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FACT FINDING AND PREPARATORY ASSISTANCE TO STUDY DATA AVAILABLE ON THE UTILIZATION OF INDIGENOUS MEDICINAL PLANTS AND TO ASSESS THE POTENTIAL FOR INDUSTRIAL PROCESSING OF HERBAL PHARMACEUTICALS

KINGDOM OF SWAZILAND

Technical report: Preparatory assistance mission*

Prepared for the Government of the Kingdom of Swaziland
by the United Nations Industrial Development Organization

Based on the work of R.O.B. Wijesekera,
chemical technologist

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Chemical Industries Branch

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* This document has not been edited.

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1. INTRODUCTION

1.1. Background to the mission

The present mission is the result of a request made by the Government of the Kingdom of Swaziland to the United Nations Industrial Development Organisation, (UNIDO), Vienna, for technical assistance in the formulation of a project proposal designed to make use of its indigenous resource of medicinal and aromatic plants. Specifically, the need expressed was: for identifying the infrastructural requirements for the establishment of a processing plant, an R. & D Laboratory, and, if feasible, small scale processing units in the rural areas.(Vide Annexure 1).

Accordingly UNIDO acquired the services of the present consultant, an industrial organic chemist with several years experience in the chemistry and technology of medicinal plants and essential oils.

The consultant's present mission commenced on 17 October 1994 following his travel from Colombo, and briefing by the special technical adviser at the UNIDO headquarters in Vienna. The consultant was held up a day in Johanesburg en route due to a stoppage of work at the airport in Manzini.

The consultant was briefed by UNDP (JPO-Mr Luke Myers acting on behalf of the UCD who was stationed in Mozambique). The consultant then met the Under Secretary, Ministry of Commerce & Industry, Dr Thembeyena A.Dlamini, (the principal secretary was away), who also briefed him and arranged for the provision of a vehicle for the duration of the mission. The consultant commenced work on the 17th by contacting the national counterpart, Dr Lydia P.Makhubu, Vice Chancellor of the University of Swaziland at the campus at Kwaluseni. Dr. Makhubu together with Dr. Jerome D. Msonthi, Professor of Chemistry, and Head of the Department of Chemistry arranged the programme in consultation with the consultant. The consultant also requested that he be enabled to see any industrial units, as well as agencies which may be potential entrepreneurs. These were arranged through the UNDP office, as well as through the offices of the principal secretary and the vice-chancellor. The relevant aspects of the visits and discussions, will be described hereinafter in the appropriate sections of this report. The consultant subsequently had a meeting with the Principal Secretary, Ministry of Commerce & Industry, which was the lead Ministry for the mission, and discussed his findings with her as well as the proposal for a technology generation centre for the country in this sector of industry. The Principal Secretary was in complete accord with the proposal and pledged her suppor to implement it.

The consultant had a meeting with the national counterpart, the vice chancellor during which he also explained to her the findings and proposals. At the final meeting where the consultant explained the salient features of his draft project proposal and report to be submitted to UNIDO, the UNIDO country Director, Mr I Fraqueli, who had travelled from Maputo, was also present.This meeting was most fruitful, and all the features of the consultant's proposals were discussed. The national counterpart felt that these proposals would serve to galvanise some mission oriented work at the University, in addtion to the work of the project. She felt that the University should have some lead time in which to prepare itself with the necessary staff intake, to implement the project and take over complete responsibility later.

The final meeting with the UNDP was one in which the resident representative Mr G.Davis, and the UCD participated along with the consultant. A resume of the findings was given to the resident representative. All aspects of the proposed project were discussed very briefly. The UCD explained the need for funding for the institution building stage where the spin off benefits in the production of trained personnel could not be overestimated. It was pointed out to the resident representative that the success of similar projects enabled UNIDO to be confident that this institution strengthening stage would be productive. The resident representaive thanked the consultant for his work on the mission.

A list of all personnel met during the entire mission, is in annexure 2. The consultant's work calendar in in Annex 3.

1.2 The case for industrial utilisation

The plant kingdom over the ages has proven to be a massive repository of all types of chemical agents that have been useful to mankind. Today as the world approaches the year 2000, and the World Health Organisation aspires to provide health for all by that time, one can only think that: a will is a way, and that having a worthy goal is something that matters. For, the reality is hard. Synthetically produced medicines are not accessible to the majority of the poor, and it is true that drug companies do not exist solely for the benefit of mankind.They do have to make their profits. Yet as the world approached the year 1700, there were no synthetics. The 250,000 to 300,000 species of the world's plants were then the main source of drugs. Even today, 75% of the world's population, the poor three quarters, relies still on those plants and other tools of traditional medicine. The story is strangely similar if one were to look at the situation as regards fragrances and flavours, though it would not be so austere.

In the industrialised nations of the world there is a distinct movement towards natural foods, natural medicines and everything natural that is deemed to be resonant with the human system which appears to have deviated from course. Likewise, yet for reasons that are dependent on the high cost of medicines, in third world countries too, the resort to original traditional medicines is gathering momentum. Rightly, in the world today there is another anxiety. The natural reserves of forests are dwindling at an alarming rate. The ethnomedical knowledge, indeed all traditional knowledge dies with their posessers and modern man has to act fast to maintain even some of the fruits of his own heritage.

The rationale behind the need to utilise the plant species in a systematic manner is quite simply to use it without endangering the very existence of the valuable species themselves. The two options are:

a. Systematic harvesting from the spontaneous flora. This has been termed "extractivism" (Duke 1989) and defined as: the renewable harvesting of economically useful products from natural ecosystems. This indeed was the old traditional manner before the greed of man got the better of the situation which then developed into what is termed exploitive harvesting.

b. Agroecosystems, which are the result of domesticating the plant species from the spontaneous flora, and developing cropwise agiculture in order to meet the demands of usage.

Both systems have their advantages and are widely used. They do not deplete or endanger species and drive them to extinction. The advantages of processing the plant species are several.The objective is to develop standardised, dosage related, stable, readily dispensable formulations for safe and reliable use in the modern context, by all types of people who, mostly, may not have the time to hunt for plants and process them when the need is acute.The procesing must, as far as is necessary,scientifically simulate the traditional recipe.

Simple technologies can and should be derived to fit the situation and requirement. The products must be relatively cheaper, than the synthetic substitute in the majority of the cases. Simultaneously, it must be ensured that standards for quality assessment and control should be formulated and put in place.

1.3. Two decades of UNIDO experience

Recent UNIDO publications have described, (Wijesekera & Tchecknavorian - Asenbauer 1982, Wijesekera 1991, De Silva 1994), the development of what is now the largest sustained international technical assistance programme on the industrial utilisation of medicinal and aromatic plants. This programme of UNIDO has through the past two decades enabled developing countries to utilise their resources of plants in a sustainable manner, and to develop industries that produce pharmaceuticals, essential oils and fragrances, as well as a variety of other plant derived natural products. These programmes were initially implemented in countries such as : Nepal, Rwanda, Guinea, Thailand, Tanzania, Cameroun, Burkina Fasu, Viet Nam, Turkey, North Korea, Guatamala, etc. They depended very substantially at first, on institution strengthening with funding provided by the United Nations Development Programme, (UNDP), and also by the individual donor countries through the United Nations Industrial Development Fund (UNIDF), and the governments of the respective countries. Projects in several other countries as well are now ongoing and the UNIDO programme is now well established. The developing countries that have been the beneficieries of the UNIDO assistance through this programme, have not all set up viable industries for themselves. The capacity to absorb and develop technology is dependent on several factors such as availability of adequate numbers of dedicated personnel, a multi-disciplinary approach, entrepreneurship, continued interaction with UNIDO and the parallel groups in other countries both developing and industrialised, the availability of literature and information from science technology to marketirg and so on. However there are an encouraging number of success stories with formidable impact, that justifies the programme completely.and calls for its extension to many other countries. For example the bringing of a drug from the conceptual stage to a market reality is estimated to cost drug companies anything from USD 1 to 50m depending on the case. Here in the instance of one country alone, 4 plant based drugs have been developed for an initial outlay in R & D of about half a million USD, through this programme. Similarly in at least two countries so assisted, viable industries based on the production and marketing of local essential oils have already been established. Many other such examples of sucess in varying degrees may be quoted, to

substantiate the very considerable impact of the UNIDO programme in several developing countries.

2. THE SCENARIO IN SWAZILAND

2.1. Ongoing Studies on the Flora

The geographical features of Swaziland are interesting. Within the borders of this small country, just 17,000 square kilometers in area, (Annex 4), almost every feature of the African continental terrain is to be found albeit with the exception of the desert. It is very much an African country and in this respect it would be pertinent to quote the author Kuki Gallmann here.

> "In Africa age is equated with wisdom, since the original culture was accumulated knowledge and skills which come only with experience and time... Having gone through many seasons and listened to their grandfathers, they could foresee patterns in the rains and recognise early signs of drought. They knew the secrets of the animals and of the plants, the traditional herbal remedies, and the rituals to keep gods happy or prevent their wrath. The elders were the library in which was stored all knowledge the tribe needed to survive and to thrive"
>
> **Kuki Gallmann: I Dreamed of Africa. (1991)**

The four regions of Swaziland (Annex 5), display a wide range of geoclimatic features which have resulted in a corresponding diversity of the flora. The westernmost belt, the Highveld, is mountainous, with an average altitude of 1300 meters, with many rivers in between, and a series of valleys and gorges. The rainfall of the Highveld is high, ranging from 1000 to 2300 mm annually. The adjacent undulating land sector, the Middleveld, has an average elevation of 700 meters. It boasts lush fertile valleys where agriculture is abundant and prosperous. The warmer and drier climate of the middleveld, gives its flora a different character, in terms of the type of species. Temperatures vary between 2 to 38 degrees Celsius, and the annual rainfall ranges between 750 to 1150 mm. Typical African bush vegetation is found in the Lowveld, where indigenous wildlife and flora abound. The climate is hotter and drier, temperatures ranging from -2 to 42 degrees Celsius, and the annual rainfall from 500 to 600 mm. The fourth region, the Lubombo, runs along the eastern length of the lowveld, broken by gorges of the three main rivers. The average altitude is 600 meters, and the overall climate is similar to the middleveld. As yet no comprehensive check list of the flora of Swaziland is available. However, in the light of the above observations, a commendable piece of work carried out at the University by L.P.Makhubu, J.M.Msonti and O.O.G.Amusan, has resulted in an ethnobotanical list of plants used in the traditional medicine and lifestyle of the people.(Annex 6). This work, representing as it does a concise arrangement of ethnobotanical knowledge handed down from the traditional healers, (or Sangomas), themselves, would be a most useful starting point for the initiation of a project for the industrial utilisation of the economically valuable plant species.

2.2. The Plants of Established Utility

Among the plant species that are indigenous to Swaziland there undoubtedly are species, that :

- occur in abundance
- are readily accessible for utilisation
- possess ingredients that make them commercially valuable, as known in the international literature
- lend themselves to relatively easy processing, based on a knowledge of work carried out internationally

Such species have been selected, and prioritised, based on the work of the University's research and investigations, and the judgement of the consultant.

This short list is designated List A in Annex 7.

2.3. The requirements of Traditional Healers

The traditional healers of Swaziland, with whom the consultant and the University's research team have interacted, utilise certain plants for their daily work, in attending to the people's health care. Some of these plant species occur in abundance in the wild state and can be harnessed, in a sustainable manner for use in processing into more acceptable dosage forms. Yet others which are not so abundant have to be cultivated, for which purpose agrotechnological research will have to be initiated. This will have to be undertaken within the proposed project, with continued interaction with the University's team and the traditional healers.

