



TOGETHER
for a sustainable future

OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.



TOGETHER
for a sustainable future

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as “developed”, “industrialized” and “developing” are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

19945

5f
ta
map

Distr.
RESTRICTED

IO/R.256
9 November 1992

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ORIGINAL: ENGLISH

FACT FINDING AND PREPARATIVE ASSISTANCE IN THE PROCESSING
OF NIGERIAN MEDICINAL AND AROMATIC PLANTS FOR INDUSTRIAL UTILIZATION

NIGERIA

Technical report: Preparatory Assistance Mission*

Prepared for the Government of Nigeria
by the United Nations Industrial Development Organization

Based on the work of K.H.C. Baser, Pharmacist/Team Leader, and
M.B. Narasimha, Chemical Technologist

Backstopping Officer: T. De Silva, Chemical Industries Branch

* This document has not been edited.

V.92-58496

TABLE OF CONTENTS

	<u>Page</u>
Acknowledgment	
Executive Summary	
1. <u>General Introduction</u>	1
1.1 Objectives of the Mission.....	1
1.2 Brief Information on Nigeria.....	1
1.3 Information on Pharmaceutical Industry in Nigeria.....	2
1.4 Medicinal and Aromatic Plant Potential in Nigeria.....	3
1.5 Previous Initiatives and Reports Related to this Mission.....	4
1.6 National Policy on Science and Engineering Infrastructure.....	7
2. <u>Visits to Institutions</u>	
2.1 Raw Materials Research and Development Council (RMRDC)..	8
2.2 Obafemi Awolowo University.....	12
2.3 University of Ibadan.....	13
2.4 ARCEDEM.....	13
2.5 University of Nigeria.....	15
2.6 National Root Crops Research Institute.....	16
2.7 National Institute for Pharmaceutical Research and Development (NIPRD).....	17
2.8 Sheanut Growing Areas in Karshi.....	24
2.9 Industrial Trade Fair.....	24
2.10 Drug Registration Section.....	24
2.11 Pharma-Deko PLC.....	25
2.12 Federal Institute of Industrial Research (FIIRO).....	26
2.13 Indev Ltd.....	27
2.14 Tonykhai Co.Ltd./Tescott & Grenfell Ltd.....	28
2.15 Association of Lady Pharmacists (ALPS).....	29

	<u>Page</u>
3. <u>Conclusions and Recommendations</u>	31
3.1 Summary of Conclusions.....	41
3.2 Summary of Recommendations.....	43
4. <u>Persons Contacted</u>	46
5. <u>Annexes</u>	52
6. Backstopping Officer's Technical Comments	53

ACKNOWLEDGMENT

The authors wish to express their sincere thanks to Dr (Mrs.) O.A.Aribisala, Director-General, R.M.R.D.C., for initiating the mission to Nigeria and providing facilities during the mission.

Special thanks go to Mr.Tuley DeSilva, Special Technical Adviser, Chemical Industries Branch and Mr.Felix Ugbor, Area Programme Officer, both of UNIDO, Vienna, and Dr.David Tommy, U.C.D. in Lagos for their helpful suggestions.

The authors are grateful to all the people contacted during the fact-finding mission to Nigeria.

EXECUTIVE SUMMARY

At the request of Raw Materials Research and Development Council (RMRDC), UNIDO sent a Fact-finding and Preparatory Assistance Mission to Nigeria to assess the potential of indigenous medicinal and aromatic plants for industrial utilization, their cultivation and post harvest treatment; to assess the progress in the production of herbal pharmaceuticals and the specific needs for improvement; industrial and institutional infrastructure related to these plant materials in the country and the development of pharmaceuticals based on traditional preparations; and to assess the current research capabilities and status of equipment for natural product based drug development.

Even though Nigeria enjoys a rich and varied flora, no systematic collection, cultivation and post harvest treatment is in practice, this plant wealth is appreciated by about 200,000 traditional medicine practitioners who collect these plants, prepare secret potions and dispense them mainly in rural areas. It is estimated that about 70% of the population in Nigeria is dependent on these forms of medicine. The country's plant wealth is not at present utilized by the indigenous industry.

The mission visited the following institutions, pharmaceutical manufacturing companies, engineering firms, and farms in Lagos, Abuja, Ibadan, Ile-Ife, Nsukka and Umudike: RMRDC, National Institute for Pharmaceutical Research and Development (NIPRD), Federal Institute of Industrial Research (FIIRO), African Regional Centre for Engineering Design and Manufacturing (ARCEDEM), National Root Crops Research Institute, Nigerian Export Promotion Council, Association of Nigerian Exporters, Drug Registration Section of FDA&C, Association of Lady Pharmacists (ALPS), Pharmaceuticals Manufacturing Group of Manufacturers Association of Nigeria (PMG-MAN), Glaxo Nigeria PLC, Pharma-Deko PLC, Universities of Obafemi Awolowo, Ibadan and Nigeria, Indev Ltd, Tonykhai Co.Ltd / Tescott&Greenfell Ltd. Having visited these institutions the mission came to the following conclusions:

(1) Plant based drugs are not produced by any industry in the country, (2) Research laboratories are conducting only bench-scale research into medicinal and aromatic plants, (3) Pilot plants for scale-up studies were not available in any of the institutions visited, (5) No systematic collection from wild sources and cultivation of medicinal and aromatic plants are carried out for industrial use, (6) Technology development and its transfer to the related industries is very weak, (7) expertise in design&engineering and fabrication of chemical equipment is in its infancy, (8) Qualified scientific manpower and engineering infrastructure of the country are not being fully utilized.

The mission identified NIPRD as the only Institute in the country with a clear mandate to carry out pharmaceutical research and development work. The Institute has integrated laboratories, qualified manpower and a large land for expansion and cultivation of medicinal and aromatic plants. It is situated in an industrial estate in Abuja, the new Capital of Nigeria. NIPRD is under the recently created National Agency for Science and Engineering Infrastructure (NASENI).

The mission drew up a project proposal for UNDP/UNIDO technical assistance to strengthen the facilities and capabilities of NIPRD.

1. GENERAL INTRODUCTION

1.1 Objectives of the Fact-finding Mission

The objectives of this fact-finding and preparatory assistance mission as stated in the job descriptions of the UNIDO consultants, Pharmacist/Team Leader and Chemical Technologist were as follows:

1. To assess the potential of medicinal and aromatic plants indigenous to Nigeria for industrial utilization
2. To assess the progress in cultivation and post harvest treatment of medicinal and aromatic plants
3. To assess the progress in the current production of herbal pharmaceuticals and the specific needs for improvement of these
4. To assess industrial and institutional infrastructure related to medicinal and aromatic plants in the country, and the development of pharmaceuticals based on traditional preparations
5. To assess the current research capabilities and status of equipment for natural product based drug development
6. To prepare a comprehensive report containing the findings, conclusions and recommendations on the basis of the above, and to recommend therein the mechanisms and modalities of a technical assistance project including the inputs in terms of equipment, training, expertise and other infrastructural requirements for the establishment of a processing plant and a research and development laboratory.

The programme concerning places and institutions to visit was drawn up by the host institution, Raw Materials Research and Development Council (RMRDC) in Lagos. Some modifications were requested by the mission in order to assess the design and engineering capabilities within the country.

Duration of the mission was 6 weeks which included 4 weeks in Nigeria.

1.2 Brief Information on Nigeria

Nigeria which is located in the western part of Africa has a land area of 926,768 square kms. It embraces coastal lowlands and thick forest zones in the South to savanna and semi-arid zones in the North. With the population of 88.5 millions (1992 census) it is the most populous country in Africa. It is estimated that one in every five Africans is a Nigerian. The growth rate is 3.2% with a life expectancy of 54 years. The country gained independence from the British on 1 October 1960 has Military (Federal Republic) form of Government. It has 30 State Governments and 503 Local Government Areas (LGA). Gross Domestic Produce (GDP) was

21.5 billion dollars in 1989 with the following sectoral percentage share of GDP: Agriculture (26.1%), manufacturing (11.8%), Government services (8.4%), and construction (6.0%). Gross National Produce (GNP) *per capita* dropped from US\$ 670 in 1986 to US\$ 250 in 1991. This is explained mainly due to crash in petroleum prices.

The major exports from the country is reported to be petroleum, cocoa, hides and skins touching an optimum level of US\$11,070 billion in 1990, an increase of US\$ 2,785 billion from that of 1989 export earnings. Petroleum alone contributed 96.1% (1990) to export earnings.

The main importing countries of Nigerian export products are USA, Germany, France, UK and EC. Machinery, transport equipment, manufactured goods, chemicals, etc. are the main items of import to the country. The import bill of 1990 was about US\$ 6.21 billion from USA, Japan, France, Germany, UK and EC being the major exporting countries to Nigeria.

The country's total external debt is reported to rise sharply from US\$ 3.8 billion (1983) to US\$ 35 billion (1990).

The exchange rate of the national currency Naira (N=100 kobo) was N 8 = \$ 1 in 1990, the present rate being N 18,50= \$ 1 (June 1992).

Education at the primary school level is reported to be 62% (1988) at the University level the enrolment is 160,967 (1988).

It is reported that, in Nigeria, the health service reaches 30% of the population and 48% access to safe drinking water.

The climatic and soil conditions in the country vary from near desert conditions in the north to rain forest belt in the south resulting in a diverse crops production in the country. Agriculture comprising crops, livestock, forestry and fishing are the most important economic activity in the country and accounts for about 70% of employment. Its contribution to GDP in 1987 was about 47%.

It is understood that the major constraints to industrial development in the country are shortage of industrial raw materials, spare parts, inadequate support facilities and services. In addition to the shortages, increased number of industries has resulted in unutilized installed capacity of about 50-60%.

1.3 Information on Pharmaceutical Industry in Nigeria

The volume of pharmaceuticals imported to Nigeria has been estimated to be about US\$ 146 million in 1990. 40% of this amount based on custom declared imports is believed to be plant based products. Only 20% of pharmaceuticals used in the country are manufactured locally and the actual locally manufactured excipient content of the product is less than 8%, while 100% of the bulk drugs are imported.

In 1991, the number of pharmaceutical companies operating in Nigeria was 138. The pharmaceutical industry in Nigeria is at present using only 30% of its installed capacity. Although the pharmaceutical industry in Nigeria follows Good Manufacturing Practice, it is reported that about 30% of the pharmaceutical products in the Nigerian market are substandard both qualitatively and quantitatively. The sources of such products are believed to be both within and outside the country.

The pharmaceutical manufacturers are represented in either or both of the following organizations: Pharmaceutical Manufacturers' Group of Manufacturers Association of Nigeria (PMG-MAN) and Indigenous Pharmaceutical Manufacturers Association.

In December 1990, the Nigerian Government approved the National Drug Policy which aims among others at making available for the health care system adequate supplies of safe, effective and good quality drugs. The objectives of this policy also included:

1. Improvement of local capability in drug manufacturing
2. Promoting research into traditional remedies as potential alternatives to western medicines with the hope that some of them might be found suitable for development into medicines for regular use in the health care system.
3. Stimulating research and development of basic pharmaceutical raw materials for production, compounding and formulation of drugs.

The finished products are imported as pharmaceutical specialities at enormous drain of foreign exchange. Some companies even import items like starch, sugar and lubricants for their drug production due to insufficient indigenous supply of such products.

1.4 Medicinal and Aromatic Plant Potential in Nigeria

In Nigeria 70% of the population are estimated to rely on traditional systems of medicine, due to accessibility of the health service to only 30%. Drugs derived from plants constitute a sizeable percentage of potent medicines in current use in Nigeria. Almost all of these plants however, are used as ingredients in traditional medicines prescribed by the native healers. The urban dwellers supplement the treatment offered in modern hospitals with herbal prescriptions.

According to verbal information obtained from Prof.E.A.Sofowora of Obafemi Awolowo University at Ile-Ife, the estimated number of traditional healers in Nigeria is around 200.000 (1989-estimation). There are six major associations of traditional practitioners, the major one being the Nigerian Association of Medical Herbalists. The Government recognizes the practices of herbal practitioners in Nigeria and allows them to receive and examine patients and prescribe home -made medicines without any Government control. Although it is not compulsory for traditional practitioners to register, some states, namely, Lagos, Kwara, Edu, etc. are registering traditional medicine practitioners.

The demand for plant based fixed oils, extractives and essential oils for cosmetics alone in Nigeria, is estimated to be about US\$ 15,4 million. Commercial scale processing and manufacturing facilities for phytochemicals do not exist in Nigeria. These plant materials are, therefore, only used to a marginal extent for modern pharmaceutical products or cosmetics. Plants are recognized as constituting viable sources of raw materials for the pharmaceutical, cosmetics and related industries.

There is no single phytopharmaceutical manufacturing company in the country, despite the fact that many commercially important plants are growing wild in Nigeria.

Research into chemistry and pharmacology of medicinal plants has been carried out in several institutions. Recently, the National Institute for Pharmaceutical Research and Development (NIPRD) in Abuja has compiled a list of 617 plants with medicinal use in Nigeria and identified 190 traditional medicine practitioners in the Federal Capital Territory.

OAU/STRC publication of 1991 titled "*Contribution to Ethnobotanical and Floristic Studies in Western Nigeria*" by E.Adjanohoun and 13 authors gives monographs and line drawings of 297 medicinal plants.

Another OAU/STRC publication "*African Pharmacopoeia, 1st Ed. 1985*" contains 95 monographs on 105 medicinal plants and identifies 100 more plants for inclusion in the forthcoming 2nd edition of the pharmacopoeia.

A recent book by L.Ake Assi and S.Guinko (published by Roche, 1991) titled "*Plants Used in Traditional Medicine in West Africa*" contains monographs and colour drawings of 51 medicinal plants in english and french.

1.5 Previous Initiatives and Reports Related to this Mission

Industrial utilization of medicinal and aromatic plants seems to have become popular in Nigeria in recent years. The following project initiatives and reports were brought to the attention of the mission.

