on national development

a. Yes ☐ b. No ☐ c. No idea ☐

2.10 Kindly indicate if the National S&T Policy is evaluated to determine its impact in addressing the societal needs

a. Regularly ☐ b. Occasionally ☐

c. Not at all ☐ d. No idea ☐

2.11 Which of the following types of policy process do you think should be adopted in Nigeria?

a. Minor (Restructuring of existing programme) ☐

b. Major (Design and implement important new programme) ☐

c. Integrated (Developing new explicit strategy) ☐

d. No idea ☐

2.12 The Federal Ministry of Science and Technology has effectively collaborated with other key S&T stakeholders (policy makers, administrators, academicians) in fostering integrated approach to national development efforts.

a. Agree ☐ b. Disagree ☐ c. No idea ☐

2.13 Kindly support your view with reasons.

……………………………………………………………………………………………………

……………………………………………………………………………………………………

……………………………………………………………………………………………………

3.0 SCIENCE AND TECHNOLOGY LITERACY

3.1 Kindly respond as appropriate to the following statements regarding S&T literacy. For each statement, give your opinion on how strongly you agree (4) or disagree (1) with the statement.

S/No	Statement	Strongly Disagree 1	2	3	Strongly Agree 4
1	There is poor understanding of the essential characteristics of S&T.				
2	There is poor understanding of how S&T influences the society and its development				
3	The S&T Policy in Nigeria has not recognized the need for technological literacy.				
4	Nigerians are not equipped to make well-considered decisions about S&T.				
5	Most policy makers at the Federal and State levels paid little or no attention to S&T education.				
6	There is lack of attention to technology literacy among policy makers.				
7	S&T policies in Nigeria are not people oriented, market-driven and job-creation.				
8	S&T Policies cannot guide national development efforts.				

3.2 Has the National Assembly considered a significant number of bills to promote S&T education and technology literacy in Nigeria?

a. Yes ☐ b. No ☐ c. No idea ☐

3.3 If your answer to 3.2 is Yes, has any of the bills become law in the past 5 years of democratic government.

a. Yes ☐ b. No ☐ c. No idea ☐

3.4 Please, assess the legislators and their staff as:

a. Technologically literate ☐

b. Technologically illiterate ☐

c. Lack understanding of S&T ☐

3.5 In your opinion, do you think that the legislators are aware of the existence of a National S&T policy?

a. Yes ☐ b. No ☐ c. No idea ☐

4.0 NATURE OF R&D

4.1 Which of these researches is your organization mainly involved

- Mission oriented research (ie fulfilling the objective and mandate of the organization) ☐
- Scientific institutional research (mandate defined in scientific terms) ☐
- Academic research ☐
- Others (please specify)………………………………………………….

4.2 What type of R&D service do you provide that target market needs?

a. Applied research only ☐

b. Basic research only ☐

c. Both ☐

4.3 Who are the major beneficiaries of your research activities?

a. The Public ☐

b. The Government ☐

c. The Private Sector (Industry) ☐

4.4 Need or market-driven research is lacking in Nigeria. Kindly comment briefly on this statement if you agree or disagree.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

4.5 Do you consider it necessary to have a national R&D policy distinct from S&T policy

a. Yes ☐ b. No. ☐ c. No idea ☐

4.6 Kindly give reasons for your response to the above question.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………

4.7 The following statements have been designed to determine the perception of research and the role of science and scientists in society. Kindly rate your opinion by indicating how strongly you agree (5) or disagree (1) with the statement.

	Statement	Strongly Disagree 1	2	3	4	Sstrongly Agree 5
1	Science contributes to development					
2	Science knowledge is universal					
3	Science should firstly produce knowledge					
4	Science should mainly lead to useful innovations					
5	Researchers should have entrepreneurial skills					
6	Science is public knowledge					
7	Researchers are free to chose their own research topics					
8	Researchers should produce goods for a competitive market					
9	Research problems are set by clients					
10	Research topics are set by sponsors					
11	Research topics are set by parent Ministry					

4.8 Kindly comment on the following statements by responding as appropriate, strongly agree (5) and strongly disagree (1)

	Statement	Strongly Disagree 1	2	3	4	Strongly Agree 5
1	Research Institutes (RIs) operate largely without sustained collaboration with users of research result (productive sector)					
2	RIs lack capacity to commercialize research findings due to their narrow mandates.					
3	RIs primarily funded by national public funds are grossly under-funded.					
4	Targets and goals are not set for RIs. performance on continuous basis					
5	There is lack of effective monitoring and evaluation of performance on continuous basis					
6	The mandates of RIs are wide with diffused focus resulting in ineffectiveness.					
7	Remuneration in the RIs are grossly inadequate to attract and retain top-rate scientists and engineers.					
8	RIs are known to be weak in the area of information dissemination of their results and general services					

9	There is little or no linkage between RIs and industry.					
10	SMEs are financially weak and lack expertise to exploit R&D results.					

4.9 Please, propose strategies for strengthening R&D capacity building under the following subject areas

a. Manpower...

....

....

b. Linkages with industry..

....

....

c. Funding..

....

....

d. Targeting of technologies, project and processes..

....

....

....

e. Strengthening intellectual property right..

....

....

4.10 Kindly list in the order of priority your scientific breakthroughs that could have impact on national development.

………

………

………

4.11 What were your sources of research funds?

Sources	Name of funding Organization
Home Institution (Internally generated)	
Government (Ministry)	
Industry or Private Organization	
International Organization	
Others (Specify)	

4.12 Kindly state your research budget from the year 2000 to 2003

Research Budget	2000 (Million ₦)	2001 (Million ₦)	2002 (Million ₦)	2003 (Million ₦)
Proposed				
Actually released				

4.13 Certain obstacles have been listed below as affecting R &D generally. Indicate by circling the relevant number (1,2,3,4) whether they are 1=insignificant 2=slightly significant, 3=significant or 4=highly significant

1 2 3 4	Poor Funding	Lack of managerial skills	1 2 3 4
1 2 3 4	Lack of qualified staff		
1 2 3 4	Access to equipment	Lack of technicians	1 2 3 4
1 2 3 4	Lack of facilities (eg.electricity-water)	Field work difficulties	1 2 3 4
1 2 3 4	Equipment repairs	Lack of monitoring and evaluation	1 2 3 4
1 2 3 4	Access to supplies	Access to project vehicle	1 2 3 4
1 2 3 4	Low morale	Access to scientific documentation	1 2 3 4
1 2 3 4	Lack of motivation		
1 2 3 4	Lack of patronage by the business community		
1 2 3 4	Others (Specify)……………………………..		

4.14 Government attitude towards the performance of Research Institutions has been very negative (1=strongly disagree, 2= disagree, 3=agree, 4=strongly agree

1 2 3 4

4.15 How often do you communicate with the following people regarding your R & D? (1=never, 2= rarely, 3=annually, 4=monthly, 5=more often)

1 2 3 4 5 Scientists in your institutions

1 2 3 4 5 Scientists from other institutions in Nigeria

1 2 3 4 5 Scientists from other institutions outside Nigeria

1 2 3 4 5 Industries

1 2 3 4 5 Funding agencies

1 2 3 4 5 Private clients

1 2 3 4 5 Others (Specify)..............................