The plant species, selected for development on this basis is designated List B in Annex 7.

2.4. Products for the Export Market

Some plant-derived products have been identified as candidate products for the export market. This is based on the research work carried out at the University's department of chemistry. It includes products which have medicinal, pesticidal, as well as other properties. The species generating these products are identified as List C, in Annex 7.

2.5 Infrastructure & Industrial Basis

Research facilities, and capability for Chemical work.

The present infrastructure appears very much a core situation. The University has a vibrant Department of Chemistry with a committed research group on Natural Products. Even the Vice Chancellor, herself a committed scientist, with commendable performance in the area of natural product chemistry, is most supportive of the idea that the University establishes a centre for the purpose of providing the R & D nucleus for an emerging industry based on Medicinal and Aromatic Plants. (The Vice Chancellor is the National Counterpart for the present mission).

Dr. Jerome Msonti, the Head of the Department of Chemistry took the consultant around the department. The consultant had discussions with several relevant personnel and particularly with the Dean of the Faculty of Science, Professor V.S.B. Mtetwa, himself a Physical Chemist. The consultant explained to the Dean the need for a collaborative effort to set up an R & D support system for developing and sustaining an industry based on medicinal and aromatic plants. The dean saw no dificulty in such a concerted effort between the two faculties of science and agriculture of the University. He stated it would enhance the work of a collaborative nature that was already ongoing in this sector. The Dean was also expressing his views on behalf of his other colleagues,and in particular, Professor A.Frost, Dean of Post Graduate Studies. and Head of Physics and Electronics, and Professor B.Nkosi. Head of Biological Sciences.

The consultant's tour of the Department of Chemistry was most informative and interesting. The department was reasonably well equipped with instrumentation (Annex 8), although the instruments were from several sources which would undoubtedly make maintainance a difficult task. However the department posessed in Mr. Sam Tsabedze a solid instrument maintenance technician, whose skills enabled the department to keep all the instruments in operating condition. The importance of someone like this technician in a developing country cannot be over-estimated, and in developing a quality control laboratory the enhancing of such skills should be a prime factor.

The consultant delivered a lecture to the students of the faculty of science, on: INDUSTRIAL UTILISATION OF MEDICINAL & AROMATIC PLANTS which was well received.

Facilities for Agrotechnology

The Malkerns Research Station

The consultant visited the Malkerns Rsearch Station in the company of Professor Msonti.This Research Station was the main arm of the Agricultural Research Division of the Ministry of Agriculture and Cooperatives. The Station carries out research today with the "farming system approach" which implies the development of agro- technologies that are relevant to the actual needs of the farming community in Swaziland especialy those with limited resources, and using Swazi Nation Land. The Chief Research Officer of the Research Station, Dr Paul D.Mkatshwa, explained that the station had several satellite experimental stations attached to it in the various ecological zones viz: the Hebron Experimental Plot, the Luve Experimental Plot, the Mangcongco Experimental Plot, the Nhlangano Experimental Farm, and the Lowveld Experimental Station. The research conducted involved many crops such as the agronomy of cereals, grain legumes, some horticultural work on fruit and vegetables, the production of suitable seedlings and propagating material,tobacco cultivation, cotton breeding, plant pathology, entomology, soil chemistry, soil fertility and crop nutrition as well as post harvest technology of foods.

The station, as was evident, had a wide and varied expertise. but the problem was a shortage of qualified staff and thereby pressure on the existing staff. The Chief Research Officer was fully willing to place the expertise of the station in order to develop a base of medicinal and aromatic plants for industrial processing. But he cautioned that if the station was to make a meaningful contribution, and he believed it could and should do so,then it was

imperative that additional staff to cover the responsibility should be placed on board. Presently there were 15 research officers and 12 technicians with other support staff.

The Faculty of Agriculture at Luyengo

The consultant also visited the Faculty of Agriculture, which had good expertise in the area of plant breeding and a campus at Luyengo,(only 3 m from the Malkerns Research Station), (Annex 9), which could collaborate fully and participate in all of the agrotechnological requirements. The consultant had detailed discussions with the Dean of the Faculty,Professor Barnabas Manene Dlamini.and the Head of Crop Production Professor G.N.Shongwe. It was felt that an ideal situation would be for the University to participate in the selection and breeding of cultivars of the pre-selected plant species and for the Malkerns Research Station to undertake the larger scale cultivation, determining the production economics before handing over technology to the farmers.

It was evident from the visits, and from other observations, that, the country possessed adequate experience in crop cultivation and management eg. sugar, citrus fruits, vegetables etc., and this expertise could conceivably be utilised, for the later purpose of commercial scale cultivation.

There was also some evidence of capability in the direction of equipment fabrication, as witnesses by the locally fabricated tanks for water and juices made of stainless steel.

The Mancini Industrial Training Centre (MITC)

The consultant also had the opportunity to visit the Mancini Industrial Training Centre at Mancini. This Centre had inter alia a workshop for metal working, although they had not as yet had any experience with working with stainlesss steel. The consultant had fruitful discussions with the Director, Sr. Dr. Judith Ellen Dean and the technical administrator, Harold D.Pagel. It was evident that this workshop with some small inputs would be able to construct locally, by contractual arrangements, some of the process equipment for the project. The fielding of an experienced design engineer, within the project for this purpose would therefore be of longterm advantage.

However,the most crucial need appeared to be, to forge a mechanism for linking the ongoing research endeavours of the university,with a pilot scale process technology unit, required for the development of suitable technology, that could be industrially employed. Since there was no such facility locally, it would be an obvious input to initiate such a pilot scale process development capability, within an overall centre for technology development. The University was the only place to cite such a centre for technology development, which would then give the opportunity for the local personnel to acquire the relevant training at several levels. A mechanism for this is proposed later.(Vide section 6). Although there was complete agreement between the concerned parties as to the feasibility of the proposed mechanism, it was clear that this was a mechanism which merited further discussion within the participating personnel. It is clear that practical adjustments could be made on the basis of the main theme. It is one of several possible models which may be considered, but in the opinion of the consultant this model lends itself to adjustment within the context of the requirements of the situation.

3. INDUSTRIAL POLICY AND ENTREPRENEURSHIP

3.1 Government organs for Industrial Support

The post-independence government policy towards local industry led to the formation of two organs viz:

- The National Industrial Development Corporation of Swaziland (NIDCS)
- The Small Enterprises Development Company (SEDC)

The overall industrial policy was to "pursue programmes to maximise domestic incomes and employment, and encourage industries with the greatest impact on other sectors of the economy". (Vide National Industrial Policy Issues : UNIDO Report 1994.SWA/93/002).

Further The Hon. Muntu Mswane, Minister of Commerce & Industry has stated thus:" Swaziland is an example of a successful blend of the old and the new, an adaptation between the tradition and modernisation "... (Vide: Swaziland : A Review of Commerce & Industry. ISSN 1016-7064.)

An industry based on medicinal and aromatic plants, will fit in perfectly with these policy initiatives.We are here looking at an industry that will derive from the traditonal, and seek to benefit the health sector as well as contribute to a betterment of the quality of life of the rural people in particular.

The overall performance record of both the NIDCS and SEDC in promoting indigenous industry, has been positively appraised (Vide UNIDO: loc cit.) It would therefore seem that if natural product based industrial technology is developed and matured, then the mechanisms are in place to extend this technology to indigenous industry.

The Ministry of Commerce & Industry.

Discussions were held between the consultant and the Principal Secretary, Ministry of Commerce and Industry, on the consultants ideas and impressions in regards to the prospects for an industry based on Medicinal and Aromatic Plants in Swaziland. As noted heretofore, the Ministry of Commerce & Industry was the lead Ministry for the present mission. The Principal Secretary, Mme A.P.Mkonza, received the consultant in her office. She wished to know the consultants views on the prospects. A resume of the work carried out so far was given. The Principal Secretary was informed of the consultant's positive impresssions of the capability of the faculties of Science and Agriculture, of the University of Swaziland together with the Malkerns Research Station, to form the nucleus of an R & D outfit for the industry in Swaziland.The Principal Secretary was supportive of the idea of such an R & D Centre and felt it would galvanise the present work of the university in addition to lending it an industry-oriented direction. The secretary confirmed the view that it would not be possible to think in terms of UNDP(IPF) funding for such an institution building project since the funds from that source was over subscribed already. She was however very much interested in the prospect of funding through the UNIDF source. The secretary confirmed the view that once the project gets underway, and visible technology for commercial

application was forthcoming the country had the necesary agencies in place to take over the responsibility. On her recommendation as well, the consultant decided to discuss the prospects of operational mechanisms with the two independent establishments, and the observations on these are recorded below.:

3.2 Other establishments

3.2.1 Swaziland Industrial Development Co.Ltd.

The Swaziland Industrial Development Co. Ltd., (SIDC) is a private development company set up as a joint venture between the government and major international development finance institutions. Its primary focus is the development of the private sector in Swaziland.The shareholders are :

The government of Swaziland
Commonwealth Development Corporation (CDC)
German Finance Co for Investments in Developing Countries (DEG)
International Finance Corporation
Netherlands Development Finance Co (FMO)
Barclays Bank of Swaziland Ltd.
Standard Chartered Bank of Swaziland Ltd.

The SIDC has support from the European Community as well.

The SIDC is committed to promote and finance investment projects in the industrial, mining, agribusiness, and other sectors, and provide advisory services to local as well as foreign investors.

The consultant had a meeting with the General Manager, Mr Peter.K.Thamm, and the Senior Operations Executive Gloria Mamba at the SIDC offices in Mbabane. The basis of the proposed UNIDO assistance was explained to them. The entire features of the programme on the Industrial utilisation of Medicinal and Aromatic Plants was also briefly outlined in view of the many questions asked by them. They stated, on behalf of the SIDC, that they were a development bank, and would be very interested in any prospective project that would lead to identifiable products. It was explained to them that the UNIDO intention was to develop the technology so that it could be transferred to the entrepreneurs, and that the result of a sucessful project would lead to identifiable product. Mr. Tamm was certain that they would be in a position to promote such industry in case there developed viable leads, but it was not in their mandate to promote the research stages. It was clear that in the event successful technology was developed in the country, the industrial promotion stage was already present.

3.2.2 Tibiyo Taka Ngwane

The Tibiyo Taka Ngwane, situated in Kwaluseni, had been established in 1968 by Royal Charter by His Majesty King Sobhuza II. It was mandated to compliment the government's national development efforts. Tibiyo is therefore a development agency, and a sponsor of cultural activity. Above all it is a National Development Fund whose central objective is to foster the sustainable development of the country.

The consultant had discussions with Tibiyo's Senior Projects Analyst, Mr. Louis Nxumala, who was also standing in for the General Manager. The consultant explained, in detail the observations of the mission so far, and the ideas for a technical assistance project that had emerged. Specifically the idea of a technology generating centre for the industry in Swaziland, was explained to him. The consultant put to him the question as to whether his organisation would be interested in developing any technological break - through that may emerge from the centre in the future years. The consultant was told that Tibyo was primarily an organisation that subsisted on the profits it was able to make. Hence it would certainly be interested, an it was its function to be, if the viability of any technological breakthrough was visibly good. They were therefore very interested in the possible followup of the project that was now being proposed. They were also interested in the possibility of joint ventures. Tibyo had land in the Malkerns area and this could be well utilised to cultivate possibly medicinal and aromatic plants as replacement crops for the present marginally profitable maize crops which are cultivated there.They were indeed looking for prospective substitution crops.