1. a) NIPRD project proposal to UNIDO (1989)
b) NIPRD project proposal to UNIDO (1992)
2. a) KIBORD project proposal to UNIDO (1989)
b) Industrial Utilization of Medicinal and Aromatic Plants in Nigeria, a report by Prof.M. Iwu (1992)
3. ALPS PROJECT '91 project concept communicated to UNIDO (1991)
4. Industrial Master Plan Project Studies: Pharmaceuticals (1991)

1 a) National Institute for Pharmaceutical Research and Development (NIPRD) submitted a project proposal to UNIDO in 1989 for funding titled as "*Proposal on Resources for the Development and Production of Drugs from Indigenous Medicinal Plants*".

The objectives of this proposal were not clearly stated. However, they could be identified as covering all necessary stages of drug development ranging from collation of data to collection/cultivation of plant materials, pharmacological studies, extraction and characterization of active principles, drug formulation, clinical studies, and commercialization of products and follow up studies.

Time period for each activity was scaled between 1-3 years but no definite time schedule was given.

For 1990/91 an estimated \$425,000 was requested which included two motor vehicles, polyfunctional pilot plant assembly, UV/VIS and IR spectrophotometers, HPLC assembly, computer, audio-visual equipment, microscopes, physiograph for pharmacological studies, etc. and did not contain the fielding of any experts. Therefore, the project was not favourably evaluated by UNIDO.

1 b) NIPRD has recently put forth another proposal for funding to UNDP. This proposal titled "*Development of Technology for the Utilization of Plant Derived Pharmaceutical Raw Materials*" is drafted properly following the usual UNDP format. It is scheduled for a period of three years and envisages UNIDO execution. UNDP funding is estimated as \$700,000 while government inputs (in kind) are entered as N 4 million.

The proposal aims at strengthening the facilities of NIPRD for research and developmental work into the production of plant based raw materials for pharmaceutical use. A pilot plant, chromatographic and spectroscopic equipment, as well as project vehicles, etc. have been listed in the equipment component. 16 m/m international expert time including chemical engineer (6 m/m), agronomist (6 m/m), and quality control chemist (4 m/m), and 28 m/m of national expert time including phytochemist (6 m/m), synthetic organic chemist (6 m/m), pharmacologist/toxicologist (12 m/m), pharmaceutical technologist (4 m/m) are included. 30 m/m of fellowships and study tours are envisaged for the project personnel.

The project budget is well balanced as \$334,000 (47.7%) for equipment and \$366,000 (52.3%) for personnel, however, estimates for some equipment have been shown to be lower than actual. Additionally, the machinery, equipment and laboratory tools listed for the production of pharmaceutical grade maize starch are not included in the equipment budget.

The project envisages the production of pharmaceutical grade starch (not a medicinal plant product), kaolin (not a plant product), cineole, menthol (*Mentha* species not specified), senna (species not specified) at the end of the project activities. Selection of the plant materials should have been more carefully planned and clearly specified. This project proposal is still under consideration by UNDP/UNIDO.

2 a) This project proposal was submitted to UNIDO through UNDP in 1989 by the Pharmacognosy Department of the Faculty of Pharmaceutical Sciences of the University of Nigeria, Nsukka in collaboration with a private cosmetic manufacturer Kates Institute of Bio-organic Research and Development (KIBORD). The project concerns the pilot plant scale production of medicinal and aromatic plants for the purpose of industrial scale up without the involvement of the Nigerian Government.

The project titled "*Production of Natural Fragrance Material and Pharmaceuticals from Locally Available Raw Materials*" was scheduled for three years with an estimated UNDP contribution of \$550,000.

The project basically comprises cultivation of selected medicinal and aromatic plants for pilot plant scale extraction/distillation with the aim to formulate them into cosmetic and pharmaceutical products.

The total cost of the project was estimated to be \$2,110,300 with \$550,000 expected to come from UNDP, the rest would be provided by the commercial company in local currency. Technical partnership with the Milan-based phytopharmaceutical manufacturer Inverni della Beffa was also considered.

The breakdown of the estimated budget was as follows:

Personnel	\$ 150,000
Training	\$ 80,000
Equipment	\$ 300,000
Miscellaneous	<u>\$ 20,000</u>
Total	\$ 550,000

This project proposal has not become a legal document for implementation.

2 b) This paper by Prof.M.Iwu of Department of Pharmacognosy, Faculty of Pharmaceutical Sciences, University of Nigeria, Nsukka was presented at the UNIDO Workshop on the Industrial Utilization of Medicinal and Aromatic Plants held in Milan, Italy between 24-27 March 1992, highlights the KIBORD project already mentioned above and gives a brief insight into the state of pharmaceutical industry in Nigeria with special emphasis on medicinal and aromatic plants on broad terms.

3) The Association of Lady Pharmacists (ALPS) of Nigeria is an interest group of the Pharmaceutical Society of Nigeria (PSN). The Association submitted a project concept to UNIDO for the development of an UNDP funded project on medicinal and aromatic plants in agriculture and pilot plant scale extraction of medicinal and aromatic plants

4) This document was prepared by a team of five experts including a UNIDO consultant (Nigerian) as part of Industrial Master Plan Project Studies concerning the Pharmaceuticals sector upon request of the Policy Analysis Department of the Federal Ministry of Industries. This comprehensive report published in April 1991 undertook an in-depth analysis and diagnosis of the operations of the pharmaceutical sub-system in Nigeria and made recommendations to assist the National Committee on Industrial Development (NCID) to formulate guidelines for the strategic management of the pharmaceutical sub-system and to achieve a private enterprise led self-reliant and self-sustaining pharmaceutical industry in Nigeria.

The report concludes that the country is still dependent on imported drugs for about 70% of consumer demand and the pharmaceutical industry in Nigeria is currently utilizing less than 30% of its installed capacity due largely to shortage of raw materials; that the market is largely infested by substandard and counterfeit drugs due to inefficient Government control; that all the bulk drugs are imported; that research into medicinal plants, raw materials, new pharmaceutical formulations and their development are at present given a low order of priority by the pharmaceutical industry; that pharmaceutical manufacturing machinery are not at present fabricated in the country; and points at the inadequacy of skilled manpower, especially for technical and engineering services.

Recommendations include the following: Capacity utilization of the pharmaceutical industry should be improved; Drugs listed in the National Essential Drug List (NEDL) should be locally manufactured; incentives to give clear encouragement to local producers should be introduced, such as abolishing or minimizing the tariffs on raw materials, providing tax incentives, etc.; incentives should be introduced for local manufacturers to start producing bulk drugs using locally available or imported starting materials; feasibility studies should be conducted to establish an antibiotics fermentation plant; private investors should be encouraged to fabricate pharmaceutical manufacturing machinery and spare parts locally; the pharmaceutical industry should give more emphasis to research into medicinal plants, raw materials and new pharmaceutical formulations. Drug companies should join hands with government to set research priorities and focus on the relevant activities to their needs; the National Institute for Pharmaceutical Research and Development (NIPRD) at Abuja should be seen and supported as a focal point for implementing the pharmaceutical sub-system's research aspirations; more effort should be put into the development and training of skilled manpower, especially for technical and engineering services; follow-up studies should be conducted for the articulation of a National Integrated Pharmaceutical Industrial Policy and an Investment Policy for the advancement of pharmaceutical manufacturing.

1.6 National Policy on Science and Engineering Infrastructure

In July 1990, the President of Nigeria Gen.I.B.Babangida inaugurated a National Committee and charged it with the task of producing a model for the development of an indigenous engineering infrastructure in Nigeria. The Committee consisting of 150 scientists

and other professionals submitted a comprehensive report to the Government in February 1991. The report was followed by a Government White Paper on Engineering Infrastructure.

In January 1992, the Government set up the National Agency for Science and Engineering Infrastructure (NASENI) and charged it with *the responsibility of establishing and executing Science and Engineering Infrastructure Development Programme (S-EIDP)*.

NASENI drew up a series of measures and advised the Government on the formulation of a National Policy on Science and Engineering Infrastructure.

President Babangida launched the National Policy on Science and Engineering Infrastructure on 2 June 1992 in Minna.

S-EIDP aims at "*catalysing the emergence of indigenous capacity able to support a progressively increasing percentage of delivery/production systems needed to support the efficient local production of goods and services*".

NASENI is mandated to (1) formulate policies and advise government on the establishment of a national science and engineering infrastructure, (2) render all necessary assistance to entrepreneurs for science and engineering infrastructure projects, (3) establish, maintain and supervise science and engineering infrastructure development institutions, (4) execute strategies for the generation of private sector science and engineering capital goods industries, (5) develop facilities and capabilities through its institutions on basic & applied research, economic development oriented research (including *indigenous raw materials development for pharmaceutical industry*), training, (6) ensure efficient use of research grants, (7) publicise research results, (8) provide the national focal point for international science, engineering and technology affiliations, (9) ensure the publication of locally produced science and technology books and journals, (10) elicit the active participation of institutions and individuals in the establishment of a National Science and Engineering Infrastructure.

National Institute for Pharmaceutical Research and Development (NIPRD) in Abuja is a research institution under NASENI mandated to carry out research into medicinal and aromatic plants for the development of industrial raw materials.

NASENI is expected to form the basis of the Nigerian Academy of Sciences. At present, it is developing to become the most important authority on Science and Technology in Nigeria. President Babangida is the Chairman of NASENI. The current Executive-Chairman is the previous Minister of the Federal Ministry of Science and Technology.

2. VISITS TO INSTITUTIONS

2.1 *Raw Materials Research and Development Council (RMRDC) in Lagos*

The Raw Materials Research and Development Council (RMRDC) established by Decree No.29 of 1987 under the Federal Ministry of Science and Technology (now Federal Ministry of Industry and Technology) was inaugurated in 1988 under the mandate that it should support

and expedite industrial development and self-sufficiency through the maximum utilization of indigenous raw materials as inputs for the country's industries.

The mandates of the RMRDC can be summarized as follows:

1. To promote raw materials development through policy-proposals in support of raw materials acquisition, exploitation and development;
2. To promote research and development activities through upgrading existing research laboratories to centres of excellence;
3. To publicize research findings and other information relevant to local sourcing of raw materials;
4. To develop management courses for R&D organizations to enhance the level of R&D capabilities through technological innovation and development of R&D expertise;
5. To provide service programmes in the form of technical advisory, counselling, extension services and supply of information requested;
6. To sponsor research in the designing and fabrication of technologies and to establish risk fund for transferring of research results to user industries;
7. To provide award and medals with appropriate incentives for outstanding contributions towards promotion of activities of raw materials research, development and utilization;
8. To undertake inventories of (a) raw materials and technology requirements of industries and their sources, (b) facilities and expertise for R&D activities within Universities, Polytechnics, etc., (c) raw materials availability and utilization;
9. To compile standards for industrial raw materials.

The day-to-day activities of the Council are managed by a Director-General who is guided by a Governing Board with the following composition: (1) A private industrialist (Chairman), and representatives of (2) Manufacturers Association of Nigeria (MAN), (3) The National Association of Chambers of Commerce, Industry, Mines and Agriculture (NACCIMA), (4) The National Association of Small Scale Industries (NASSI), (5) The Nigerian National Petroleum Corporation (NNPC), (6) Federal Ministry of Industry and Technology, (7) Federal Ministry of Mines, Power and Steel.

RMRDC receives 1% of duties paid on imported raw materials with the objective of using the fund for funding research to develop technologies for the production of local substitutes for imported raw materials.

RMRDC's headquarters is located in Lagos. It has liaison offices in 16 out of 30 states of Nigeria.

Apart from Administration, Finance and Supply Department, RMRDC consists of the following technical departments and (divisions): Planning, Research and Statistics (Divisions: Information and Documentation, Planning and Evaluation), Raw Materials (Divs.: Mineral Raw Materials, Agro Raw Materials, New Materials).

Technology Development, Computer, Documentation, Library sections are covered under Planning and Evaluation Division; Chemicals and Pharmaceuticals section is under the Mineral Raw Materials Division.

The Technical Development and Advisory Centre (TEDAC) has no facilities of its own to develop technologies in the use of raw materials in industries. However, it undertakes advisory consultancy in investment promotion, technology and equipment survey, joint ventures, troubleshooting in industries and training programmes. The Centre has identified the following projects in the field of medicinal and aromatic plants as having great industrial potential: (1) starch from corn and cassava, (2) oleoresin and essential oil from ginger, (3) palmoil from palm kernel, (4) cocoa butter and (5) sheabutter. Negotiations are in progress for the transfer of technologies from various Asian and European countries on turn-key basis. The Centre has a compilation of 3000 national experts covering various disciplines in its roster.

In pursuance with its mandate, RMRDC sponsors R&D projects with a view to develop indigenous processes in the utilization of raw materials. Sponsoring of research projects carried out at various research institutions in the country is done through the Planning, Evaluation and Statistics Department by the following procedure. The Department identifies project areas needing R&D activities. Applications are invited through advertisements and shortlisted by the Staff Committee. Discussions are held with the shortlisted institutions or individuals separately in a meeting with the participation of staff committee and representatives from related industries. As a result of these discussions the list is further shortened. Thereafter, a monitoring committee visits the promising institutions to evaluate their infrastructural facilities and manpower, and recommends funding specific research projects to the extent of N2 million over a period not exceeding one year. During the implementation of the project, the monitoring committee periodically visits the implementing institutions to evaluate progress.

In the year 1991, 11 research projects were funded to the tune of N1,157,157.50 (\$62,549 at rate N18,50/\$) as against the total request of N15,851,363 (\$856,830,43) concerning raw materials other than medicinal and aromatic plants. Plant based projects included Development and Production of Soft Drink Concentrate (FB/90/1/2), Development of the Natural Protein Sweetener from *Thaumatococcus daniellii* Benth for General Consumption (FB/90/2/11), Production of 25 Litres of Standard Amylase Enzyme (FB/90/2/15), Extraction of Dyestuff/auxiliary from Vegetable Sources (TW/90/1/8). The project titled Rehabilitation of Ginger Extract Pilot Plant is about the procurement of a boiler for the Ginger Extraction Plant existing in Federal Institute of Industrial Research in Oshodi, Lagos(FIIRO) (SP/90/12/47). For the current year, the sponsoring list does not contain any activity on medicinal and aromatic plants either. However, RMRDC has advertised to invite projects on medicinal and aromatic

plants and received a number of applications mainly concerning ginger, garlic, *Monodora*, etc. These proposals are being evaluated for possible funding in 1993.