4. REQUIRED INSTITUTIONAL INFRASTRUCTURE

4.1 Development of Technology

During several decades of UNIDO technical assistance project implementation within this industrial sector it has become evident that several infrastructural facets would be needed to set up a a technology generating base for a viable industry, in a small developing country. (Annex 10). These are the following;

AGROTECHNOLOGY - There has to be an availability of raw material in the wild state to be harnessed in a sustainable manner; there has to be personnel with expertise in systematic botany, agronomy, particularly cropwise cultivation of several species, and also it would be advantageous to have expertise in the genetic improvement of species.

PROCESS TECHNOLOGY - Although many countries possess expertise in Natural Product Chemistry, seldom does this knowledge leave the scale of the laboratory to extend to pilot scale processing. It is crucial to have a facility in pilot scale work and often this is the area requiring strengthening. Any process developed at the laboratory scale is then up-scaled to what is termed the "bench scale". This is intermediate between the laboratory scale and the pilot plant scale. In the case of most developing countries aspiring to work on plant based industrial projects both these, ie. bench as well as pilot plant scale facilities have to be built up. This often means acquisition of hardware and experience. In the present instance the following pilot operations appeared necesary as a first stage, in the consultant's view.

Pilot scale steam distillation unit (Annex 11)
Pilot scale unit for extraction/percolation (Annex 12)
Unit for reboiling - recovery of solvent (Annex 12)
Drying cabinet (Annex 13)

N.B. The UNIDO polyvalent Pilot Plant may also be an option, but in the given situation, (and particularly since the distillation of essential oils would

be considered for installation in the rural areas in the future), the array of individual items as specified would be more acceptable.

QA/QC METHODOLOGY.- The setting up of a modern instrumental analytical laboratory for the quality assessment and control of both raw materials and products is a vital part of the process of setting up of the industry. This sector of industry is very dependent on the methods of chemical and instrumental analysis and as such product quality has to be established on those terms according to internationaly acceptrd standards. Furthermore in the processing itself analyses are required to monitor the progress be it laboratory or pilot scale. These are the parameters based on which it would be decided if the processing is satisfactorily being up-scaled from the laboratory to the pilot plant processing. Accordingly some additions (Annex 14) to the university's present outfit are needed viz:

A High performance liquid chromatography unit
A gas chromatography unit to conduct analyses of essential oils
An integrator for quantification of GLC & HPLC

4.2 R.& D. Support Services

The above factors constitute the main features of Research and Development within the industry. As this must be an ongoing exercise, a R & D facility to give guidance in all the main areas of work is the kingpin of the support service for the industry. Such an R & D facility would over the years build up sufficient knowledge and experience that it could serve to innovate, direct and handle trouble shooting for the industry.

4.3 Marketing and Export Services

Another back-up service has to be the provision of information on marketing, the exploration of potential markets and the identification of market trends for the product range. Market research is important as such work could dictate the trends in processing. Both local as well as external markets need evaluation. The Ministry of Commerce and Industry would be in a sound position to gather and disseminate information on the marketing aspects.

5. SALIENT FEATURES OF TECHNOLOGY OF MEDICINAL & AROMATIC PLANTS

5.1 The Production of Essential Oils

Essential oils are produced from aromatic plants by the process known as steam distillation. This is simply described as the passage of steam through a bed of the stacked plant material. The steam can be from an external source (a boiler/steam generator), or can be generated in situ. These two variations are the most commonly employed techniques in the production of essential oils. The principle of steam distillation is quite simple. The steam and the oil for a mixture in the vapour state that distills off at temperatures lower than the boiling points of water or the oil. Thus the distillate is just below the temperature of boiling water as it emerges from the plant material. The distillate vapours are condensed, by cooling when they

separate into two phases, the aqueous phase and the oil phase. A mechanism to separate this is in place in the distillation assembly and the oil is filtered and dried for storage. Annex 11 represents a typical simple distillation assembly. This type of technology could be carried out at a central distillery, on a pilot scale or in field stills of varying size in the cultivation areas. Thus the technology is both variable and flexible, but the core requirement is that the processing should be constantly monitored via a laboratory. An essential oil is a complex mixture of a number of compounds of different chemical types chief among them being the TERPENOIDS, and the PHENYL PROPANOIDS. Each essential oil has a characteristic array of these compounds and the quantity and distribution is responsible for the typical aroma of the oil. The essential oils themselves are seldom used as such in the fragrance and flavour industries but they are fractionated to give required fractions which may be pure chemicals or groups of chemicals. However the international market lists the various essential oils as products.

5.2 The processing of Medicinal Plants

Medicinal Plants can be processed into several different products viz:

PLANT EXTRACTS. Made with water or other solvents.
STANDARDISED EXTRACTS.
PARTIALLY PURIFIED EXTRACTS
PURE PHYTOCHEMICALS/GROUP OF PHYTOCHEMICALS
SIMULATED TRADITIONAL PREPARATIONS.

In these preparations we are looking beyond the simple dried and powdered plant material itself, and into more value-added preparations. The above extracts all demand a type of technology based on the unit operations of :

Solvent/Water extraction
Solvent removal/drying.

In the case of standardised extracts one is looking for estimating an individual constituent or group of constituents of the plant that is in the extract. For example in a total extract of (say) Centella asiatica, or Harpogophytum procrumberns, one may estimate the total content of glycosides in the extract, and the estimated value then standardises the extract with respect to the glycosidal content. Partially purified extracts would mean that substances extraneous to the active ingedient may be removed by some chemical operation. An example would be an extract of Senna, where the total sennosides are partially separated to yield an enriched extract with respect to the sennosides, or even the total alaloids from a Rauwolfia species. The final type involves the isolation of a pure phytochemical, or a group of phytochemicals, and this involves separation methods. Examples would be the alkaloids from Rauwolfia, and Berberine from Coscinium fenestratum. This stage must be regarded as the advanced stage of technology. More easily achievable and no less important than all these is the simulation of the traditional preparations and making these in new dosage froms that are dose related, and are stored well for distribution among rural practitioners.

It must be noted that a major difference between the technology of production of essential oils and that of medicinal plants is that the latter has to be conducted in a central situation. Whereas there can be sited rural

units for production of essential oils, the processing of medicinal plants should for many reasons such as safety, and complexity of operations be conducted centrally.

5.3 Other Herbal Products

Several types of products other than those already described can also be encompassed when a central facility for technology development is envisaged. Some of these are the following:

OLEORESINS FROM SPICES
ROSIN & TURPENTINE FROM PINE WOOD CHIPS
CONCRETES & ABSOLUTES FROM FLOWERS
DYES & PIGMENTS
GUMS
TANNINS

The advantage in a technology development unit is that there could be spin off benefits; the technology could be generated within the country if needed to extend production into other areas such as the above. There are many plants within Swaziland which could be industrialised under this category.

6. MEDICINAL & AROMATIC PLANTS INDUSTRIAL TECHNOLOGY DEVELOPMENT CENTRE - A MODEL FOR THE SWAZILAND CONTEXT

The consultant, having assessed a range of relevant factors, is of the view that the creation of a Medicinal and Aromatic Plants Technology Development Centre (MAPTECH) associated with the two campuses of the University of Swaziland,and the Malkerns Research Station, would be a model of choice in the context of Swaziland. The model is not a new one for UNIDO. It is one that has been implemented with exemplary success in Turkey - the now famous Medicinal Plants Research Centre of the Anadolu University in Eskesehir. In making this recommendation the consultant has considered the following factors:

a. There is an agricultural base in the country. There is expertise and practice in cropwise cultivation of sugar, vegetable crops, a variety of fruits.It follows that given the agrotechnological parameters and the incentives local farmers should be able to cultivate medicinal and aromatic plants in cropwise fashion to suit industrial requirements.

b. There is distinct potential in the flora as the Annex 6, and the lists A B & C of Annex 7, amply demonstrate. The required botanical expertise is also available at the University's Faculty of Biological Sciences.

c. The research carried out at the Luyengo campus of the University of Swaziland where the Faculty of Agriculture is cited,demostrates that it would indeed be able to deliver the agrotechnological parameters required to initiate and sustain cultivation. The plant species identified in the lists A B and C are well known to the personnel here in terms of their cultivation and harvest methodology. Some inputs would have to be made nevertheless with respect to the cultivation and the post harvest needs of medicinal and

aromatic plants. Further extension onto industrial scale farming could easily be undertaken (given the availiability of additional staff), by the Malkerns Research Station.

d. The research carried out at the Chemistry department at the Kwaluseni Campus (The two campuses are about 25 km apart), are indicative of a capability to handle the ongoing needs of chemical research, and quality assessment. The team will have to be strengthened in terms of numbers as well as expertise. The appealing prospect is that UNIDO's centre in Turkey could be used to serve as a model in this respect, and also to serve as a means of technology transfer. The provision of analytical instrumentation will have to be considered (see above and recommended list in project proposal).

e. The market requirements are in two categories:

- for internal use: Essential oils, Medicinal plant extracts
- for export; Essential oils, Standardised extracts, and Standardised Traditional Preparations.

The market possibilities are not only in the Republic of South Africa, where some of the indigenous population of non-european descent are used to herbal medicines and use them plentifully, but also in the neighbouring countries of the region, particularly those of the Southern African Development Community (SADC). Assistance in the marketing aspects, could as mentioned heretofore, be provided by the Ministry of Commerce & Industry through one of their affiliated institutions.

f. Setting up of a Centre as proposed will enhance the possibility at a later stage of initiation the distillation of essential oils in rural centres, where there is an abundance of raw materials. At the moment there does not appear to be any such distillation centres or even established factories for the production of herbal preparations.

The proposed Centre can then function as the R & D Centre with a capability for QA/QC, pilot scale processing, and technology diffusion.

N.B.

A NOTE ON THE CHARACTERISTIC FEATURES OF THE PROPOSED CENTRE IS IN ANNEX 15.

RECOMMENDATIONS

1. In order to initiate a mechanism to serve as the engine for technology development, it is proposed that a MEDICINAL AND AROMATIC PLANTS TECHNOLOGY DEVELOPMENT CENTRE (MAPTECH) be set up within the University of Swaziland.The national counterparts, would determine its actual location. (A document on the proposed centre is annexed. This would be only in the nature of a suitable guideline, in the experience and knowledge of the consultant and it is recommended that this be widely discussed, and suitably modified according to local needs.)

2. The plant propagation efforts be strengthened with respect to the creation of a LIVE HERBARIUM, and a DRY HERBARIUM for the country's

medicinal and aromatic plant species. UNIDO COULD PROVIDE A SHORT TERM CONSULTANT FOR THE PURPOSE.

3. The capability of the chemical facility would be strengthened via the establishment of the MAPTECH centre to initiate and conduct research and quality control analysis. The University should seek to strengthen the facility further, with the recruitment of personnel at graduate and technician level.

4. Training facilities for all categories of staff should be provided, by means of study tours and fellowships. The technological as well as analytical aspects could be provided by UNIDO at the Medicinal Plants Research Centre, in Turkey, the CISIR, Colombo, Sri Lanka,or the TISTR, Bangkok, Thailand.

5. There would be a distinct advantage if fabrication of process equipment could be undertaken locally. Since some fabrication workshops exist locally they may be examined for the future. UNIDO could provide the services of a mechanical engineer to assess the capability here and to instruct the MAPTECH accordingly.

6. Study tours to Centres such as in Turkey is strongly recommended for the project leader and the principal investigators, particularly to study the methodology of multidiciplinary research and industrial services related to this specialised field. (Vide MAPTECH document).

ACKNOWLEDGEMENTS

The consultant wishes to place on record his apreciation as follows:

The Ministry of Commerce & Industry who provided the consultant with a vehicle for transport.

The UNDP through Mr L.Myers, and Ms Finchy Lapidos who provided administrative assistance.

Those who assisted the consultant with their views and all the information requested.

Professor Dr. Makhubu, the Vice Cancellor of the University, Professor J.M.Msonti, and Dr O.O.G.Amusan for help with the technical aspects.

PROJECT IN SWAZILAND

JOB DESCRIPTION

Post Title: Chemical Technologist

Duration: 1.0 m/m

Date Required: ASAP

Duty Station: Swaziland

Purpose of Project: Fact-finding and preparatory assistance mission to assess the potential for the industrial utilization of medicinal and aromatic plants.

Duties: The expert will work in collaboration with counterparts to accomplish the following:

1) Assess the potential of medicinal and aromatic plants indigenous to Swaziland for industrial utilization.

2) Assess the progress in cultivation and post harvest treatment of medicinal and aromatic plants.

3) Assess the progress in the current production of herbal pharmaceuticals and essential oils and the specific needs for improvement particularly in terms of rehabilitation of existing factories.

4) Assess industrial and institutional infrastructure related to Medicinal and Aromatic Plants in the country, and the development of pharmaceuticals based on traditional preparations and essential oils.

5) Assess the current research capabilities and status of equipment, for natural product based drug development.

6) Assess the market potential and economic viability of industrial production of plant based products.

7) Prepare a priority list of plants for industrial utilization based on raw material availiability, market potential and economic viability of their industrial use.

8) Study the feasibility of establishing small scale production units for essential oils and herbal preparations in rural areas.

9) 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 a draft project document containing the inputs in terms of equipment, training, expertise and other infrastructural requirements for the establishment of a processing plant and a R&D laboratory and if feasible small scale production units in rural areas.

Qualifications: A Pharmacist/Chemical Technologist with at least 10 years experience in industrial utilization of medicinal and aromatic plants and with experience in developing countries

Language: English

Annex 2

LIST OF PERSONS WHOM THE CONSULTANT INTERACTED DURING THE MISSION

1. UNDP

   Mr. G. Davis, Resident Representative
   Mr. Fraquelli, UCD
   Mr. Luke Myers, JPO
   Mme. Finchy Lapidos, Secretary

2. Ministry of Commerce and Industry

   Mme. A.P. Mkonza, Principal Secretary
   Dr. Thembayena A. Dlamini, Under Secretary

3. University of Swaziland

   Prof. L.P. Matehubu, Vice Chancellor, National Counterpart
   Prof. V.S.B. Mtetwa, Dean, Faculty of Science
   Prof. B.M. Dlamini, Dean, Faculty of Agriculture
   Prof. J.D. Msonthi, Head, Department of Chemistry
   Prof. G.N. Shongwe, Head, Department of Crops Production
   Dr. Oluwole O.G. Amusan, Lecturer in Chemistry
   Mr. Sam Tsabedze, Instrument Maintenance Technician

4. Malkerns Research Station

   Dr. Paul D. Mkhatshwa - Chief Research Officer

5. Swaziland Industrial Development Co. Ltd.

   Peter K. Tham - General Manager
   Gloria Mamba - Senior Operations Executive

6. Tibiyo Taka Ngwane

   Louis D. Nxumalo - Senior Projects Analyst

7. Mancini Industrial Training Centre

   Sr. Dr. Judith E. Dean, Director
   Mr. Harold G. Pagel, Technical Administrator

Annex 3

CONSULTANTS WORK CALENDAR

IN SWAZILAND

Monday 17/10/94 1. Arrival at Marzini Airport 2. Drive to Kwaluseni Campus of University of Swaziland - Discussions with National Coordinator (L.P.Makhubu) 3. Discussions with UNDP (Myers, Lapidos)	Monday 24/10/94 1. Kwaluseni Campus Discussion plant species with Dr. Msonthi
Tuesday 18/10/94 1. UNDP Visa formalities for Swaziland. Briefed JPO on mission. 2. Meeting with Makhubu/Msonti. Detailed discussions on procedure & approach	Tuesday 25/10/94 1. Malkerns Res. Station 2. Dean/Agriculture. Discussion on participation in MAPTECH idea.
Wednesday 19/10/94 1. Kwaluseni Campus. Detailed discussion (Msonti and Amusan) on lists of plants, and possible technology, & QA/QC requirements. 2. Other appointments scheduled.	Wednesday 26/10/94 Individual appointments - UNDP - JPO review - Contact with UCD Minutes. Commerce & Industry discussion with Principal Secretary. Resumé of Proposals.
Thursday 20/10/94 1. UNDP: Transit visa for SA. Ticket reconfirmation. 2. Establishing contact with Industrial Units. UNDP to make appointments.	Thursday 27/10/94 Individual appointments: UNDP & Visa Tibiyo. Take Ngawane. Discussions with Mr. Nxumalo. SIDC. Meeting with Mr. Thamm. Discussion & funding prospects for follow-up.
Friday 21/10/94 1. Kwaluseni Campus. Discussions cont'd. 2. Lecture IUMAP at University Campus Kwaluseni.	Friday 28/10/94 University Kwaluseni Campus. Finalized lists/selected A,B, C. Cont'd project documents preparation.
Saturday 22/10/94 Preparation of report (draft).	Saturday 29/10/94 Project documents drafted
Sunday 23/10/94 Preparation of project documents in preliminary form & outline.	Sunday 3/10/94 Working on project documents draft

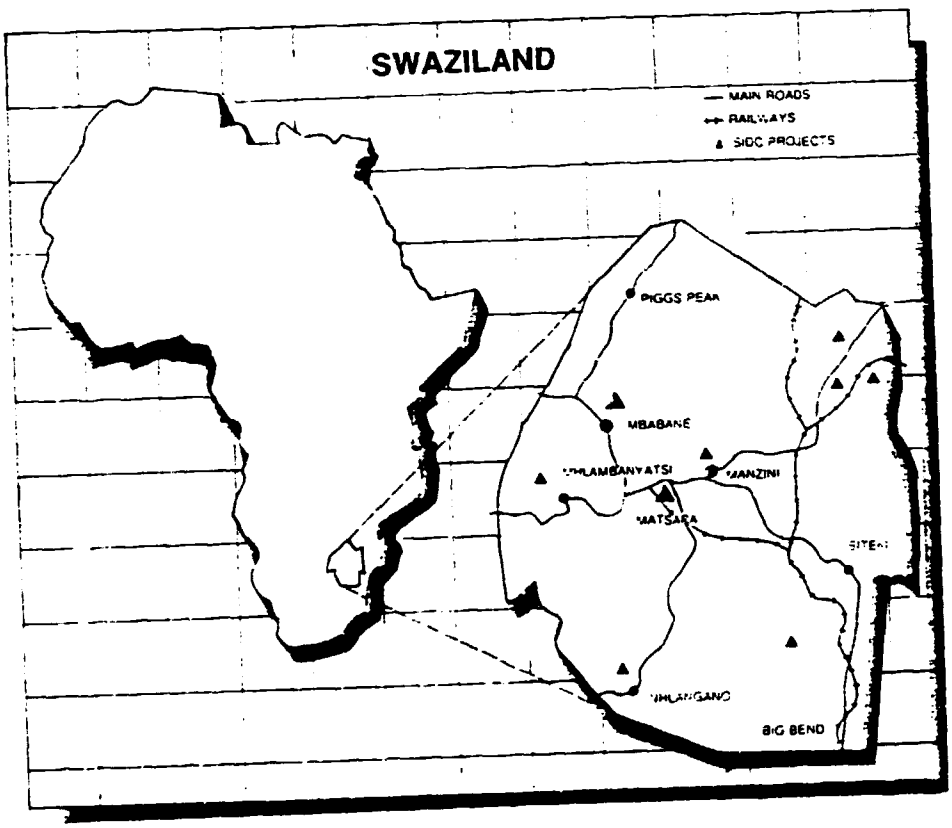
SCHEDULE OF ACTIVITIES

(SWAZILAND)

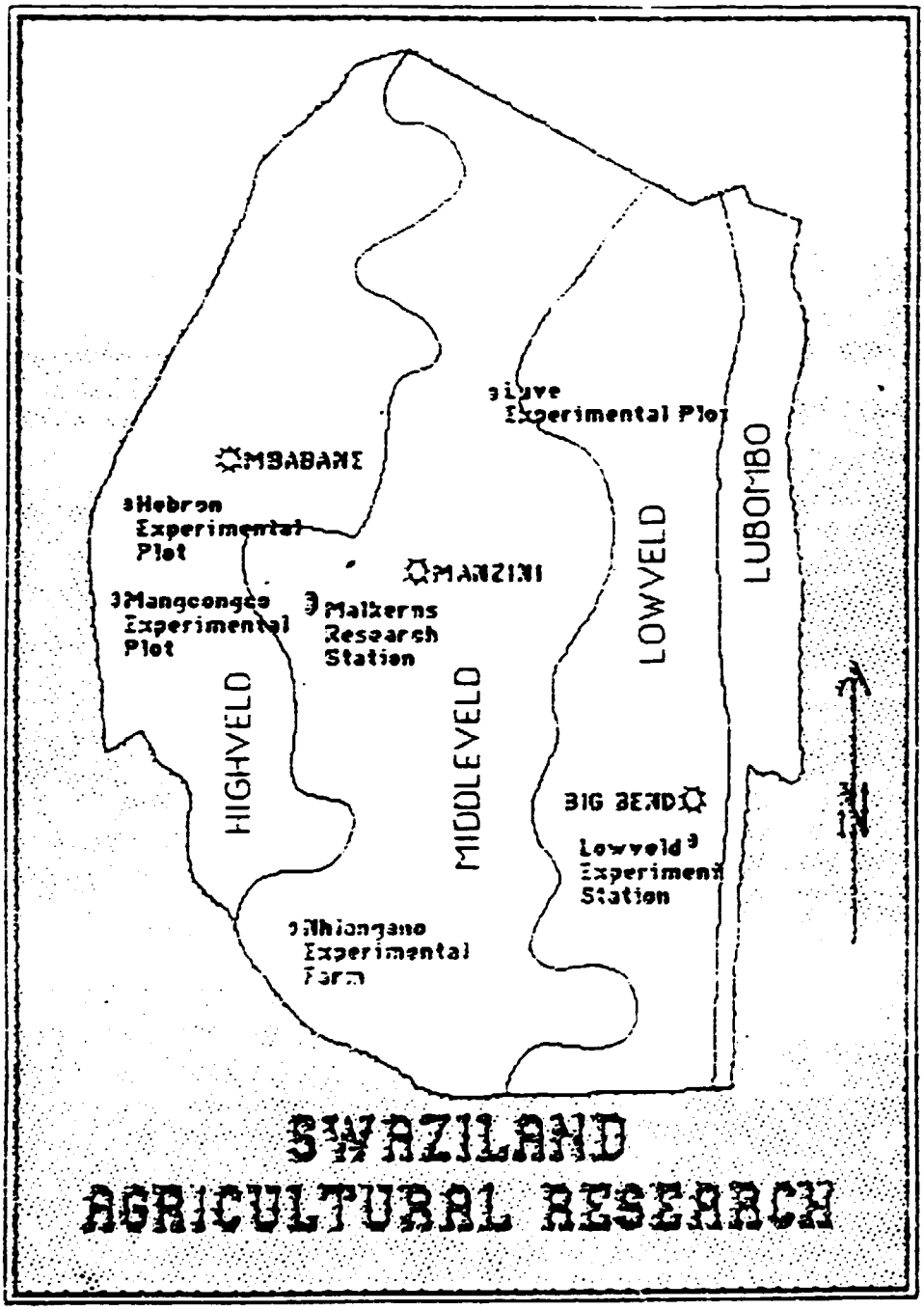
Monday 31/10/94 Debriefing: University Full discussions on proposals and feed back	Monday 7/11/94 Finalization of report
Tuesday 1/11/94 Debriefing + UCD Final Meeting. Proposals discussed and accepted. UNDP - Final meeting with UCD and Res.Rep. Discussion of project proposals	Tuesday 8/11/94 Finalization of report Debriefing
Wednesday 2/11/94 Departure for Johannesburg Arrival in Johannesburg	Wednesday 9/11/94 Departure for CMB
Thursday 3/11/94 Departure for Vienna	
Friday 4/11/94 Arrival in Vienna and VIC	