RMRDC is also funding 16 projects for the design and fabrication of several plants, machinery and universal components for industrial operations, which include (1) essential oil production plant, (2) sheanut butter plant, (3) filter press, (4) continuous centrifuge, etc. Funding for these projects amount to N4.481.116 (\$242,222).

The Council has been executing and implementing an UNDP project No.DP/NIR/89/004 titled "*Assistance to the Raw Materials Research and Development Council (RMRDC)*" since July 1991. This two-year project to the tune of \$659,700 aims at strengthening the RMRDC to enable it provide information on raw materials and advisory services on the utilization of the country's raw material resources. It envisages the establishment of an information system and a technical library. Through this project existing facilities of the Computer Section and the Library of RMRDC are being strengthened by additional computers, etc. Altogether the Section has 20 XT, 12 AT and 4 laptop computers of which 20 are functional. Out of 27 dot matrix and 7 laser (one colour laser) printers, 18 are functioning. Power system in the Computer Section is subsidized by a central UPS which can supply power for upto 1 h in case of power failure. The Section together with the library has been developing a Raw Materials Information System (RMIS) using CDS-ISIS database donated by UNESCO. RMIS contains information on raw materials in all the books, reports, journals, etc. kept in the library. These information can be retrieved easily and the system is continuously updated. So far, databases for "Food and Beverages" and "Tobacco" have been completed. One fileserver computer and eight microcomputers use UNIX/XENIX operating system. These units are to be linked up to the file server in a network system. Provision has been made for 24 workstations to serve 32 users. The Computer Section, apart from RMIS, keeps payrolls, personnel files, general accounting ledger and computer roster for experts, consultants (resource persons) and institutions. The Section has a staff strength of six system programmers and fifteen operators.

The Library section of RMRDC has three terminals linked with the Computer Section and two printers (one laser), one microfiche reader, one photocopier. One CD-ROM has recently been ordered. The Library has 2060 volume of books in its holdings and 75 local and international periodicals are currently being received. There is only one abstracting journal (Metal Abstracts). Gifts and Exchange Unit of the Library handles book-exchange with other libraries. The Library is open to the public but lends out books only to researchers of RMRDC. The Mission observed the lack of important abstracting journals such as Chemical Abstracts, Biological Abstracts, Engineering Abstracts, etc. as well as journals related to medicinal and aromatic plants. If relevant journals and books are acquired RMRDC can provide a much better service to the user industries and researchers in this field.

RMRDC has so far published 28 reports and brochures on various raw material resources of the country. It has recently started the publication of a biannual "Raw Materials Abstracts" and three copies of "RMRDC Newsletter".

The Secretariat of the Action Committee on Raw Materials of Group 77 (G-77) is RMRDC in Lagos, Nigeria. RMRDC has received approval for a grant of \$100,000 on behalf of the Committee to undertake a feasibility study for the establishment of Raw Materials Information Service for the African Region.

RMRDC has established a National Risk Fund for the development of resource-based and strategic industries as well as for commercialization of research results by potential entrepreneurs.

2.2 *Obafemi Awolowo University in Ile-Ife (Osun State)*

When the mission visited the University, due to strike action by the academic staff, Faculties and Departments related to the mission could not be visited

This University established in the year 1962 has on its campus 12 Faculties including Pharmacy, Medicine, Chemical Engineering, Food Technology, etc.

The Faculty of Pharmacy was established in 1966. It offers graduate and postgraduate courses. Pharmacognosy Department is the focal point of research activities in the Faculty on medicinal and aromatic plants and on traditional medicine. The Departments of Pharmaceutics and Pharmacology are also engaged in some collaborative research with the Pharmacognosy Department in this area. Pharmacognosy research laboratory has standard laboratory ware for lab scale extraction and distillation. Thin layer chromatography and column chromatography are the only chromatographic techniques employed. In the Faculty there are spectroscopic equipment such as UV/VIS (4 pcs), IR (3 pcs), NMR (60 MHz); chromatographic equipment such as Gas Chromatograph (2 pcs) and High Pressure Liquid Chromatograph (isocratic with only UV detector). In this Faculty there are 500 students enrolled for the undergraduate course. In the Pharmacognosy Department 3 students are enrolled for MSc, 1 for M.Phil., and 3 for Ph.D. programmes. Academic staff strength of the Department is prof.(1), reader (1), senior lecturers (3), lecturers (4), and supporting staff (12). The Department is currently conducting laboratory level research into antispasmodic agents from plants such as *Zanthoxylum zanthoxyloides*, laxatives such as *Cassia alata* and *C. podocarpa*, and antifertility agents from plants. This Department has no pilot plant facilities.

In the Faculty there is an unit meant for Natural Drug Products Research. This unit could not be visited because of its closure but it was brought to the attention of the mission that it is conducting full time research into plant based medicines, especially on schistosomiasis and molluscicides. Six full time researchers employed in the Unit also conduct field experiments for testing their research findings. The unit was said to have some pharmaceutical production facilities as well. It was understood by the mission that this unit, also, has no facility for any scale up work.

Other technical Departments like Chemical Engineering and Food Technology could not be visited due to reasons mentioned earlier. However, it was brought to the attention of the

mission that they do not possess any scale up facilities nor they have any research programmes dealing with medicinal and aromatic plants.

In addition to this University, there are six more Universities have Faculties of Pharmacy as approved by the educational authorities as follows: Ibadan, Lagos, Benin City, Nigeria (Nsukka), Amadu Bello (Zaria) and Jos. Two Faculties of Pharmacy which have not yet been approved are Ogun State University (Abeokuta) and Federal University of Technology (Uyo).

2.3 *University of Ibadan, in Ibadan (Oyo State)*

The mission could visit Department of Food Technology in the Faculty of Technology of the College of Science and Technology, where laboratory scale experiments are being conducted on some essential oil bearing plants and spices, namely, *Monodora myristica*, *Ocimum gratissimum*, *Cymbopogon nardus* (Lemongrass), *Cungrunima latifolia*, *Allium sativum* (Garlic) and *Zingiber officinale* (Ginger). The mission also visited the technology laboratory. This laboratory consists of some equipment which are mostly incomplete and non-functional appear to be not being used for long time. The machine shop of the Mechanical Engineering Department situated in the same building contains old machine tools such as Lathes, milling machine, shaper, cutting, drilling machines, a small hand-operated triple roll mill which can be only used for rolling tin gauge metal sheets of small lengths and oxy-acetylene cutting/welding set.

The Department conducts laboratory scale extraction and water distillation work jointly with the Pharmacognosy Department of the Faculty of Pharmacy, which has one UV-VIS spectrophotometer and a HPLC equipment. There is one gas chromatograph in the Chemistry Department of the Faculty of Science. The 60 MHz NMR, MS and elemental analysis instruments were said to be non-functional due to mechanical failures.

No visits could be made to the Departments of Chemical Engineering, Mechanical Engineering and Industrial Coordination Unit due to non-availability of any staff member on the Campus.

2.4 *ARCEDEM in Ibadan (Oyo State)*

ARCEDEM stands for African Regional Centre for Engineering Design and Manufacturing. The idea for its creation germinated at a conference of African Ministers of Industry held in Nairobi, in 1975. This was followed by a preparatory expert mission which visited selected African countries. After several deliberations by the experts from Africa, the creation of the Centre was formally agreed to at a Conference of African Plenipotentiaries in 1979.

Sponsored by United Nations Economic Commission for Africa (UNECA) and co-sponsored by Organization of African Unity (OAU), UNIDO and UNDP, the Centre was established in the temporary premises in Ibadan, Nigeria in October 1980 with the following 23

African states as member countries: Algeria, Benin, Burkino Faso, Burundi, Comores, Congo, Egypt, Ghana, Guinea, Kenya, Liberia, Mali, Morocco, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Sudan, Tanzania, Togo, Zaire and Zambia.

The functions of the Centre are the following:

1. Design, development and adaptation of machinery and equipment and dissemination to member states,
2. Development of prototypes for machines and equipment and promotion of entrepreneurship by demonstration,
3. Manufacture of machines and equipment and promotion of same in member States in collaboration with manufacturers from other countries,
4. Training of engineers and technicians in the fields of machine design and manufacture and also maintenance of plant and equipment,
5. Co-operation with national and international Centres involved in design and manufacture of machines and equipment,
6. Provision of engineering consultancy services especially for the development and operation of plants and factories.

In order to achieve its objectives, the Centre is being treated as a medium-scale industry. In the establishment of the permanent structures of the Centre, the Nigerian Government has provided 85 Ha of land free of cost in Ibadan. The present setting of the Centre has spacious buildings to house office block including design and consultancy offices, training and study rooms, and the library. It also has a hostel for the trainees. There are three separate large workshop buildings.

The Machine Workshop equipped with the precision machine tools, namely turning lathes, 3 ft to 8 ft bed milling machine, shapers, planners, drilling machines both fixed and radial arms, two computerizer drilling units whose accuracy of drilling is reported to be 1 micron, besides, metal cutting and welding accessories. Some of the equipment in this workshop are Indian made and are the gift from the Government of India. This workshop has a capability to design and manufacture prototypes of agricultural preharvest equipment, food processing equipment, equipment for transport, handling and construction. Some of the units designed and manufactured in this workshop located at the site are manually operated two-stage hydraulic presses which can develop a maximum pressure of 800 kg/sq.cm, another of similar type single-stage but resulting in lesser operating pressures, portable hydraulic jacks.

The Fabrication Workshop is very well equipped with heavy duty machinery exclusively meant for the fabrication of pilot plants, semi-commercial and commercial plants. Major equipment installed in this workshop are plasma cutting, oxy-acetylene gas cutting, shearing, crimping and limpet pipe sections making machines, triple-roll mill. All these machines have the capacity to handle stainless steel sheets of up to 12 mm thick and 2.5 m length. It also has argon arc welding, electric arc welding, oxy-acetylene cutting/welding sets. It is understood

that this workshop also has a weld testing unit. As in the Machine Workshop, most of the equipment in this workshop are also of Indian made and gifts of the Government of India. A couple of heat treatment furnaces, both oil fired, and electrically heated furnaces are located in this premises.

The use of this well-equipped and spacious (two-base) workshop is restricted in the absence of a hydrolically operated dished-end machine. The dished-ends form essential part in the fabrication of chemical process equipment. An overhead moving electric hoist (6 directions) necessary for handling fabrication parts in their assemblies. Some of the constraints noticed are: (a) design of chemical process equipment, (b) non-availability of stainless steel and mild steel sheets, (c) stainless steel and mild steel pipes and fittings, (d) formed dished ends, (e) overhead hoist, (f) argon, oxygen and acetylene welding electrodes. With the installation of the above mentioned additional equipment, the procurement of the raw materials and the provision of a senior design engineer this workshop will acquire the capability of turning out large scale industrial units in the manufacture of pharmaceutical bulk drugs, medicinal and aromatic plant based drugs, and food processing equipment.

The Forging Workshop is reportedly equipped with heat treatment, foundry and testing equipment. The mission was not conducted to this workshop.

Additionally, there is an experimental laboratory, a conference centre, and other infrastructural facilities. The Centre is executing training programmes since 1982 for three and six months duration for graduate mechanical engineers from member countries in the design and engineering, and design of spare parts and equipment maintenance.

In the design section of the Centre there is one CAD/CAM unit and six PCs with a large size graphic printer and a laser printer. It also has well equipped drawing section manned by trained draftsman.

The Centre is headed by an executive-director supported by a CTA and a programme officer. It has on its rolls ten engineers, twenty workshop technicians and thirty service and administrative personnel.

2.5 *University of Nigeria in Nsukka (Enugu State)*

When the mission visited the University students and academic staff were on strike.

The Faculty of Pharmaceutical Sciences has a Medicinal Plants Research Unit which is part of the Pharmacognosy Department of the Faculty. During the visit, the laboratories were closed and no responsible staff member could be found to give information and to show the laboratories. This has disappointed the mission since this Department had put forward proposals to UNIDO for funding of its project on medicinal and aromatic plants. The laboratories are housed in part of a one storey building and according to information given by another Department Head of the same Faculty there are only simple laboratory facilities in the

Medicinal Plants Research Unit. No scale up facilities exist in the University for extraction/distillation.

In the Department of Pure and Industrial Chemistry there is a Glass Blowing Unit where facilities exist for the manufacturing of glass laboratory ware and apparatus.

The Food Technology Department of the Faculty of Agriculture has a pilot plant unit which contains a hot air dryer made of mild steel, a grinder, a sterilizer and few other equipment all made of mild steel. All these equipment are very old and obsolete and appear to be in disuse for a long time, except the grinder.

Veterinary Physiology and Pharmacology Department of the Faculty of Veterinary Medicine has been involved in research into medicinal plants on laboratory scale only. No scale up facilities exist.

The Department has facilities for the testing of some pharmacological activities. Bioassay guided fractionation is also followed to some extent using laboratory animals, mainly rats and tests are also conducted on isolated organs. Chemical analysis of the isolated active fractions is carried out by collaborating laboratories abroad. The Department is recipient of research funds from EC and WHO on some specific surveys concerning trypanosomiasis in Africa. It has recently submitted a proposal to EC for funding of a project titled "Investigation of Trypanocidal Activity of Extracts from Some Tropical Medicinal Plants". This project amounting to ECU 157,000 includes the following plants: *Annona senegalensis* (root), *Picrolima nitida* (bark), *Acalypha hispida* (leaves), *Garcinia cola* (seeds), *Morinda lucida* (leaves) and *Alstonia boonei* (bark).

The staff strength of the Department is as follows: 6 supervisors, 8 graduate students and 5 technicians.