Annex 4

MAP OF SWAZILAND



Annex 5


MBABANE
Hebron Experimental Plot
MANZINI
Mangcongco Experimental Plot
Malkerns Research Station
HIGHVELD
MIDDLEVELD
LOWVELD
LUBOMBO
BIG BEND
Lowveld Experiment Station
Luve Experimental Plot
Nhlangano Experimental Farm
SWAZILAND
AGRICULTURAL RESEARCH

Annex 6

List of Medicinal Plants Studies

by

Makhubu L. P., Msonthi J. D and Amusan O.O.G

University of Swaziland, Chemistry Department
P\Bag Kwaluseni, Swaziland

AMARYLLIDACEAE
Haemanthus magnificus

ANACARDIACEAE
Hurperphyllum caffrum

ANNONACEAE
Annona senegalensis

APOCYNACEAE
Carrisa edulis Vahl
Conopharyngia elegans

AQUIFOLIACEAE
Ilex mitis

ARALIACEAE
Cussonia Spicata

ASCLEPIADACEAE
Ectadiopsis oblongfolia
Mondia whytei skeels

BIGNONIACEAE
Kigelia africana
Spathodea campanulata P. Beauvis

BORAGINACEAE
Trichodesma zeylanicum

CAESALPINIOIDEAE
Bauhinia galpinii
Bauhinia thonningii
Cassia petersiana
Schotia brachypetala
Tamarindus indicum

CHRYSOBALANACEAE
Parinari capensis
Parinari curatellifolia

COMPOSITAE
Acanthospermum hispidum
Helichrysum nitens
Helichrysum quinquenerve
Vernonia glabra
Vernonia cinerea
Vernonia stipulacea
Vernonia ococorymbosa

CUCURBITACCEAE
Lagenaria abyssinica C Jeffrey
Momordica foetida

EBENACEAE
Diospyros lycioides A.DC
Diospyros usambarensis
Diospyros whyteana F White
Diospyros zombensis F White

EUPHORBIACEAE
Andrachne ovalis Mull Arg
Acalypha senensis
Croton sylvaticus
Uapaca kirkiana

FILICALES
Cyathea mamiana

FLACOURTIACEAE
Flacourtia indica

GUTTIFEREAE
hypericum revolutum
Psorospermum febrifugum

HYPOXIDACEAE
Hypoxis obtusa
Hypoxis nyasica Bacl:
Hypoxis rooperi S. Moore

IRIDACEAE
Crocosmia aurea

LABIATAE
Ocimum cannum Sims

LILIACEAE
Aloe corperi
Urginea delagoensis

LOGANIACEAE
Strychnos spinosa
Strychnos henningssi

MALVACEAE
Azanza garckeana
Sida acuta

MELIACEAE
Azadirachta indica
Khaya nyasica
Trichlia emetica

MIMOSOIDEAE
Albizia versicolor

MYRSINACEAE
Maesa lanceolata
Rapaena melanophloes (L) Mez

MYRTACEAE
Syzygium guineense

OLEACEAE
Olex africana
Ximenia caffra

PAPICIONIODEDE
Dolichos kilimandscharius
Neorautanenia mitis
Pterocarpus angolensis
Sphenostylis marginata
Tephrosia vogelii

PEDALIACEAE
Sesamum angolense Welw

PHYTOLACCACEAE
Polygala nyikensis
Polygala virgata
securidace longepedincculata Friesn

PROTULACACEAE
Talinum tenuissimum

RHAMNACEAE
Ziziphus mauritiana
Ziziphus mucronata

RUBIACEAE
Canthium crassum
Psychotria capensis
Vanguera infausta

SMILACACEAE
Smilax kraussiana

THYMELAEACEAE
Lasiosphon kraussianus

VERBENACEAE
Cissus integrifolia
Cyphosterma jatrophoides Welw

A LIST OF SOME MEDICINAL PLANTS STUDIES IN SWAZILAND

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
1.	Acalypha senensis	Euphorbiaceae	umsongo	root-bark in water diarrhoea	saponins	J.D. Msonthi (1982)
2.	A.ornata	Euphorbiaceae	umsongo	worms, stupefies fish, kills snails, soap substitute	saponins	J.D. Msonthi (1982)
3.	Acanthospermum hispidum	Compositae	dilizungcabo	asthma, burnt ashes with a little salt are licked	acanthosperm -olides	J. Jakupovic (1986)
4	Adansonia digitata	Bombacaceae	umkomo (Ndebele)	edible fruit	nutritional data	J. D. Saka (1992)
5	Albizia versicolor	Mimosoideae	mhlakaza	love potion	saponins, glycosodes	L. P. Makhubu (1987, 1986)
6	Andrachne ovalis	Euphorbiaceae	mahlombohlanya	root bark	molluscicidal	D.O.G. Amusan (1994)
7	Aloe corperi	Liliaceae	lisheleshele	vegetable, eases labour/delivery	glycoside	L. P. Makhubu (1987, 1986)
8	Annona senegalensis	Annonaceae	umtelemba	hysteria	saponins, glycosides	L. P. Makhubu (1986)
9	Azanza garckeana	Malvaceae	uxakuxaku (Ndebele)	edible fruit	nutritional data	J. D. Saka (1992)
10	Baukinia galpini	Calsalpiniaideae	lusoloto	anthelmintic	saponins glycosides	L. P. Makhubu (1987, 1986)
11	Capsicum annuum	Solanaceae	ibilebile (Ndibele)	edible fruit seasoning	nutritional data	J. D. Saka (1992)
12	Carisa edulis	Apocynnceae	umusankuzi	leaves, stem and root bark for oedema, tooth-ache, abortifacient, purgative	3 sesquiterpenes , carissone, carissonene and edulonene	J. D. Msonthi (1982)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
3	Cassia petersiana	Caesalpinioideae	Lijoye	edible fruit, root bark, for coughs, colds, syphillis, stomachache	nutritional data, antibacterial, colensanone, colensenone	J. D. Msonthi, (1982, 1984)
4	Chironia baccifera	Gentianaceae	bitterbos (African)	whole plant	glycosides	J. L. Wolfender (1991)
5	C. Krebssi	Gentianaceae	tjatame (Sotho)	whole plant, toothache, piles	xanthones	J. L. Wolfender (1991)
16	C. pupurascens	Gentianaceae	tjatame (Sotho)	whole plant	secioridiods	J. L. Wolfender (1991)
17	Cissus zombensis	Vitaceae	umthambise	anthelmintic, luber for premenstrual syndrome	steroids, glycosides	J. D. Msonthi (1982)
18	Clerodendron uncinatum	Verbenaceae	umphehlacwati	bilharzia, roots	uncinatone	J.D. Msonthi (1984)
19	C. wildii	Verbenaceae	sigibanyongo	bilharzia, roots	saponins	M. Toyota (1989)
20	Crocosmia aurea	Iridaceae	ndevevendvweni	love, lucky charm	glycosides, alkaloids, steroids	L.P. Makhubu (1986)
21	Croton sylvaticus	Euphorbiaceae	mnyakeni	chest ailments	glycosides, alkaloids, steroids	L.P. Makhubu (1978,1986)
22	Conopharyngia elegans	Apocynaceae	kakope (chichewa, Malawi)	fruit for barrenness	cortico-type sterone, eleganol	J.D. Msonthi (9184)
23	Cussonia spicata	Araliaceae	umsenge	whole plant stupefies fish	saponins	J. Guzinger (1986)
24	Dalbergia bohemii	Papilionoideae	licobbe	smoled woold as mosquito repellent, root bark for coughs and abscesses	coumarins, dalberginones	J.D. Msonthi (1984)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
25	Diospyros kirkii	Ebenaceae	satinyama	edible fruit, panaceae	nutritional data, naphthoqiunones	J.D. Saka (1992) F. Gafner (1987)
26	D. lycioides	Ebenaceae	umchafutane lomhlophe	panaceae, chewing stick	naphthoquinones, saponins	F. Gafner (1987)
27	D. usambarensis	Ebenaceae	umchafutane lomnyama	panacea	flavonoids naphthoquminones	A. Marston (1988)
28	D. whteana	Ebenaceae	satinyama	chewing stick	naphthoquinones saponins	F. Gafner (1987)
29	D. zombensis	Ebenaceae	umchafutane lomnyama	chewing stick	flavonoids naphthoquinones	F. Gafner (1987)
30	Dolichos kilimandscharius	Leguminoseae	jero (Shona, Zimbabwe)	dyeing pots, tuber stupefying fish	antibacterial antifeedant	J.D. Msonthi (1984)
31	Ectadiopsis oblongifolia	Asclepiadaceae	bwazi, (Chewa, Malawi) inkamamasane enduna (Ndebele)	gum diseases stomache ailments	Xanthones	J.D. Msonthi (1992)
32	Elephantorrhiza goetzi	Mimosoideae	intfolwane	tuber, after childbirth	steroidal hormoney	J. D. Msonthi (1984)
33	Ficus natalensis	Moraceae	inkhiwane	fruits edible, stembark sap for skin diseases	nutritional data	J. D. Saka (1992)
34	Flacourtia indica	Flacourtiaceae	umtabhata	local toothbrush, intestinal worms, pneumonia, fruit edible	antibacterial molluscicidal nutritional data	S.S Chiotha (1984,1986) J. D. Saka (1992)
35	Garcinia huillensis	Guttifereae	impimba (Zulu)	edible fruit	nutritional data	J.D. Saka (1992)
36	Haemanthus magnificus	Amaryllidaceae	labatseka	infertility	glycosides alkaloids stercids	L.P. Makhubu (1978, 1986)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
37	Harpephyllum caffrum	Anacardiaceae	umgwenya	chest ailments	terpenes	L.P. Makhubu (1986)
38	Helichrysum nitens	Compositae	emakha	leaves expectorrant	phellandrene menthane epicuticular mathylated flavonoids	J.D. Msonthi (1984) Tomas-Baberar (1988)
39	H.quinquenerve	Compositae	impbepbo	wards off ghosts	steriods	L.P. Makhubu (1986)
40	Hypericum revolutum	guttiferene	mchenjere (Chewa, Malawi) Usukumbhili (Zulu)	panacea	antifusssor hyperforin derivatives	L. Decorsted (1987,1988,1989)
41	Hyphaene ventricosa	Palmae	Ilala (Ndebele)	edible fruit	nutritional data	J.D. Saka (1992)
42	Hypoxis nyasica	Hypoxidaceae	Chikasu, Kamba, (Chichewa, Malawi)	uterine cancer and premanstrual syndrome	monyasine A and B, Hypoxoside nyasicoside nyasoside	G.B. MariniBettolo (1985, 1987) J.D. Msonthi (1989).
43	H. obtusa	Hypoxidaceae	inkofe-enkulu (Zulu)	prostate hypetrophy	nyasicoside hypoxoside phenolic glycoside	J.D.Msonthi (1990)
44	H. rooperi	Hypoxidaceae	inkofe-enkulu (Zulu)	prostate hypetropy	molluscicidal	OOG. Amusan (1994)
45	Ilex mitis	Aquifoliaceae	libota		glycosides steroids	L.P. Makhubu (1978)
46	Kigelia africana	Bignoniaceae	umvongotsi	stem, root-bark and fruit for ulcers and fresh wounds	antibacterial B amyrin derivative molluscicidal	J.D Msonthi (1981)
47	Maesa lanceolata	Myrisinaceae	magucu	cleansing bad luck	glycosides saponins steroids	L. P. Makhubu (1986)
48	Momordica foetida	Cucurbitaceae	inshubaba	diabetes	sterpods saponins	L. P. Makhubu (1989)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
49	Mondia whytei	Asclepiadaceae	Chiswankongo (Chichewa, Malawi) Mungurawo (Shona, Zimbabwe)	aphrodisiac anorexia bilharzia	phenolic glycoside	J.D Msonthi (1989)
50	Ocimum canum	Labiatae	mpungambi (Chichewa, Malawi) Zonubevanukwa (Zulu)	night mares decongestant	volatile oils piperitone	J.D. Msonthi (1984)
51	Olea africana Mill	Oleaceae	umsecuma	complicated delivery, appeasing spirits	glycosides saponins	L.P. Makhubu (1978,1986)
52	Parinari capensis	Chrysobalanaceae	umkhuna	abdominal pains	glycosides saponins	L. P. Makhubu (1978,1986)
53	P. Curatellifolia	Chrysobalanaceae	umkhuna	edible fruits	nutritional data	J.D. Saka (1992)
54	Phytolacca dodecandra	Phytolaccaceae	ingub'ivamile	berries, leaves, stem and rootbark	molluscicidal	O. O. G. Amusan (1994)
55	Polygala nyikensis	Polygalaceae	nginyedhla	rootbark stomach ailments	xanthones isoflavones	B Bashir (1992)
56	P. Virgata	Polygaleceae	ithethe (Zulu) ea moru (Ndebele)	rootbark stomach ailments	xanthones isoflavones	B Bashir (1992)
57	Psorospermum febrifugum	Guttifereae	mdima, mstiloti msilanyama kabvu undula (Chichewa, Malawi) inchithamuzi (Ndebele)	leaves, stem and rootbark panacea	bianthrones anthrones anthraquinones psorospermin vismiones D and F antitumour	A. Marston (1986) F. Botts (1985)
58	Psychotria capensis	Rubiaceae	dzoilidzili	anthelmintic	steroids	L.P. Makhubu (1986)
59	Pterocarpus angolensis	Papilionoideae	umvangati	abortifacient	glycosides	L.P. Makhubu (1978,1986)
60	Rhaphaena melmophloes	Myrsinaceae	mophipha	abdominal pains	glycosides saponins	L.P. Makhubu (1978,86)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
61	Rhoicissus capesis	Vitaceae	sincwati	labour pains	glycosides steroids	L.P. Makhubu (1978,1986)
62	Rhynchosia angutosa	Papilionoideae	mawungula	chest ailments	glycosides tannins	L. P. Makhubu (1986)
63	Schotia brachypetala	Caesalpinioideae	thunzinkunzi	lucky charm	glycosides	L.P. Makhubu (1978,1986)
64	Securideea longipedunculata	Polygalaceae	bwazi (Chichewa, Malwi) Umfufu (Ndebele)	leaves, stem and rootbark. abortifacient, birth control rheumatism	Saponins, tannins, methylsalicylate	J.D. Msonthi (1985)
65	Sesamum angolense	Pedaliaceae	Chitowe (Chichewa, Malawi) ludvonca loludliwako	leaves edible, hair shampoo chicken and small pox	sesangolin fatty acids local shampoo	J.D. Msonthi (1984)
66	Sphenostylis marginata	Leguminosae	Nkhunga (Chichewa, Malawi) Chitupatupa (Shona, Zimbabwe)	tuber as a soap substitute, stipefies fish. treating earthen ware pots	molluscicidal saponins pterocarpinoids antfecdant antibacterial	J. D. Msonthi (1984) J.Guzinger (1988)
67	Sida acuta	Kalvaceae	indlekwane	difficult labour, sicholo-women's hairstyle	ocytocic steroids hormon glycosides	J.D.Msonthi (1984) L.P. Makhubu (1978)
68	Spathodea campanulata	Bignoniaceae	Oruru (Yoruba) Owewe (Bini) Imi we (Ibo) Nigeria	antimalarial	terpenoids quercetrin caffeic acid molluscicidal	O. O. G. Amusan (1988, 1994)
69	Steganotaenia araliaceae	Umbelliferae	mpandanjobvu (Chichewa, Malawi) umpombohlove (Ndebele)	leaves to irrigate sore eyes protective charm	fusidicacid derivative	J.D. Msonthi (1979)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
70	Strychnos henningsii	Loganiaceae	umhlala	rootbark rheumatism	four alkaloids	W.A. Chapya (1983)
71	S. inocua	Loganiaceae	umhlala	edible fruit	nutritional data	J.D Saka (1992)
72	S. spinosa	Loganiaceae	umhlala	panacea edible fruits	secoiridoid lactone bitter principle	J. D. Msonthi (1981, 1985)
73	Syzigium guineense	Myrtaceae	umncozi	rootbark diarrhoea edible fruits	nutritional data	J.D. Saka (1992)
74	Talinum tenuissimum	Portulacaceae	mphunyuka	tuber, premenstural syndrome, virility, fertility	steroids saponins	F.Gafrier (1985)
75	Tamarindus inducum	Caesatpinioideae	musika (Shona, Zimbabwe) bwemba (Chichewa, Ndawu)	edible fruits	nutritional data	J.D. Saka (1992)
76	Tephrosia vogelii	Papilionoideae	ombwe (Chichewa, Malawi)	leaves to stupety fish	molluscicidal rotenone diquetin tephrosin	A. Marston (1984)
77	Trichtia emetica	Meliaceae	umkhutu	edible fruits	nutritional data	J.D Saka (1992)
78	Trichodesma zeylanium	Boraginaceae	chirikumwamba (Chichewa, Malawi)	aerial parts anti-itch, sore throat, fevers, stomach ulcers	germacrene squalene phytol	J.D. Msonthi (1984)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
79	Uapaca kirkiana	Ephorbiaceae	masuku (Chichewa, Malawi) maboobobo (Ndebele)	edible fruits	nutritional data	J. D. Saka (1992)
80	urginea delagoensis	Liliaceae	mahlanganisa	splints for bone fractures	saponins,, terpenes glycosides	L. P. Makhubu (1986)
81	Vanguera infausta	Rubiaceae	umntulu	edible fruits wards off lightning	nutritional data	J. D. Saka (1993)
82	Vernonia cinerea	Compositae	linyatselo, inyathelo (Ndebele)	Stomach complaints venereal diseases skin diseases	sesquiterpene lactones germacra nolides	J. Jakunpovic (1986)
83	V. glabra	Compositae	linyatselo	aerial parts rheumatism sprains	antitumour fifteen vernolepin derivatives	J. Jakupovic (1986)
84	V. neocoryonbosa	Compositae	lihlunguhlungu	anthelmintic	saponins, glycosides tannins	L. P. Makhubu (1975)
85	V. poskeana	Compositae	lihlunguhlungu	aerial parts rheumatism, sprains	sesquiterpene lactones	J.Jakupovic (1986)
86	v. scopoides	Compositae	linyatselo	aerial parts rheumatism sprains	germacranolides	J. Jakupovic (1986)
87	V. stipulaca	Compositae	tihwaibahwaba	mental illness	glycosides saponins	L. P. Makhubu (1978)

	SCIENTIFIC NAME	FAMILY NAME	SISWATI NAME	PROCEDURES	REMARKS	REFERENCES
88	Vitex doniana	Verbenaceae	umkhosikati	fruits edible, leaves and stem bark, toothache, stomachache	aryl glycosides nutritional data	J. D. Saka (1992) J. D. Msonthi (1984)
89	Xeromphis obovata	Rubiaceae	sikhwakhwane	root-bark panacea	molluscicidal	S. S. Chiotha (1984)
90	Ximenia caffra	Olacaceae	umtfundvuluka	edible fruits	nutritional data	J. D. Saka (1992)
91	Ziziphus mauritiana	Rhamnaceae	umphafa	rootbark, venereal diseases, uterine disorders	tannins, xanthones	J. D. Msonthi (1984)
92	Z. mucronata	Rhamnaceae	umlahlabantfu	edible fruits	nutritional data	J. D. Saka (1992)

1. A Marston, J D Msonthi and K Hosterttmann (1984). "Napthoquinones of Diospyros usambarensis, their molluscicidal and fungicidal activities". Planta Medica 50 (3) 279 - 280

2. J D Msonthi, A Local Shampoo. Leaf extract of Sesanum agolense Welw. (1984) Medica Times, Vol XIX (11-12), 25 - 26

3. B Botta, F Delle Monache, G B Marini-Bettolo and J D Msonthi (1985) "Prenylated Bianthrones and Vismione F from Psorospermum febrifugum" Phytochemistry 24 (4), 827-830

4. G B Marini-Bettolo, M N Coletti, I Messana, C Galeffi, J D Msonthi and A W Chapya. "Research on African Medicinal Plants Part X (1985) Glucosides of Hypoxis nyasica. Bak. The structure of nyasoside, a new glucoside giologically related to hypoxoside". Tetrahedron 41 (4), 665-670

5. A Marston, J C Chapuis, B Sordat, J D Msonthi and K Hostettmann (1986). Anthracenic derivatives from Psorospermum febrifugum and their in vitro cytotoxicitiesto human colon carcinoma cell line. Plant medica 50 (3), 207 - 210. 35.

6. F Gafner, J C Chapuis, J D Msonthi and K Hostettmann (1987). Cytotoxic naphthoquinones, molluscicidal saponins and favanols from Diospyros usambarensis". Phytochemistry 26 (9), 2501 - 2503.

7. O Potterrat, H Stoeckli-Evans, J D Msonthi and K Hostettmann (1987). Two new antifungal naphtoxirene derivatives and their glucisides from Sesamum angolense Welw. Hevetica Chimica Acta 70, 1551 - 1557

8. C Galeffi, C Multari, J D Msonthi, M NIcolleti, I Messana and G B Marine-Bettolo (1987) "Research on African Medicinal Plants Part XIII - Nyasicosi.e , a new glucoside of Hypoxis nyasica Bak". Tetrahedron 43 (16), 3519 - 3522.