2.6 National Root Crops Research Institute in Umudike (Abia State)

This Institute functions under the control of the Federal Ministry of Agriculture. The main function of the Institute is the cultivation and supply of planting materials to the farmers. These materials include ginger (*Zingiber officinale*) (black and white varieties), cassava and yam. The Institute has pilot plant facilities for the processing of cassava which consist of a mild steel rotary peeler, rotary roaster heated with direct fire indigenously fabricated, a disk mill grinder. All these equipment are very old and appear to be under disuse, except the grinder.

The Biochemistry Laboratory has simple laboratory equipment. It has been reported that the laboratory was in possession of a gas chromatograph which is out of order for a long time.

The Institute cultivates ginger in 2 hectares. The yield per hectare is 27 tonnes for black and 35 tonnes for yellow varieties. The average yield of dried ginger after drying in the open for 4-5 days during dry season (October-March). The mission was informed that the black variety yields more oleoresin than the yellow variety. Although the actual figures were not available, the yellow variety was said to yield 3-4% oleoresin on extraction with acetone.

It was also brought to the attention of the mission that the Kaduna State Government is setting up an industrial plant of 4-5 tonnes a day capacity of dried ginger (average moisture content 12%) at Kachia for oleoresin production. According to the information supplied by one of their advisers, it has batch type percolators of Romanian origin.

Nigeria produces an estimated 60,000 tpa fresh ginger of which 80% is exported after drying.

The Director of the Institute indicated his desire to do research into medicinal and aromatic plants, but his existing facilities and manpower do not qualify his institute to conduct such research.

2.7 National Institute for Pharmaceutical Research and Development (NIPRD) in Abuja (Federal Capital Territory)

The Institute is situated in Idu Industrial Estate which is 22 km away from the centre of Abuja, the Capital of the Federal Republic of Nigeria.

The idea of establishing a research Institute charged with research and developmental activities in the field of pharmaceuticals was initiated by the Pharmaceutical Society of Nigeria in 1985. The Society provided a seed money of N 100,000 for its realization. This initiative by the private sector found immediate support of the Federal Government and the Institute was established by Government Decree in 1987 under the Federal Ministry of Science and Technology. The activities of the Institute started in 1989 after the assignment of the Director/Chief Executive. The Institute was established to serve as a practical forum for an aggressive and result-oriented research and development of pharmaceutical raw materials from the abundant local resources of Nigeria. Furthermore, the Institute was charged with the task to identify and conduct applied and multi-disciplinary scientific research into Nigeria's potential resources for drugs. Such an approach was expected to lead to some degree of self reliance in the Drug Industry, optimal utilization of local raw materials and consequently enhance the effective control of the quality of drugs in Nigeria as well as generate significant savings in the country's foreign reserves and hard currency earnings both directly and indirectly.

The Institute was mandated by the Government to do the following:

1. Identify and conduct basic and applied scientific research into Nigeria's potential natural resources for drugs and pharmaceutical raw materials.
2. Evaluate and develop methods, quality standards and specifications for the production and use of locally produced drug substances and pharmaceutical raw materials.
3. Act as a Drug Information Centre and as a National Centre for Drugs and Pharmaceutical Substances Reference Standards; and

4. Liase with related research establishments, the petrochemical industry, government agencies, universities, traditional medicine practitioners and allied institutions for the achievement of the objectives set out in this order.

Since January 1992, NIPRD is under the aegis of the National Agency for Science and Engineering Infrastructure which was established under the Presidency. The Agency formulates policies and advises Government on all matters related to the development of science and engineering infrastructure in Nigeria. Furthermore, the Agency executes government policies on local raw materials development and acquisition of technology for industrial development.

The enabling decree of the Government stipulated the following functions for the NIPRD:

1. To conduct research into and develop both old and new drug substances and pharmaceutical agents, particularly for tropical diseases, from local materials as well as *via* synthesis.
2. To carry out research and development into the pharmaceutical utilization of local raw materials.
3. To evaluate, preserve, purify and standardize useful medicinal plant preparations into suitable and generally acceptable dosage forms.
4. To conduct bio-pharmaceutical and pharmacokinetic studies on both imported and locally manufactured drug products.
5. To develop new or improved quality control methods, quality standards and specifications for the production and use in the manufacture of pharmaceutical products.
6. To promote and sponsor the development of staff through workshops, seminars, conferences and training courses organized within or outside Nigeria.
7. To carry out research on drug distribution, storage, stability and shelf-life; and
8. To carry out such other functions or activities as are necessary or expedient for the achievement of the objects of this Order.

The NIPRD presently has the following technical departments:

1. Medicinal Plant Research and Traditional Medicine
2. Pharmacology and Toxicology
3. Medicinal Chemistry and Quality Control
4. Raw Material Research and Development
5. Pharmaceutical Technology and Pilot Drug Production

In addition to Personnel and Management Services, there are the Finance and Supplies Departments. When the Institute is fully developed there shall be eight technical departments.

The Institute has a Director who is the Chief Executive in charge of the day to day operation and management of the Institute. There is a governing board under a chairman which directs the policy matters relating to the mandates of the Institute.

The Board of Governors of NIPRD consists of the following:

(1) Chairman (part-time) - an expert who is familiar with the mandates of the Institute, representatives of (2) the Federal Ministry of Health and Human Services, (3) the National Agency for Science and Engineering Infrastructure, (4) the Traditional Medicine Practitioners, (5) the Pharmaceutical Society of Nigeria, (6) the pharmaceutical industry, and (7) Director of NIPRD.

At present the Institute has 150 staff of whom 44 are research fellows and technicians. Some of the technical staff are pursuing studies abroad. In addition to the above departments the Institute also has a Library and Drugs Information Service and a Medicinal Plant Garden for the cultivation and display of selected medicinal and aromatic plants. It is also planned to establish zonal offices/laboratories in different ecological zones of the Country as the Institute develops.

According to the information given by the Director of NIPRD, the Institute plans to realize its main objectives within the following time periods:

- a) Short Term (i.e. 1-3 years): Quality assurance services and the development of processing technologies for pharmaceutical grade excipients (e.g. starch, glycerine, kaolin, etc.)
- b) Medium Term (i.e. 3-6 years): Development of active drugs from medicinal plants by isolation of active principles and to apply chemical modifications, when necessary, to enhance the activity, and formulation of traditional drug preparations with confirmed activity into standardized modern dosage forms (e.g. antimalarial, antidiabetic and anticholera drugs)
- c) Long Term (i.e. 6-10 years): Pilot and semi-industrial production of synthetic pharmaceutical chemicals (e.g. chloroquine, paracetamol, etc.)

The Institute has a land area of 68.5 Hectares of which, at present, 7.5 Ha is developed. 50 Ha land area is 80 km away from the present establishment and shall be developed in future.

The Institute has four self-contained guest chalets in a separate building. There is a clinic to provide health care assistance to the staff of the Institute and their families. A nurse/midwife is in charge of the clinic and a medical practitioner from Abuja visits the Clinic once a week for attending to the medical needs of the staff members and their families.

Power is supplied through step-down transformer of 300 KVA capacity, exclusively for use in NIPRD. Additionally, the Institute has two power generating sets of 100 and 250 KVA to supply power in case of failure of the main supply. The Institute has plans to purchase another generating set of the same capacity as a stand by.

Water is supplied by municipality through two-inch galvanized iron (G.I.) pipes. The Institute has plans to bore a well and to construct an overhead tank for independent water supply.

The Institute has a two-storey administration building, one-storey independent buildings for 1) Laboratories, 2) Tablet production, 3) animal house, 4) clinic, 5) Guest chalets, and a two-storey new laboratory block. At present there is no building for pilot plant facilities.

There are four motor vehicles including a minibus (cap. 18 people), two pick-ups (one is out of order) and an official car of the Director.

The Library was established a year ago. It has 300 volumes of books in its holdings and 100 research journals are currently been received. To facilitate usage of the materials available in the Library, a monthly journal known as "NIPRD Bulletin" is being published. The bulletin lists, in an alphabetical order, all monographs and contents of journals added to the Library in the preceding month.

The Institute has compiled a list of 617 medicinal plants growing in Nigeria and identified 190 traditional medicine practitioners in the Federal Capital Territory.

Departments visited:

Department of Pharmacology and Toxicology

The department has been engaged in both basic and applied research programmes. One of the objectives of the department is to encourage research into indigenos medicinal plants and products as alternative sources of drugs. The department has a staff of seven research fellows (two are on study leave), three technicians, one assistant technician and three laboratory assistants and three animal house attendants. The laboratories are equipped with the following major equipment: incubator/oven, analytical balances (3 pcs), microscopes (2pcs), water distillation apparatus, pH meter, fridges (2 pcs), microdynamometer (2 pcs) with accessories for *in vitro* studies on isolated organs, 4-channel polygraph for CNS studies, hand glucometer for diabetes detection, QBC haematology kit with necessary accessories for malaria paracyte detection, and neuroaverager. The following projects are still in progress:

Basic research:

- Platelet Activating Factor in pentobarbitone sleep
- Role of muscarinic receptors in sleep mechanism

Applied research:

i. Malaria Research: Malaria is one of the most important tropical diseases. In Nigeria alone, one million lives are lost every year due to malaria. The Institute has developed an indigenous plant product coded as NIPRD-AM1. Preliminary results in the laboratory has confirmed the efficacy of this product against malaria paracyte in laboratory animals. Effords

are currently geared towards standardization of the product using modern pharmacological and phytochemical protocols.

ii. Diabetes Research: The department has been conducting pharmacological tests for the activity of another plant product of the Institute NIPRD-AD1, using routine antidiabetic drugs as standard. The data gathered so far suggests that the product may be of value in the treatment of diabetes.

iii. Contraceptive Research: NIPRD-CC1 is an indigenous plant material which has been employed locally as a long acting contraceptive. The department has developed a standard protocol for the investigation of this activity in laboratory animals. So far, it has only been possible to observe the activity of the crude product in mice.

iv. NIPRD Feed Formulation: Due to non-availability of standard animal feed in Nigeria, the department has for some time been developing animal feed for laboratory animals using locally available foodstuff. The preliminary results revealed the potential of local foodstuff as ingredients for laboratory animal feed formulation.

The animal house is situated in a separate one-storey building having animal rooms (10), stores (3), offices (8) and toilets (2). All the animals are in-bred. The animals in stock during the day visited included mice (508), normotensive rats (428), hypertensive rats (198), diabetic rats (25), guinea pigs (5), New Zealand rabbits (7) and indigenous breed rabbits (72).

Department of Medicinal Chemistry and Quality Control

The department has a staff strength of 14 including research fellows (6), technicians (4) and assistant technicians (4). The laboratories are equipped with the following major equipment: a high pressure liquid chromatography (HPLC) system comprising injector, variable UV-VIS detector and pen-recorder suitable for isocratic work, water deionizer, vacuum filtration unit, ultrasonic bath, flame photometer, oven, fridge, water distillation still, laboratory centrifuges (2 pcs), water bath, pH meter, and some very old donated equipment such as two manually variable wavelength UV-VIS spectrophotometers, one VIS spectrophotometer, and two gas chromatographs with data station. The GCs are not functional awaiting to be installed. Since the models are very outdated it may not be possible to get necessary accessories and spareparts for their installation. There are also a few donated highly outdated computers which can only be regarded as museum pieces.

Research programmes of the department include the following:

1. Quality assurance of (a) chloroquine, (b) cotrimoxazole, (c) ampicillin, (d) chloramphenicol, (e) metronidazole, (f) pyrimethamine, (g) paracetamol preparations.
2. Phytochemical screening of medicinal plant extracts
3. Development of analytical techniques using HPLC
4. Extraction and chemical analysis of a medicinal plant seed with contraceptive activity

5. Analysis of antimalarial drugs in body fluids for pharmacokinetic studies.

Department of Medicinal Plant Research and Traditional Medicine

This department has a staff strength of 16 comprising research fellows (6), technicians (6) and technical assistants (4). The activities of the department include:

1. Documentation of traditional medicine practice in Nigeria
2. Compilation of Nigerian Herbal Pharmacopoeia
3. Distillation of essential oils from indigenous aromatic plants
4. Pharmacognostic characteristics of Nigerian medicinal and aromatic plants
5. Phytochemical evaluation of selected medicinal plants
6. Development of NIPRD Medicinal Plant Garden

For the documentation of traditional medicine, all available information such as uses, parts used and methods of preparation on 187 medicinal plants have been documented. Voucher specimens of these plants are kept in the herbarium for future identification.

Herbal extracts of some plants with medicinal value are obtained in the solvent used by traditional medicine practitioners. In most cases either water or locally brewed alcohol is used. Apart from phytochemical studies, pharmacological and toxicological studies are also carried out these extracts.

A list of essential oil bearing plants was compiled. These plants include *Aframomum melegueta*, *Allium cepa*, *A.sativum*, *Anethum graveolens*, *Annona senegalensis*, *Blumea mollis*, *Capsicum annum*, *Cinnamomum zeylanicum*, *Citrus species*, *Cymbopogon citratus*, *Dennetia tripetala*, *Elettaria cardamomum*, *Eucalyptus citriodora*, *E.species*, *Hyptis suaveolens*, *Lippia citriodora*, *Mentha piperita*, *Monodora myristica*, *Murraya koenigii*, *Ocimum basilicum*, *O.gratissimum*, *O.sanctum*, *Piper guineense*, *P. nigrum*, *Pongamia pinnata*, *Satureja montana*, *Thymus vulgaris*, *Xylopi aethiopica*, *X.parvifolia*, *Zanthoxylum alata*, *Zingiber officinale*

The laboratory is equipped with basic laboratory equipment to pursue some bench scale extraction and distillation of medicinal and aromatic plants. The major facilities include 250 ml glass Soxhlet extractors (2 pcs), Cleverger apparatus (wrongly designed, end indigenously fabricated) with 10 liter flask (!) and no insulation resulting in increased time of distillation, water baths, flask heaters, vacuum pumps (2 pcs), rotary evaporator, fume cupboard, TLC spreader for coating plates, TLC development tank (only one), and UV lamp. The laboratory has no grinder for pulverization of plant parts and coarse grinding is done using a primitive wooden mortar and pestle. The reason given for the use of this device was to replicate the grinding technique used by traditional healers.

The department has also established a herbarium containing, at present, 150 mounted specimens of 86 plant species belonging to 26 genera. The department is also using a traditional healer from a nearby village as consultant.

Live specimens of medicinal and aromatic plants collected on expeditions to the forest areas are kept in an open air nursery under a shed. These seedlings will provide necessary material for the establishment of the Medicinal Plant Garden.

Department of Pharmaceutical Technology and Pilot Drug Production.

This department is currently working on the production of pharmaceutical grade starch, kaolin and glycerine. A pharmaceutical grade starch is said to be developed from cassava, but since the pharmaceutical industry prefers to use starch obtained from maize, research has been in progress to obtain pharmaceutical grade starch from corn. Presently, entire starch used in pharmaceutical industry is imported. Research is also under way to obtain pharmaceutical grade glycerine from spent liquors/lye obtained as a by-product from vegetable soap factories. Efforts are made to produce pharmaceutical grade kaolin from natural kaolinitic clay deposits found in many parts of the country. With a view to developing ointment bases suitable for pharmaceutical and cosmetic manufacture, the production of fixed oil (sheabutter) from sheanuts is also in progress. The Department has also formulated an antimalarial syrup code-named as NIPRD-AM1 from the leaves of a Rubiaceae plant. The department has the following basic test equipment for testing disintegration, tablet friability, dissolution and pH meter. In the Tablet Production Building already under construction there is a powder blender/mixer, and a tableting machine with 150,000 tablets/h capacity, having different size dies. Both the equipment are of industrial size and apparently previously used.

Department of Pharmaceutical Microbiology and Biotechnology

This department is charged with routine bacteriological studies including examination of extracts and pharmaceutical formulations for bacterial contamination with particular emphasis to pathogens. Routine diagnostic service is also provided for hospitals and clinics in and around Abuja. The department has six researchers, four technicians and five laboratory assistants.

The available equipment in the department includes microscope, hot air oven, autoclaves, deep freezer, refrigerator, laminar flow cabinet, UV-VIS spectrophotometer, incubator, hot plate/magnetic stirrer and a grinder/mixer.

Current activities of the department includes the following:

(a) screening of local plants for anti-tuberculosis and anti-salmonellosis activity, (b) development of a diagnostic kit for typhoid fever, and (c) sterilization and aseptic procedures, e.g. water for injection.

2.8 Sheanut Growing Areas in Karshi Near Abuja

Karshi is a village situated at 30 km east of Abuja. Sheanut trees (*Butyrospermum parkii*) grow wild abundantly in the forests in and around this area. The Chief of Karshi is the powerful local governor of this region. He organizes the collection of sheanuts and their sale to collector-traders. 7-10 trees growing nearby are named as a "farm" and there are plenty of the so-called farms in the region.

According to the verbal information given by the Chief of Karshi, sheanuts are harvested once a year in May-June. A fully grown tree may yield 4-5 sacs (each weighing 120 kg) of shelled nuts a year. Sheanut fruits contain a thin sweet pulp when ripe and a seed with a thin hard coat.

After removal of the pulp the nuts are boiled in water and dried in the sun. After drying the seed coat (also called the shell) easily breaks on pressure to yield sheanut. The cooked and dried nuts are shelled and separated manually. The nuts are then sold to the traders.

Fruits are also processed locally in the following primitive way: after removing the nuts from ripe fruits the shells are manually cracked and the nuts are crushed using a pestle and mortar. The crushed nuts are then boiled in water over an open fire. The oil floating on top is continuously scooped out and collected. Boiling is stopped when oil ceases to separate. The marc is manually pressed to get more oil. Sheanut oil so obtained hardens in normal temperature due to high content of saturated fatty acids in its composition, hence called sheabutter. The cake is thrown away. Sheabutter is locally used for cooking and has some medicinal uses as an antitussive medicine if licked with finger. It is externally applied on boils. The softened boils burst upon slight pressure after a few days.

Sheabutter has in recent years become very popular in cosmetic and pharmaceutical formulations in the western world. It is also widely used in Nigeria by soap and cosmetic industries. Sheanuts are exported from Nigeria in large quantities.

2.9 Industrial Trade Fair in Lagos

The mission visited the fair with the expectation to see major indigenous manufacturers of pharmaceuticals and equipment. However, dissappointingly, no such exhibits were seen. A number of traditional medicine practitioners was noticed to exhibit their skills in treating various diseases and selling their home-made plant based medicines. Their stands were attracting quite a number of the public, which was evident from long queues.

2.10 Drug Registration Section, Lagos

This section is under the Food and Drug Administration and Control (FDA&C) of the Federal Ministry of Health, and deals with the registration of drugs in Nigeria.

According to the information supplied, drug registration procedure in Nigeria is as follows:

Application for registration of a drug product can only be made by a manufacturer. The applicant addresses a letter to the Drug Registration Section mentioning briefly the name of the product to be registered, its composition and indication(s). The section evaluates the request and, if satisfied, asks the company to supply detailed information according to "Application Format for Drug Registration" in the form of five detachable dossiers. The official application forms are obtained from the Section upon payment of N100. The application form includes data on name, composition, method of manufacture, indications, contra-indications, and analytical, pharmacological and clinical information in detail and relevant reference literature is also attached.

Before 31 March 1992, the Section would reject the registration of a drug which was not included in the Essential Drugs List (EDL), but since the beginning of April this year, EDL applies only to drugs imported by Government hospitals according to Government Decree No.13, 1992. Therefore, this restriction is removed.

The submitted files for drug registration are reviewed by the pharmacist staff of the Drug Registration Section, and if it satisfies the requirements, a "*provisional registration*" for that product is granted pending "*full registration*". Full registration is not, at present, granted. This practice is expected to begin after the formation of a professional "*Drug Registration Committee*".

Drug control is under the Inspectorate Division of the Federal Ministry of Health. Regular and random inspections of pharmaceutical manufacturing premises and products are carried out by this Division and samples collected are analysed at the Central Drug Laboratory of Food and Drug Administration and Control (FDA&C). The Inspectorate Division controls pre- and post-registration exercises. Recalls are also effected by this Division. It was unofficially admitted that it would not be possible to give the number of drugs currently circulating in Nigeria due to frequent smuggling of unregistered drugs and the presence of fake drugs.

Herbal medicines are not, at present, registered in Nigeria. The reason given to the Mission was the lack of any clear indication for their registration in the Food, Drugs, Cosmetics and Devices Act.

2.11 *Pharma-Deko PLC, Agbara (Ogun State)*

The pharmaceutical company Pharma-Deko PLC (formerly Parke Davis and Company Ltd) was incorporated in Nigeria in 1969 by Wagner Lambert Company and its subsidiary Parke Davis and Company. In compliance with the Nigeria Enterprises Promotion Act 1977, 68% of the issued shares are currently held by Nigerian citizens or associations. In May 1990, Wagner Lambert divested its 32% share holding. These shares are being held for ultimate sale.

The factory operates according to Good Manufacturing Practice (GMP) regulations and produces tablets, syrups, suspensions and suppositories.

Although the company does not, at present, manufacture or market any herbal preparations, there are plans to acquire and install a multipurpose pilot plant for extraction/distillation of medicinal and aromatic plants. Research has been in progress for the preparation of a standardized extract from *Cassia podocarpa* leaves for formulation into a Senna preparation and for the isolation of a protein sweetener from the fresh arils of *Thaumatococcus daniellii*. The Company is also interested to develop formulations with antifungal/antimicrobial activities from leaves of *Acalypha wilkesiana* and to produce essential oils from aromatic plants, e.g. *Zingiber officinale*, *Ocimum gratissimum*, etc.

These researches are carried out by the Project Manager of the company, a pharmacist, who has a M.Sc. degree in pharmacognosy in collaboration with Obafemi Awolowo University (Ile-Ife), University of Lagos (UNILAG), FIRO, Lagos State University and NIPRD (Abuja).

2.12 Federal Institute of Industrial Research Oshodi, Lagos

This Institute popularly known as FIRO started in 1956 as a small laboratory in Lagos on the site now occupied by the Federal Palace Hotel and moved to the present site at Oshodi, Lagos in 1958. Since 1979, FIRO is administered by the Ministry of Science and Technology. It is governed by a board which lays down the general policies and the day to day policy implementation. The execution of research activities is carried out by the Director of the Institute.

The Institute was set up to "quicken the pace of industrialization in Nigeria through:

- research and development of local raw materials for industrial utilization,
- upgradation of indigenous technology and adaptation of imported technology, and
- routine technical and consultancy services to industries, government establishments and private organizations, and individuals."

The mandate of FIRO includes research and development upto pilot plant stage in food science and technology, textiles, pulp and paper, forest products specific to industrial processes, engineering design on processes and fabrication of equipment in related fields, provide laboratory and other technical services to industries and disseminate research findings.

It has four laboratory divisions such as (1) Biotechnology, (2) Food, (3) Agro-allied, and (4) Material Science Divisions, and the following engineering divisions: (1) Process Development, (2) Foundry and Metallurgical, (3) Design and Fabrication, and (4) Electrical and Electronic Divisions.

It also has a Consultancy and Techno-marketing Division, Commercialization Division and Analytical Services Division.

The Mission when visited FIRO was conducted to Ginger Extraction Plant set up sometime in 1986, imported from Greece is designed to extract oleoresin from dried ginger (500 kg/batch) using acetone as solvent. It was reported that when it worked solvent losses

incurred in the plant per batch was about 35% and the residual oleoresin in the marc was about 5% of its original content. The oleoresin yield was reported to be 6-8% of ginger by weight.

Ginger was extracted thrice in the horizontal stirred extractor of 2 cubic meter capacity using fresh solvent for every extraction, and the resulting miscella distilled in a steam heated distillation still of 1 cubic meter capacity fitted with a packed column at the top and the condenser. The non-condensable gasses were let out through a cold-trap. The residual acetone content in the oleoresin obtained is desolventized under vacuum in another 100 L vessel. The material of construction of all the contact parts of the pilot plant is stainless steel.

The pilot plant remains "shut down" for a long time due to the explosion in the boiler and awaiting its operation for the arrival of the new boiler.

The Mission was also conducted to the workshop. It has three lathes of 12 ft, 8 ft, and 3 ft beds, resp., a motorized hacksaw, a shaper, two milling machines, cylindrical grinder, a surface grinder, a pedestal drilling machine, a radial drilling machine, heavy duty shearing machine, heavy duty limpet pipe section making machine, hydraulic guillotine shearing machine capable of cutting 12 mm thick and 3 m wide stainless steel sheet, a triple roll plate bending machine with a capacity to roll 12 mm thick and 2.5 m wide stainless steel sheets, plasma cutter, argon arc, and electric arc welding sets.

At the first sight some of these machines looked old and under disuse, some opened for repair and yet some wrongly located thus severely restricting designed capacity utilization.

If these machines were properly repaired/recommissioned, relocated providing ample working spaces around and with the addition of hydraulic dished end making machine, and the provision of overhead electric hoist, it has all the potentials for undertaking fabrication of chemical process equipment from pilot plants through commercial plants in the utilization of medicinal, aromatic plants, food products, synthetic fine chemicals, and bulk drugs.

One of the chief constraints noticed by the Mission at FIRO as well as in all the technical institutes/Centres/factories visited is the inadequate design and engineering capability of chemical plant and equipment.

2.13 *Indev Ltd, Lagos*

A privately owned small scale engineering company located in Lagos managed by mechanical engineers has a modest machine shop consisting of small lathes, pedestal drilling machine, a shaper, cutting and welding sets.

The Mission when visited this company noted that the following equipment were at various stages of fabrication.

- Oil fired shell and tube heat exchanger (mild steel) for heating air to be used as drying medium in the rotary dryer.
- Mild steel rotary dryer of 0.6 m dia., and about 3 m length.

- An oil expeller of the capacity of 500 kg/h sheabutter seeds.
- Small rotary disc grinders
- Mild steel jacketed storage tanks of about 1 cubic meter.

Mission noticed that a 50 HP motor was being used through a very large reduction gear system to run the above mentioned oil expeller. It is considered that the HP to drive this expeller could be considerably reduced if the seeds are crushed and steamed before feeding into the oil expeller. These facts were explained to the management. The Mission also extended suitable advise in the design of dryer and the jacketed vessels.

2.14 *Tonykhai Co.Ltd.*, a sister concern of *Tescott & Grenfell Ltd, Lagos*

This company is undertaking design and fabrication of chemical process equipment.

RMRDC sponsored two projects with these companies to design and fabricate prototypes of "Essential Oil Production Plant" to the tune of N482,790 (\$26,097), and "Hydrated Lime Plant" to the tune of N489,258 (\$26,446).

The Mission visited the design office where two mechanical engineers and three draftsmen are working on these designs. The Mission discussed in detail with the design engineers about the design of "Essential Oil Production Plant". It is in effect a steam-distillation still. The lower part filled with water is oil fired to generate steam and the flue gasses (exit gases) from the boiler are designed to pass through the jacket around the entire length of the distillation still. The vapours of essential oil and steam are to be condensed in a shell and tube heat exchanger. The tube diameter is 12 mm and tube wall thickness is 3 mm. The tube plate thickness is also 3 mm. A provision is made for a separator. The material of construction of all contact parts is stainless steel and that of boiler and jacket is mild steel.

The Mission is of the opinion that the unit is wrongly designed and may result in inefficient operations.

The Mission also visited the workshop where this equipment along with the other equipment are at various stages of fabrication. It has a hand shearing and hand operated triple roll mills, a turning lathe, radial drilling and pedal drilling machine, a motorized hack-saw and oxy-acetylene and arc welding sets.

This company as well as the other workshops visited exhibit limitations in the design & engineering capability. Given this capability these companies can turn out very good modern equipment and could as well meet the needs of chemical process and food industries in Nigeria.

2.15 Association of Lady Pharmacists (ALPS)

Association of Lady Pharmacists (ALPS) is an interest group of the Pharmaceutical Society of Nigeria. It was inaugurated in July 1988. As explained earlier in Chapter 1.5, it has interest in developing farms and production plants for medicinal and aromatic plant products.