9. O Petterat, J D Msonthi and K Hostettmann (1988), " Four iridoid glucosides and a phenylpropanoid glycoside from Sesamum angolense. Phytochemistry. 27 (8), 2677 - 2679.

10. I Messana, J D Msonthi Y De Vicente, G Mulatari and C Galeffi (1989). Mayonyasine A and Mononyasine B: Two glucosides from Hypoxis nyasica Phytochemistry 28 (10), 2807 - 2809

Annex 7

Plants growing in abundance in Swaziland where research has already revealed potential uses	Utility and Development
1. Phytolacca dodecandre L. Hérit (Phytolaccaceae) syn. P. abyssinica Hoffin. Pircunia abyssinica Mog.	Used as a molluscicide. Well established as such by local and international research. Plantatations established in Swaziland. Extraction work at laboratory level underway in Swaziland. Pilot studies to isolate active Saponin group needed.
2. Mentha spicata Fam. Labiatae	A variety of this species, well known for its essential oil, is cultivated in Swaziland for culinary purposes. Commercial processing of the essential oil and GLC studies are needed. Cultivation trials to be initiated.
3. Andrachne ovalis (MAHLOMBOHLANYA) Fam. Euphorbiaceae	The powdered root bark, mixed with milk is administered to flies, and is lethal. An aqueous infusion kills lice used also as an anthelmiutic. An extract should be made on a pilot scale for (a) further chemical studies, (b) study of effects on lice and flies as a potential herbal pesticidal agent, sustainable method of harnessing of bark required.
4. Aloe corperi (LISHELESHELE)	Used to facilitate child delivery. Glycosidic content noted. Chemical work could be undertaken with a view to producing an acceptable extraction method for a pilot scale operation. Cultivation trials may be initiated.

5. Androstachys johnsonii (BUKHUNKU)	Potential purgative. Pilot plant studies needed to follow chemical studies to prepare a "standardized" extract of leaves. The active agent should be chemically investigated.
6. Bauhinia galpinii (LUSOLOLO)	Decoction of the root is used as an anthelmintic. Presence of saponins and glycosides noted. Further chemical study (literature on allied species could help) required.
7. Acacia species Several species in Swaziland	Standardised extract may be targetted. Studies on the Resins, similar to the commercial gum accacia. They must be obtained on a large scale and evaluated for commercial potential.
8. BI may be included here	

B. Plants of Priority in the Preparations of the Traditional Healers **Plant** (LOCAL NAME)	**Utility and Development Prospect**
1. Lippia javanica "UMSUNTANE" Verbenaceae	Traditional healers use the plant [redacted] (aerial parts) for bronchial disorders. Administered as a steam inhalation. It is also an insect repellent. Research conducted at the Kwalaseni campus isolated an essential oil whose composition has been studied. 56% Not on cultivation scale yet. Essential oil will be of

commercial value for pharmaceutical preparations.

2. Momordica foetica "INSHUBABA"
Cucurbitaceae

Used by Traditional Physicians. Decoctions of leaf/root for controlling infective boils - used along with Pittosporum biridiflorum and Vernoria natalensis. Decoction of the runner, used as sedative for intestinal/stomach irritation. Leaves used in treatment of diabetes. An extract could be processed on a pilot scale and standardised (HPLC) for use by traditional healers as a tincture and other applications.

3. Pterocarpus angolensis "UMVANGATI"
Fam. Leguminosae

Has anti-infammatory activity (ssed). Red gum from bark has antibacterial effect on skin sores. Decoction of the root is used for intestinal parasites. Biologically monitored chemical isolation studies needed to establish any specific activity of seed, gum, root. Total extract with water may be prepared on a pilot scale for examining antiparasitic potential.

4. Spathodea campanulata
Bigoniaceae

Decoction of the leaves and stem bark used in treatment of fevers/infammation of the urethra. Infusion of stem bark arrests diarrhoea. (Probably tannins). Flowers and leaves are crushed for topical application to control ulcers. More chemical study indicated. Extract of leaves could be examined as a topical application. Tannin content may be examined.

5. Hypoxis rooperi

Decoction of tuberous rhizome used for uterine cancer, urinary infection, and prostatic hypertrophy.

6. Dichoma zeyheri	"MAHLABANE"	Decoction of roots taken to ease body pains. Chemical studies indicated. Pilot scale preparation of a standardised extract must be the target.
7. Parinari capensis	"UMKHUNA"	Decoction of the leaf arrests diarrhoea in infants. Again, chemical work and the preparation of a standardized extract should be the target. Cultivation trials may be initiated.

C. Plants which if processed have export potential

Plant species	Utility and Development Prospect
1. Sesamum angolense Welw. PEDALIACEAE	Chemical studies locally reveal presence of Sesangolin naphtroxirenes. Potential herbal shampoo.
2. Psorospermum febrifugum GULTIFERAE	Local chemical studies reveal presence of antimalarial- Psorospermin
3. Diospyros lycioides EBENACEAE	Edible fruits contain naphtraquinones with molluscicidal, anticoaqulant action.
2 and 7 of List A and 1 of list B may also be included here	In all these cases direct pilot scale studies monitored by analysis have to be undertaken. Cultivation trials too need to be initiated.

A. List of equipment available for Analytical Quality Assessment

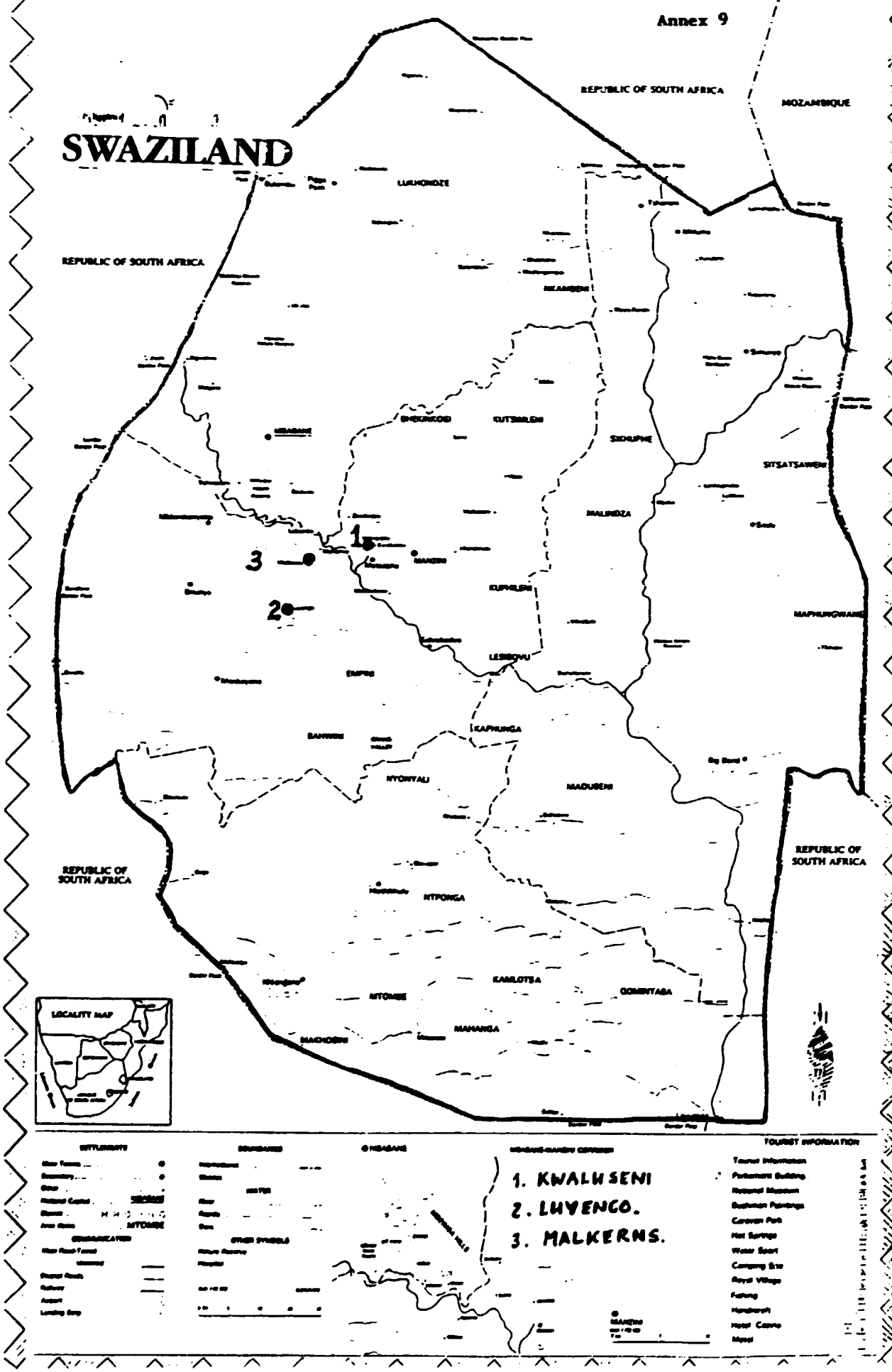
(N.B. Not all this equipment could be dedicated full time to the work of the proposed project. Some of the instruments are used for teaching and others for research)

1	x	IR Spectrophotometer (JASCO IRA - 1)
1	x	IR Spectrophotometer (JASCO IR-700) with screen monitor
1	x	GC (Pye Unicam) with Fl detector
1	x	GC (Varian 2400) with Computing Integrator (Philips)
1	x	GC (PU 4410 Philips)
1	x	AA (Varian -Spect. AA -10) with recorder
1	x	UV-VIS Scanning spectrophotometer (Philips PU 8750) with display screen
1	x	UV-VIS-NIR Kinetic spectrophotometer (Philips PU 8630)
1	x	UV Spectrophotometer (UNICAM SP 1800)
1	x	AA Spectrophotometer (GBC 906 AA) with PAL autosampler

B. List of Equipment for Extraction of Plant Material

3	x	5L all glass Soxhlet Extractors
3	x	2L all glass Soxhlet Extractors
1	x	Macerator (RETSCH) capacity 100-200g