ALPS organized a meeting presided over Bashorun M.K.O.Abiola, Chairman of the Governing Council, a prominent businessman and philanthropist/Dr (Mrs.) O.A.Aribisala, Director-General, RMRDC, and attended by Mr.D.Tommy, UCD; Dr.P.Emafo, PSN President, and members of the Governing Board and Technical committee. Technical Committee members presented the objectives, plans and programmes of ALPS. Thereafter, the UNIDO Mission explained the objectives and mandate of the fact-finding mission and requested ALPS to conduct the mission to R&D infrastructure created by it, results of the past R&D efforts and future programme connected with the utilization of the country's medicinal and aromatic plant resources. According to the information given, ALPS has so far raised N5,000,000 for ALPS PROJECT 91. ALPS agreed to give written documents explaining the objectives and outputs of the project.

On the second day, ALPS organized a visit to Glaxo Pharmaceutical Company and its farms. According to the account given to the mission, part of the farm in Ado-Odo had belonged to ALPS for growing plants. The Managing Director of Glaxo Nigeria PLC frankly admitted that the company had no interest in the utilization or cultivation of medicinal and aromatic plants in the near or far future, and sent along a staff member to show the mission and the senior members of ALPS, the Nucleus Farm located at Ado-Odo. It is a well maintained farm covering an area of 500 hectares (consisting of two nearby farms). It was brought to the attention of the mission that the farm belonged to Glaxo and no land was allocated for use by ALPS. At this farm, a small, not-so-well-maintained, patch of land was under *Aloe vera*, of which, according to farm hands seedlings had been brought by Glaxo (U.K.) from Kew Gardens, London (U.K.) for use of the company. The major portion of the farm was under cassava for use by Glaxo Nigeria PLC to make "baby food", and not by ALPS for the production of pharmaceutical grade starch. The so-claimed ginger cultivation could not be seen.

The third day ALPS arranged a meeting with the Board of the *Pharmaceutical Manufacturers Group of Manufacturing Association of Nigeria (PMG-MAN)*. It has 50 members. Some of its members are also members of Nigerian Indigenous Pharmaceutical Manufacturers Association (NIPMA). Some indigenous manufacturers expressed interest to produce plant based drugs if plant based raw materials were made available. The mission explained the necessity to develop know-how/technology on a pilot plant level before being scaled up to the industry.

ALPS submitted the following documents to the Mission:

1. ALPS PROJECT 91 (ARBORETUM)

This is a printed booklet indicating plans, the choice of plants for cultivation, location of "Arboretum" and pilot extraction scheme. According to this booklet, ALPS plans to establish

farms in 8 states, namely Abuja, Anambra, Bendel, Kaduna, Lagos, Ogun, Plateau and Rivers. The plants selected for cultivation are *Allium sativum* (Garlic), *Aloe vera* (Aloe), *Burtyrospermum parkii* (Sheanut), *Manihot utilissima* (Cassava), *Ocimum gratissimum* (Teabush), *Vanilla planifolia* (Vanilla), *Zanthoxylum zanthoxyloides* (Fagara) and *Zingiber officinale* (Ginger).

2. ALPS PROJECT 91 Project Proposal

"Feasibility Studies and Engineering Design for Utilization of *Manihot utilissima* for the Production of Agro-Allied and Pharmaceutical Raw Materials"

This is a proposal prepared by a consultant from the School of Pharmacy, College of Medicine, University of Lagos. He proposes to undertake feasibility studies, design and fabrication of a model plant, detailed engineering design, installation, commissioning and management consultancy services. The consultancy fee for these activities is N990,000 (1991 figure). This fee is presumably for the design and fabrication of model plant to produce pharmaceutical grade starch, liquid glucose and soluble starch from cassava tubers

3. ALPS PROJECT 91 Project Proposal

"Multi-Purpose Extraction Plant"

The consultants of O.A.U. made a proposal to undertake "project studies" for setting up of multi purpose extraction plant. The consultancy fee for this study is N321,530 (1991 figure).

4. ALPS PROJECT 91 A Pre-investment Brief

This is a pre-investment proposal

- To develop 28 hectares of land at seven locations in the country (4 ha per site) at a cost of N138,800.

- To set up a Sheabutter Production Plant (capacity not specified) at a cost of N7,593,000 (1991 figure).

5. ALPS PROJECT 91 Architectural Design

It appears from this report that architects have prepared the drawings for the building, approved by ALPS and foundation laying ceremony concluded at the site near NIPRD in Abuja. Tenders for construction are yet to be invited.

The mission thus concludes that ALPS is yet to create scientific infrastructure and scientific manpower to conduct R&D activities. However, ALPS indicated its plans to construct buildings and set up semi-commercial plants to produce starch, ginger oleoresin, sheabutter, etc.

3 CONCLUSIONS AND RECOMMENDATIONS

Having visited seventeen research institutions, factories, government departments and organizations, and having reviewed related documents, the mission has reached the following conclusions.

The conclusions and recommendations are covered under separate headings based on the objectives stated in the job description of the consultants (Chapter 1.1)

1. Assessment of the potential of medicinal and aromatic plants for industrial utilization

Nigeria is one of the largest countries in Africa with a total geographic area reaching nearly one million square kilometers. Its climate varies from tropical at the coast through sub-tropical further inland to near desert conditions in the North resulting in a rich and diverse flora.

The plant wealth of Nigeria is better appreciated by an estimated number of 200,000 herbal practitioners who deliver health service to 70% of the country's population using local medicinal plants.

The National Institute for Pharmaceutical Research and Development (NIPRD) in Abuja has recently compiled 617 Nigerian medicinal plants and recorded the existence of 190 traditional medicine practitioners in the Federal Capital Territory.

African Pharmacopoeia 1985, 1st Edition, (OAU/STRC Publication) contains 95 monographs on 105 medicinal plants and gives a list of 100 more plants for inclusion in the 2nd edition.

A recent OAU/STRC publication titled "Contribution to Ethnobotanical and Floristic Studies in Western Nigeria" by E. Adjanohoun et al (1991) gives botanical and ethnopharmacological information, and line drawings of 297 medicinal plants.

Another recent book (Plants Used in Traditional Medicine in West Africa, by L. Ake Assi and S. Guinko, Roche, 1991) contains botanical and ethnopharmacological information and colour drawings of 51 medicinal plants growing in Nigeria and other countries of West Africa.

Nigeria is traditionally known to be the exporter of many medicinal plants which include Calabar bean (*Physostigma venenosum*), Cola nuts (*Cola nitida*), Gum Arabic (*Acacia senegal*), *Garcinia cola* Shea nuts (*Butyrospermum parkii*), etc. However, the mission could not obtain any information on the names and volumes of medicinal and aromatic plants currently exported from Nigeria.

There is, at present, no phytochemical industry in Nigeria. Glaxo Nigeria PLC produces a small quantity of Capsicum Tincture using local capsicum for its own formulations.

Federal Institute of Industrial Research in Oshodi, Lagos (FIIRO) has a pilot plant for the production of oleoresin from dried ginger. The plant imported from Greece and commissioned in 1986 was in operation only for a short period of time until explosion in the boiler. Raw Materials Research and Development Council (RMRDC) has recently provided funds to FIIRO to import a new boiler.

RMRDC has also sponsored a local chemical process equipment manufacturer to design and fabricate a prototype steam distillation pilot plant for the distillation of essential oils from aromatic plants. The mission noticed that the design was wrong and based on obsolete ideas.

The Nigerian research and engineering institutions such as ARCEDEM and FIRO have basic engineering infrastructure and installed capacity to undertake fabrication of chemical process equipment. However, due to lack of suitable design and engineering capability, the existing infrastructure is, at present, not at all utilized to contribute to the country's industrial development.

In order to scale up bench-scale research results into industrial operations, experimentation at pilot plant level are very necessary. A pilot plant capable of carrying out various unit operations such as extraction, distillation, fractionation, evaporation, etc. can be suitably used to derive necessary process parameters for scaling up to the industry. There is, at present, no multipurpose pilot plant in Nigeria. Therefore, bench-scale research work cannot find industrial applications.

The provision of a multipurpose pilot plant for extraction and distillation of medicinal and aromatic plants is seen as a right step to develop indigenous industrial processes.

In-depth studies at pilot plant level would establish technical feasibility and economic viability of a new process know-how and leads to obtain technical data for scale up to industrial operations, serve to impart training and confidence to scientists and technologists who would later design, set up and operate a commercial plant.

Pilot plant operations should be monitored and evaluated using modern analytical instruments to establish optimum conditions and the quality assurance of the products.

Some local pharmaceutical manufacturers, namely Pharma-Deko, showed willingness to commercialize feasible research results for industrial utilization. The company has complete bench scale experiments on a number of medicinal plants and desires to develop industrial processes through pilot plant studies.

2. Assessment of the progress in cultivation and post-harvest treatment of medicinal and aromatic plants

The importance of cultivation is to be stressed and seen as essential for the development of plant based industries, because without a steady supply of standard quality plant raw materials a healthy development of phytochemical industries cannot be achieved. Dependence on only wild sources can not only create a rapid depletion of natural resources but also make it difficult for user industries to produce products of standard quality.

At present, no medicinal or aromatic plant is cultivated in Nigeria for industrial utilization. Association of Lady Pharmacists (ALPS) has plans to cultivate eight selected plants in various locations in Nigeria for the production of pharmaceutical raw materials.

Glaxo is cultivating Aloe (for Glaxo, U.K.), cassava, paw paw (papaya), pineapple, etc. for use in its food products.

Shea nuts are collected from wild trees abundantly growing in Abuja and Kaduna states for a primitive local production of sheabutter and for export.

NIPRD in Abuja is in the process of establishing a medicinal plant garden and a farm in the 50 Ha land that it owns for the cultivation of medicinal and aromatic plants.

Most plant drugs are gathered from forest trees. During logging operations of trees with medicinal attributes or aromatic properties, barks, leaves, branches, fruits, etc. may be collected. People living in forest villages and rural areas may be employed in such operations. Such a practice may result in a sustainable system of the management of ecologically sensitive and species-rich tropical forests.

Proper post-harvest handling and storage should be followed to prevent deterioration and loss of the raw materials. In the case of aromatic plants, distillation in the field can be a suitable solution.

3. Assessment of the progress in the current production of herbal pharmaceuticals and the specific needs for improvement of these

No herbal pharmaceutical product has currently been produced by the industry in Nigeria. However, traditional medicine practitioners produce and prescribe their secret plant based formulations without any government control. Since safety and efficacy of such preparations is questionable due to primitive methods followed in their preparation, thus creating a potential hazard for the public health.

Although some states in Nigeria register traditional medicine practitioners, it is not yet mandatory for them to register with the Federal Ministry of Health. They freely advertise their skills through radio and press, and participate in trade exhibitions and fairs to practice and sell their obscure formulations.

It is an usual practice to test the safety and efficacy of any drug preparation first on animals and then on human beings. Pharmacological and clinical test protocols for testing of drug substances and preparations are internationally well established. Before testing of any medicinal plant formulation measures should be taken for its preparation in a standard and reproduceable form. Multifurpose pilot plant is a useful solution for the preparation of adequate quantities of extracts and essential oils for pharmacological and clinical testing. The use of modern analytical instruments is necessary for their quality assurance.

Dry extracts and essential oils can be stored for longer periods than plant materials and liquid preparations under appropriate conditions for later use in drug or cosmetic formulations. Plant extracts and essential oils have a ready export market if produced in adequate quantities of standard quality. Their use in formulations facilitates the preparation of reliable and reproduceable medicines with assured quality. This is also a prerequisite for their commercial scale manufacturing by pharmaceutical companies.

4. Assessment of industrial and institutional infrastructure related to medicinal and aromatic plants in the country and the development of pharmaceuticals based on traditional preparations

The pharmaceutical industry in Nigeria does not manufacture any plant based pharmaceutical and all the bulk drugs and more than 90% of excipients are imported for use in formulations. 20% of the pharmaceuticals in the Nigerian market are locally produced.

The volume of pharmaceuticals imported into Nigeria is estimated to be about \$ 146 million (1990); 40% of this amount is believed to be plant based products, based on custom declared imports.

Sizeable quantities of ginger, cola nuts and crude gum arabic are exported from the country, but due to lack of indigenous manufacturing facilities Nigeria has to acquire purified gum arabic for its industry through imports. Gum arabic (Acacia powder) requirement for the local pharmaceutical industry in 1989 was 104 tonnes valued N3.8 million. Total industrial requirements of gum arabic for use in food industries in Nigeria was estimated in 1989 to be 1745 tonnes (See Tables I-III).

The surveys conducted by the Multi-disciplinary Task Force in 1989 has clearly revealed that in Nigeria chemical process industry - production of industrial raw materials and finished products - is either in its "embryonic state" or altogether non-existent. The picture of this industry apparently remains the same even today.

Information placed at the disposal of the mission suggests that the following agricultural by-products are not properly utilized. If this is true, the mission is of the opinion that there exists a potential for their industrial utilization.

It is reported that, in 1990, Nigeria produced 5,768 million tonnes of maize. About an equal amount of cobs would have resulted as a by-product after separation of maize from cobs. These cobs can be industrially utilized as in most of the developed and developing countries for the production of furfural which is an important raw material in the plastic and chemical industries.

Considerable quantity of rice (actual figure was not available to the mission) is produced in Nigeria. The entire quantity of rice bran obtained as by-product during the polishing of rice was said to be not used industrially.

It is a well known fact that rice bran contains about 20% fixed oil (triglycerides of fatty acids), besides a small amount of waxes, chlorophyll, vitamin B, etc. The unique quality of rice bran is that the enzyme contained in the bran remains dormant as long as it remains on the rice grain as brown coating. As soon as it is separated from the grain, the enzyme becomes active and split the oil into its composite fatty acids. During the initial stages of its activity, increase in free fatty acid content (FFA) is reported to be 1%/h. In Japan, the fresh bran collected from rice

mills is subjected to sterilization before being solvent extracted. The resulting oil after dewaxing and refining is used for edible purposes.

In India as well as in some other developing countries, most of the bran produced is solvent extracted for its oil which, in turn, is used in the soap industry. The exhausted bran after blending with other ingredients is used as cattle and poultry feed.

The mission brought these to the attention of the Director-General of RMRDC.

Although several universities and research institutions in the country have been conducting laboratory scale research for plant based products, the indigenous industry does not seem to have benefited from these research results, thus creating the current situation where 0% of active ingredients and 2% of excipients for use in pharmaceutical formulations are locally sourced (Table II).

In order to commercialize research results, an integrated approach is necessary. This can be achieved through a research institution with the necessary built-in infrastructural requirements including trained manpower. It should be able to carry out research and development of plant based products from the field to the industry.

Among the institutions visited in Nigeria, the mission identified the National Institute for Pharmaceutical Research and Development (NIPRD) as the most suitable institute with potential for further development. NIPRD appeared to be the only institution in the country with well integrated laboratories and a clear mandate to research and develop pharmaceutical materials and preparations from locally available medicinal and aromatic plants. It functions under the aegis of the National Agency for Science and Engineering Infrastructure (NASENI) which is mandated to formulate and execute national policies on science and engineering infrastructure development in Nigeria. Therefore, it is imperative that NIPRD should be strengthened to conduct bench-scale and pilot plant scale processing of medicinal and aromatic plants for the production of extracts, essential oils and their isolates.

Medicinal Plant Chemistry (Phytochemistry) Laboratory should be equipped with modern analytical and other facilities.

The Library should be strengthened to function as a national information centre for plant based pharmaceutical and cosmetic materials.

The Institute should interact with other institutions, scientists and pharmaceutical companies conducting research into medicinal and aromatic plants for speeding up the transition from bench scale through pilot plant scale to industrial level.

The Institute should have separate buildings to house multipurpose pilot plant with explosion proof fittings. Other general purpose pilot plant equipment should be located separately. Boiler should be housed in an annexed building.

Table I Demand situation of some selected raw materials used by the pharmaceutical industry in Nigeria

(Ref.: Report of the Multidisciplinary Task Force on Chemical and Pharmaceutical Industries, RMRDC, 1989)

Raw Material	Annual Demand (MT)	Total Cost (N)
1. Sugar (sucrose)	3614	14,563,512
2. Maize starch	1410	7,717,920
3. Acacia powder (gum arabic)	104	3,834,480
4. Menthol	16	2,099,840
5. Camphor	72	1,275,840
6. Citrus pectin	2	736,000
7. Liquorice extract	6	578,580
8. Potato starch	20	464,000
9. Pine oil	16	336,000
10. Cassava starch	70	315,000
11. Aniseed oil	2	252,520
12. Eucalyptus oil	6	249,720
13. Thymol	2	192,000
14. Vanillin	2	186,000
15. Peppermint oil	2	162,000

Table II Local sourcing of pharmaceutical raw materials (Ref.: same as Table I)

Pharmaceuticals	Locally Sourced (%)	Potential local source
Active ingredients	0	34 %
Excipients	2	9 %

Table III Annual consumption and local production of some plant based products used in food and beverages industries

(Ref.: Report of the Multidisciplinary Task Force on Food, Beverages and Tobacco Sector, RMRDC, 1989)

Raw Material	Annual Consumption (MT)	Local Production (%)
Sugar	1,000,000	3-5
Glucose	30,000	10
Hydrolysed vegetable protein	20,000	0
Corn starch	15,000	0
Flavourings	2,000	0
Cocoa butter	2,000	100
Gum arabic	1,745	0

These pilot plant buildings should be equipped with the required infrastructure such as electrical (explosion-proof where necessary), water, water cooling, steam, drainage, ventilation, etc.

The Institute should possess a voltage stabilizer and an uninterrupted power source (UPS) for the protection of sensitive and sophisticated equipment and for their reliable performance. The laboratories should be fully air-conditioned. The Institute should have an independent source of water that is a bore-well, overhead tank and pumping systems. A boiler should be installed to generate 500 kg/h of steam for supply to the pilot plant. A cooling water tower and a water-chiller are necessary prerequisites for satisfactory operation. All electrical fittings in the multipurpose pilot plant area must be ex-proof. Adequate fire-fighting facilities should be made available in the pilot plant area and the laboratories. A modest workshop for repair and maintenance of pilot plants and glass blowing facilities should be created for minor modifications and repairs.

This workshop should consist of the following equipment:

Turning lathe with chuck 5 ft bed complete with all accessories, tools and essential spares.

Pedestal drilling machine cap. up to 25 mm dia. holes, with tools, accessories and spares.

Portable drilling machine with tools accessories and spares.

Portable cutting/grinding unit with tools accessories and spares.

Argon arc welding set with tools, filling rods, accessories and spares.

Electric arc welding set, 200 Amps electrodes, complete with tools, accessories and spares.

Oxy-acetylene cutting/welding set with accessories and spares.

Motorized hacksaw machine with tools, accessories and spares.

Hydraulic pipe bender, manually operated with tools, accessories and spares.

Working tools: sets of spanners, pipe wrenchers, hammers, etc.

Stainless steel pipes, valves, sheets, etc.

Mild steel seamless pipe, fittings and valves.

G.I. pipes, fittings and valves.

The Medicinal Plant Chemistry Laboratory will need the following facilities to carry out phytochemical and analytical studies:

1. Laboratory glassware
2. Consumables such as chemicals, solvents, adsorbents, reagents, etc.
3. Rotary evaporators with vacuum and temperature controllers, and waterjet vacuum attachment complete with temperature controlled water bath, flasks, and spares (2 pcs)
4. Glass Soxhlet extractors (250 ml - 10 sets, 500 ml - 5 sets, 1000 ml - 3 sets, 2000 ml - 2 sets)
5. Glass Clevenger apparatus for essential oil content determination (5 pieces each for oil-rich and oil-poor materials)
6. Volumetric moisture content determination apparatus complete with flask (10 pieces)
7. Buchner filtration set up (a range of all available sizes)
8. Chromatography columns made of glass or solvent resistant synthetic material
9. Thin Layer Chromatography (TLC) plate spreader unit
10. Cut glass TLC plates of sizes 5x20, 10x20, 20x20, 40x20 cm (50 pieces each)
11. TLC chromatography tanks to develop the above mentioned plates (10 pieces each)
12. Hot-plate/magnetic stirrers with speed and temperature controls (5 pieces)
13. Drying ovens with thermostatic control and timer (2 pieces)

14. Heating mantles with thermostats to suit various sizes flasks mentioned above (3 pieces each size)
15. Water baths with thermostatic control to take up to six flasks at a time with concentric top cover rings (3 pieces)
16. Circulating thermostatic water bath
17. Flask shakers (5 pieces)
18. Moisture balance - microprocessor controlled with timer and all other controls
19. Bench-top electronic balances (toploading - 2 pieces; analytical - 3 pieces)
20. Vacuum oven complete with controls and a vacuum pump
21. Laboratory vacuum pumps (3 pieces)
22. Laboratory centrifuge (up to 10,000 rpm) with tubes and various size changeable rotors to suit most tube sizes
23. Deep freezer, horizontal type, -18°C, 250-300 L
24. Abbe type refractometer
25. Electronic digital polarimeter with a range of cells to measure down to 0.1 ml of material
26. Ultrasonic baths (2 pieces)
27. Muffle furnace for ash value determination
28. UV lamps (2 pieces - one hand lamp, the other mounted in a cabinet)
29. Binocular and stereo microscopes (2 pieces each)
30. Bench top freeze dryer with manifold and chamber with tray-heating and vial stopper attachments
31. Distilled water still (10 L/h capacity)
32. Water deionizer (300 L/h capacity)
33. Microprocessor controlled UV-VIS double beam scanning spectrophotometer with recorder, quartz cells, chart paper and spares
34. Microprocessor controlled IR spectrophotometer complete with recorder, cells, cell holders, hand-operated press to make KBr discs, chart paper and spares
35. Gas-liquid chromatograph complete with computerized integrator, ECD and FID detectors, a range of polar and non-polar fused silica capillary columns, chart papers, diskettes, split/splitless injector, syringes, septums, two each of hydrogen, nitrogen and oxygen cylinders complete with gauges and regulators, and spares

36. High pressure liquid chromatograph complete with computerized integrator, two pumps, detectors (UV-VIS, refractive index, conductivity, fluorescence, photo-diode array), a range of packed columns, automatic injector, syringes, column oven, diskettes, chart papers, a range of HPLC-grade solvents, spare parts
37. pH-meter/Conductimeter with electrodes and spares
38. Automatic titrator
39. Cold room, 5 cubic meter capacity, temp. range: -5/+5

Audio-visual and office equipment

The following equipment will be necessary for teaching, word-processing, computer-communication, data processing, recording (video and sound), etc.

1. Word processors (3 pieces) complete with necessary softwares for word processing and bench-top publishing, letter quality printer, laser printer
2. Computers for data collection, storage and processing, complete with necessary softwares (3 pieces) with two dot-matrix printers
3. Photocopier with zoom function, upto 50 copies/min., A3, A4, B4 size cartridges, feeder, sorter, etc.
4. Fax machine
5. Modem with suitable baud rate
6. CD-ROM
7. Slide projector with carousel magazine
8. Overhead projector
9. Portable TV camera outfit and all necessary accessories and spares
10. Photographic camera and accessories
11. Large screen TV set
12. Video recorder/player
13. Portable sound recording outfit

A drafting table and drawing tools are necessary for design and engineering drawings of equipment to be fabricated.

All essential books and journals should be purchased to strengthen the library. At present, NIPRD is hardly receiving any periodical on medicinal and aromatic plants.

Three project vehicles should be acquired. One of them should be a long-chassis 4-wheel drive land cruiser, and two cars.

3.1 SUMMARY OF CONCLUSIONS

1. Sporadic laboratory scale experiments are being conducted on medicinal and aromatic plants in a few Universities and research centres.
2. Pilot plants for scale up studies are not available in any of the Centres visited.
3. Technology development and its transfer capability is very weak.
4. Expertise in design & engineering, and fabrication of chemical plant and equipment is in its infant state. However, installed capacity exists at some centres to undertake fabrication of not only pilot plants but also industrial size plants.
5. Nigeria has a wealth of natural resources and well qualified scientific manpower. Due to the lack of well coordinated interaction between scientists/scientific groups, no herbal medicines or essential oils are produced in the country despite the fact that there is a great demand for the herbal medicines as about 70% of the population is dependent of medicinal plant preparations for their health care needs.
6. National Institute for Pharmaceutical Research and Development (NIPRD) at Abuja, established in 1987 and now functioning under the aegis of the National Agency for Science and Engineering Infrastructure (NASENI) has built-in scientific infrastructure, qualified scientific manpower, buildings, and headed by a qualified and experienced scientist with vision and dynamism. This Institute is, at present, wholly engaged in conducting bench-scale research in the utilization of medicinal and aromatic plants, and the development of pharmaceutical drugs.

Taking all the prevailing conditions in Nigeria *vis-a-vis* processing of medicinal and aromatic plants, the mission concludes that NIPRD qualifies for UNDP/UNIDO support to set up multipurpose pilot plant for extraction, distillation and fractionation of medicinal and aromatic plants to enhance R&D infrastructure together with the inclusion of modern analytical instruments and training of scientific and technical manpower.

At the end of this project, NIPRD will be in a position to

- undertake process development leading to appropriate technologies for the industrial production of phytochemicals. An additional spin-off of the project would be to develop skills in the development of appropriate technologies, capabilities in the design & engineering of chemical process equipment necessary for the transfer of technology.

- employ and develop modern analytical techniques both in the process control and quality control of plant based pharmaceutical raw materials produced at the Institute or elsewhere. Modern chromatographic and spectroscopic equipment can also be used in research activities of the Institute, hence contribute to the quality of scientific research. The Institute is expected to offer analytical services to the industry and other research institutions in the country.
- compile, compute and disseminate information concerning medicinal and aromatic plants, phytochemicals, traditional medicine, etc. through its well established databases. On-line and off-line linkages with commercial databanks, information institutions and networks can also be established.
- provide consultancy and advisory services to the user industry and government institutions.
- undertake training and development of scientific and technical manpower.

In-depth studies at pilot plant level would establish technical feasibility and economic viability of a new process know-how and lead to technical data for scale up to industrial operations, serve to impart training to the scientists and technologists who could later design, set up and operate a commercial plant.

With the acquisition of modern R&D facilities including multipurpose pilot plant and modern analytical instruments, the Institute should be able to successfully develop, demonstrate and transfer technologies for the industrial utilization of medicinal and aromatic plants.

3.2 SUMMARY OF RECOMMENDATIONS

Identification of the problem	Action to be taken	Responsible party
<p>1. Nigerian flora is rich in medicinal plants and is appreciated by the traditional herbal practitioners who use them in their formulations. Although sporadic bench-scale research has been conducted by various institutions in the country, due to lack of coordination, research results could not be commercialized, resulting in the fact that 100% of active ingredients (bulk drugs) used by the drug industry is imported. NIPRD is the only institute in Nigeria with integrated laboratories and a clear mandate to develop pharmaceutical raw materials from medicinal and aromatic plants.</p>	<p>A UNDP/UNIDO project to strengthen NIPRD should be initiated. Through this project a multipurpose pilot plant for extraction and distillation should be established at Abuja with the modern facilities for R&D and Q.C. to ensure development of processes to produce standard herbal extracts and essential oils which could be used in the formulation of herbal preparations. Modern information facilities should also be provided.</p> <p>An important prerequisite is the completion of pilot plant building with necessary infrastructure and the provision of national personnel. Strengthening of NIPRD should be realized in phases. The first phase should cover the above and the second phase should concentrate on strengthening of pharmacology/toxicology and formulation units.</p>	<p>National project staff, building(s) to accommodate the pilot plant, boiler with necessary infrastructure, raw materials, running cost of the pilot plant and laboratories, and other locally incurring expenditure should be borne by the Government.</p> <p>Acquisition of the pilot plant, analytical instruments and other necessary equipment, international and local experts, international training and study tours should be covered by UNDP/UNIDO.</p>
<p>2. Steady supply of adequate amount of plant materials to support industrial operations</p>	<p>Cultivation and/or systematic collection from the wild of medicinal and aromatic plants on a sustained yield basis should be programmed and executed. Agricultural institutes and farmers should be encouraged to cultivate potential medicinal and aromatic plants as intercrops and on marginal lands. NIPRD should initiate cultivation in its own land.</p>	<p>The Government / NIPRD</p>

3. Pharmaceutical and related industries are not at present interested in investing in the production of plant based pharmaceuticals, since viable technologies are not available for the production of plant based raw materials and due to design & engineering capabilities. Lack of these capabilities are seen as the main impediments to the growth of chemical process industries.

NIPRD should develop technology base, design & engineering capability, and then identify some potential entrepreneurs to whom the technology could be transferred.

NIPRD / The Government

4. The country has a variety of essential oil bearing plants. This potential for industrial exploitation has not been sufficiently explored.

Production of essential oils comes under small and medium scale industries. It does not require large capital investment. Farmers can be encouraged to cultivate aromatic plants and to produce essential oils in the field. This can be done by installing field distillation still or by installing proper distillation set up at a central location so that farmers can bring their harvest of aromatic plants and distill them at these units.

NIPRD / Private sector

5. The mission had difficulty in obtaining exact figures, names and parts of medicinal and aromatic plants exported from Nigeria. If this information is not available no adequate measures can be taken for the conservation of rare and vulnerable species and no planning for the industrial utilization potential of medicinal and aromatic plants of Nigeria can be accurately made.

Information on export of individual medicinal and aromatic plants should be correctly recorded and monitored. When necessary conservation measures should be considered.

Export Promotion Council of Nigeria / NIPRD

6. Alloy steels are not presently produced in Nigeria. Industrial gases such as argon, oxygen are produced in the country. However, imported stainless steel sheets, pipes and valves are said to be available in the local market. There is installed engineering infrastructure available to undertake fabrication of chemical process equipment. However, there exists shortage of some equipment and design & engineering capability

Some institutions such as ARCEDEM in Ibadan and FIIRO in Lagos have installed infrastructure to fabricate all sorts of chemical process equipment. Stainless steel dished-ends could be imported. This would save not only large amounts of foreign exchange but also saves precious time in acquiring the needed equipment and impetus to the growth of indigenous engineering industry. This could result in many opportunities for employment to engineers, technicians, etc.

The Government

4. PERSONS CONTACTED

RMRDC

1. Dr.(Mrs.) O.A.Aribisala, Director General
2. Dr.P.O.Ogazi, Asst. Director (agro-based division)
3. Dr.B.N.Olorunfemi, Asst.Director (TEDAC)
4. Dr.(Mrs.) F.Bogunjoko, C.S.O., Planning, Evaluation and Statistics Div.
5. Mr.V.I.Maduaka, Planning, Evaluation and Statistics Division
6. Mr.I.U.Mmah, Scientific Officer
7. Mr.S.B.Fagbemigun, Scientific Officer
8. Mrs.R.O.Enwereuzoh, Scientific Officer
9. Mr.D.Omotoso, Asst. Chief Librarian
10. Mr.O.Christopher, Senior Programme Officer
11. Mr.E.A.Thompson, A.C.P.A. (computer Division)
12. Mr.R.N.Ihenacho, Head of Administration
13. Mr.S.B.Olaniyan, Secretary, Risk Fund
14. Mr.M.M.Adamu, Head, Liaison Office, Abuja

NIPRD

15. Prof.C.O.N.Wambebe, Director/Chief Executive
16. Dr.N.A.Ochekpe, Head, Medicinal Chemistry and Q.C. Department
17. Dr.K.Gamaniell, Head, Pharmacology & Toxicology Department
18. Mr.A.O.Ohaeri, Taxonomist
19. Mrs.N.Enwerem, Acting-Head, Medicinal Plants Research and Traditional Medicine Department
20. Mr.L.Panya, Head, Pharmaceutical Technology and Pilot Plant Production Department
21. Dr.K.Ibrahim, Head, Pharmaceutical Microbiology and Biotechnology Department
22. Dr.T.O.Daniel, Chief Librarian
23. Mr.V.O.Oyaigbevwen, Administrative Secretary

NASENI

24. Prof.G.O.Ezekwe, Executive Chairman (previously Minister of Science and Technology)

Obafemi Awolowo University, Faculty of Pharmacy, Ile-Ife

25. Dr.J.A.Aladesanmi, Head, Pharmacognosy Department
26. Prof.A.Sofowora, Pharmacognosy Department
27. Dr.A.Elujoba, Reader in Pharmacognosy

University of Ibadan

28. Prof.A.O.Olorunda, Department of Food Technology, Faculty of Technology
29. Dr.G.O.Adegoke, Department of Food Technology, Fac.Technology
30. Prof.A.A.Olaniyi, Department of Pharmaceutical Chemistry, Faculty of Pharmacy

University of Nigeria, Nsukka

31. Prof.S.M.Anika, Dean, Faculty of Veterinary Medicine
32. Prof.O.K.Udeala, Faculty of Pharmaceutical Sciences
33. Mr.F.U.Ekezie, Chief Technologist, Dept. Pure & Industrial Chem.

National Root Crops Research Institute, Umudike

34. Dr.P.A.Okwuowulu, Director
35. Dr.B.O.Njoku, Coordinator of Ginger Programme

ARCEDEM, Ibadan

36. Mr.J.L.Halborn, C.T.A.
37. Mr.T.A.Diallo, Programme Officer

FIRO

38. Prof.S.A.Odunfa, Director/Chief Executive
39. Dr.A.O.Osinowo, Head, Chemistry and Fibre Technology Division
40. Mr.A.B.Meadows, Ginger Extraction Plant

Drug Registration Section, FDA&C, Federal Ministry of Health

41. Mr.S.A.A.Adetunji, Chief Pharmacist

Pharmaceutical Society of Nigeria (PSN)

42. Dr.P.Emafo, President

Association of Lady Pharmacists (ALPS)

- 43. Chief M.K.O.Abiola, Chairman, Governing Council
- 44. Mrs.M.O.Olorunshola, National Chairperson
- 45. Dr.(Mrs.) D.Awosika, Chairperson, Technical Committee
- 46. Dr.(Mrs.) C.Igwilo, Chairperson, Research Committee
- 47. Ms.C.Chukwuani, Chairperson, Monitoring Committee
- 48. Mrs.S.Adesonya, Chairperson, Publicity Committee

PGM-MAN

- 49. Chief A.A.Egboh, Executive Secretary
- 50. Mr.O.G.O.Olukoya, Chairman, Management Committee

Nigerian Indigenous Pharmaceuticals Manufacturers Association (NIPMA)

51. Chief O.Akoni, President

West African Pharmacists Federation (WAPF)

- 52. Mr.T.C.Corquaye, President
- 53. Dr.U.S.Inyang, Executive Secretary

Pharmaceutical Companies

Glaxo Nigeria PLC

- 54. Mr.N.G.K.Wilson, Managing Director
- 55. Prof.B.L.A.Fetuga, Business Development Director
- 56. Dr.N.D.Ifudu, Food Development Laboratory

Pharma-Deko PLC

57. Mrs.R.Soremekun, Project Manager

58. Mr.A.I.Ogbolu, Production Manager

Ibachem (Ibafon Chemicals) Ltd.

59. Prof.I.U.W.Osisiogu, Production Development Executive

Chez-Pharma Nigeria Ltd

60. Mrs.O.A.S.Gyoh, Managing Director

Hess Pharmaceutical Co.Ltd.

61. Mr.N.G.Uzoezie

Smith Kline Beecham Nigeria PLC

62. Mr.B.A.Soremekun, Controller Pharmacist

Panpharm Ltd.

63. Dr.F.B.Adenika, Managing Director

Nigerian Export Promotion Council, Abuja

64. Dr.S.A.Ingawa, Director, Product and Market Development

Association of Nigerian Exporters

65. Mr.O.A.Kolawole, Marketing and Research Manager

Indev Ltd.

66. Mr.C.Madueke, Managing Director

67. Mr.L.Eziokwu, Mechanical Engineer

Tonykhai Co.Ltd./Tescott&Grenfell Ltd

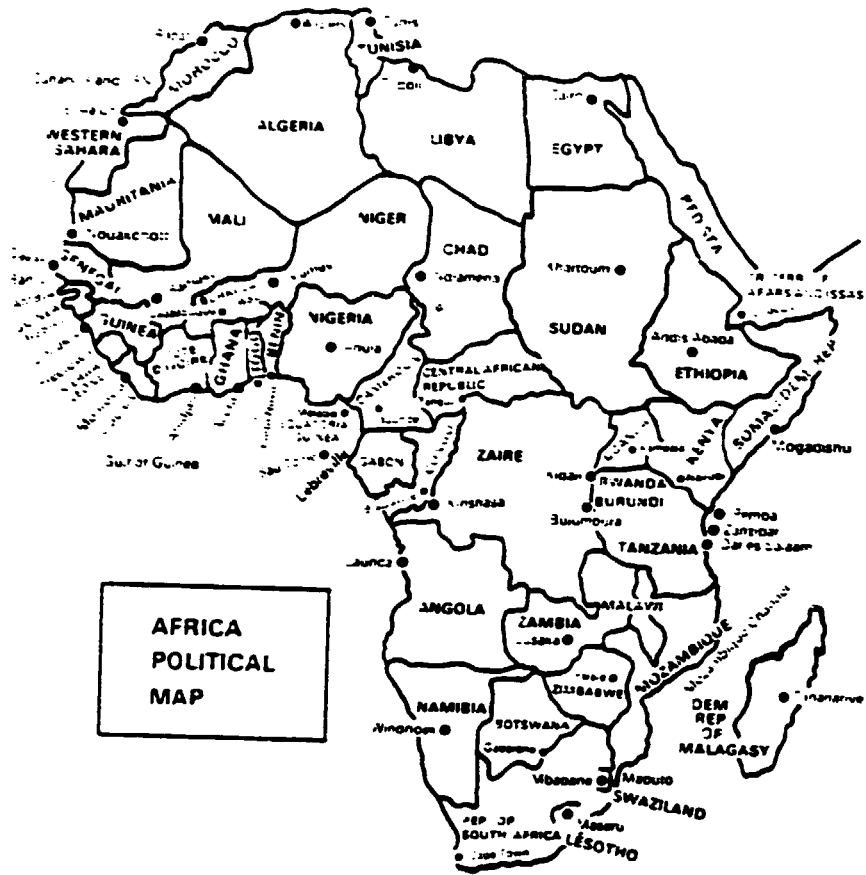
68. Mr.E.C.M.Obata, Executive Director

69. Mr.D.Osunbaya, Technical Director

70. Mr.S.O.Sorunke, Head, Design&Engineering

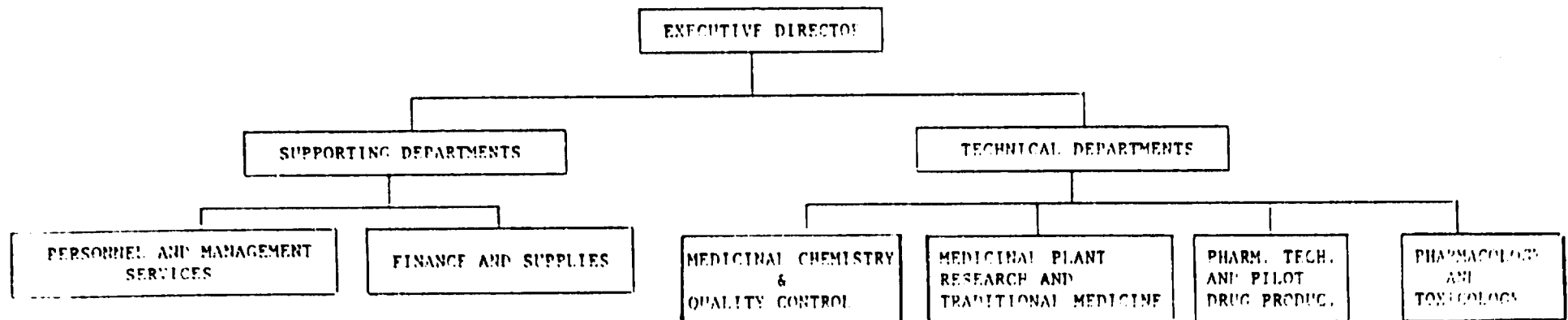
UNIDO

71. Mr.D.Tommy, U.C.D.
72. Mr.S.Frydenlund, Asst.to U.C.D.
73. Mr.A.Ajani, Programme Officer
74. Mr.A.F.Dallalah, Junior Programme Officer



NATIONAL INSTITUTE FOR PHARMACEUTICAL
RESEARCH AND DEVELOPMENT
P. M. B. 21, IDU ABUJA

ORGANIZATIONAL CHART



**Backstopping Officer's Technical Comments
based on the work of K.H.C. Baser and M.B. Narasimha**

The report contains a detailed account of the work of consultants highlighting the relevant areas for the development of plant based industries, pharmaceutical industry in particular. All past project documents, publications, reports and available statistics have been reviewed and analyzed in making their conclusions and recommendations. The current status of the sub-sector has been obtained by interacting with the staff of sixteen institutions visited.

The consultants have also given technical advise on how to improve certain on going activities and to initiate related new activities which could be economically viable. The report can also be considered as a review of the present status of the plant based industries. The consultants have been constructive in their comments and recommendations. They have successfully accomplished their task and hope that their recommendations would be considered favourably and urgently for necessary action.

The specific recommendations for a technical assistance project has been drafted separately. It contains the requirements for the development of industrial processing of medicinal and aromatic plants in terms of infrastructure, human resources, equipment, technology and expertise. The necessity for UNIDO execution has been made on the basis of the long experience of UNIDO in successfully implementing such projects in developing countries in Asia, Africa and Latin America. The draft project document prepared by them will be the basis of formulation of a project document for technical assistance.

It would have been very useful if the consultants had the opportunity to discuss their findings and recommendations with relevant government departments and the local UNDP staff. It is hoped that the report will be a useful document for the development of plant based industries in Nigeria.