Annex 9

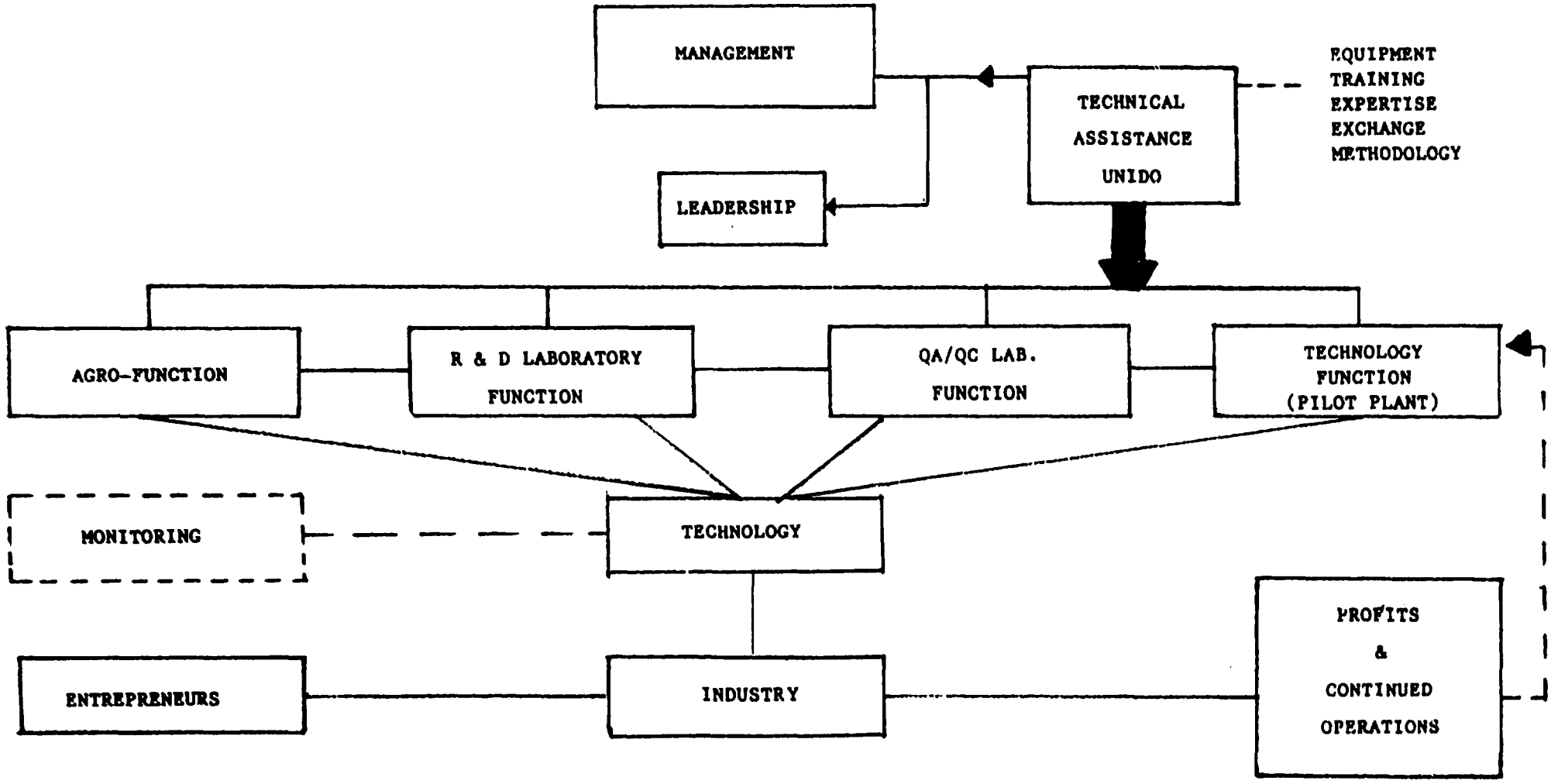

SWAZILAND
REPUBLIC OF SOUTH AFRICA
MOZAMBIQUE
REPUBLIC OF SOUTH AFRICA
REPUBLIC OF SOUTH AFRICA
REPUBLIC OF SOUTH AFRICA
LUHOHOZE
MBABANE
EMBUKODO
KUTSHALENI
SIDVUPHE
SITSATSAWENI
MALKERNS
KUPHALENI
MAPHUNGWANE
LESHOWU
EMPHE
BAHWENI
KAPHUNGA
MADUBENI
NYONYALI
NTFONGA
KAMLOTSA
MANANGA
MADHOBENI
1
2
3
LOCALITY MAP
1. KWALUSENI
2. LUYENGO.
3. MALKERNS.
TOURIST INFORMATION

Annex 10

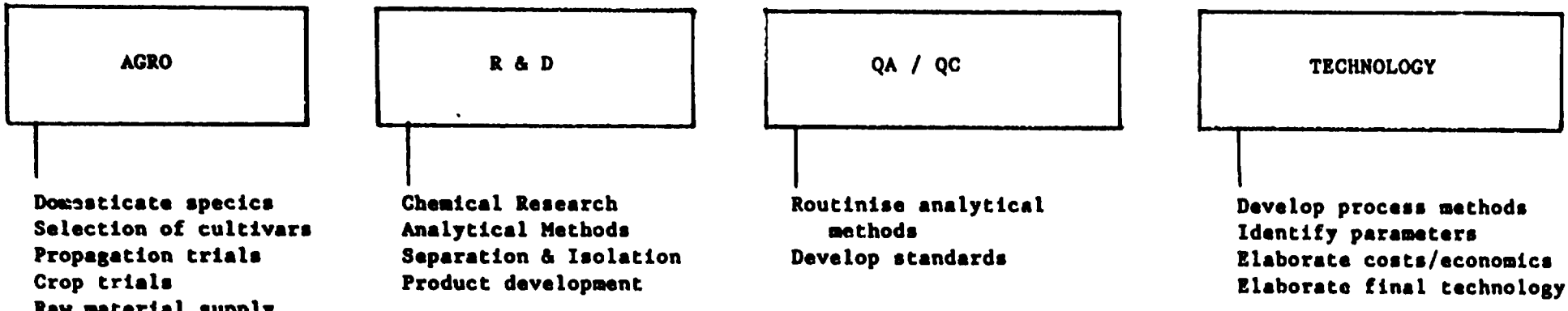
ELEMENTS THAT CONSTITUTE THE DEVELOPMENT OF

INDUSTRY BASED ON MEDICINAL & AROMATIC PLANTS

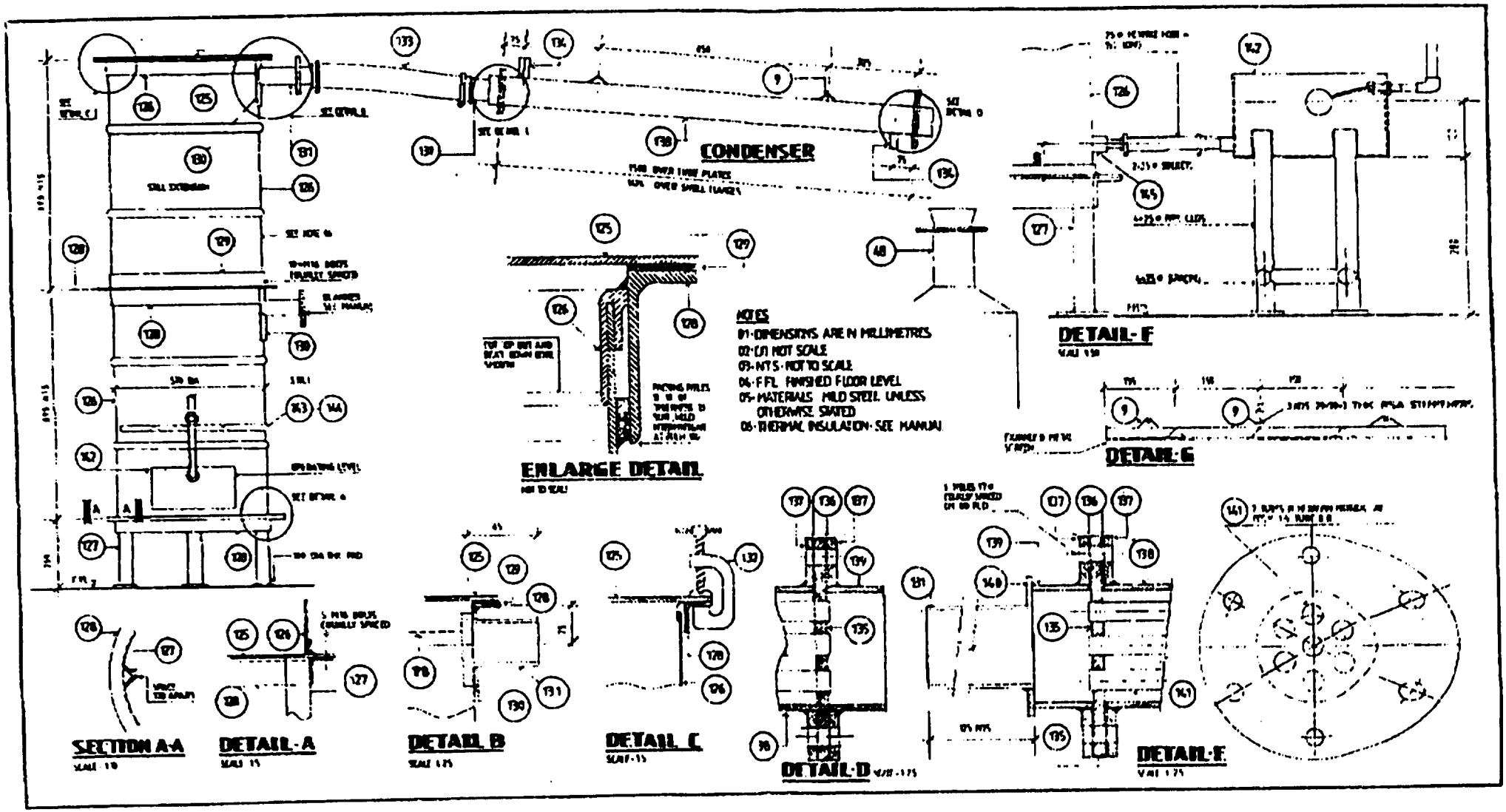
IN A DEVELOPING COUNTRY



FUNCTIONS OF A TECHNOLOGY GENERATION CENTRE



DESIGN FOR PILOT SCALE STEAM DISTILLATION UNIT



09	LIFTING LUG SEE DRG 01-LT-02 FOR 138 & 144	06
48	SEPARATOR- SEE DRG 01-LT-07 (SELECT TYPE)	01
125	PLATE 3THK×675 DIA DRILL 10 HOLES 17 ϕ EQUALLY SPACED ON 630 PCD	02
126	BODY- STANDARD OIL DRUM 200 LITRES NOMINAL WITH TOP & BOTTOM CUT OUT	02
127	LEG- 50×50×5THK RSA × 250 LONG C/W 100 DIA 5THK PAD	03
128	RIM FLANGE- 50×50×3THK RSA HEAT AND FORM IN TO HOOP OF INSIDE DIA 580, DRILL 10 HOLES 17 ϕ EQUALLY SPACED ON 630 PCD	03
129	GASKET- CUT FROM 3THK PACKING SHEET RATED FOR SERVICE AT DEG C	02
130	REINFORCEMENT PLATE 3THK, 270 SQUARE WITH CENTRAL HOLE 89 DIA, ROLL TO INSIDE RADIUS 580	01
131	CONNECTION 65 NB×125 LONG FLANGED	02
132	STANDARD C-CLAMP	12
133	FLEXIBLE 65NB OW FLANGED CONN'N ONE END	01
134	CONNECTION 40 NB × 75 LONG WELD TO 138	02
135	TUBE PLATE 10 THK ALUMINIUM PLATE × 210 OUTSIDE DIA DRILL AS DETAIL E - DRILL TUBE HOLES TO ACTUAL OD AS PROCURED WITH TOLERANCE +0·1 TO +0·2	02
136	GASKET 3 THK. CUT FROM PACKING SHEET RATED FOR 100 DEG C	04
137	FLANGE 10 THK × 210 OUT DIA TO FIT 100 NB PIPE, DRILL 6 HOLES 12 ϕ EQUALLY SPACED ON 170 PCD	04
138	SHELL - 100 NB PIPE × 1570 LONG	01
139	END COVER- 100 NB PIPE	02
140	PLATE 3 THK × 120 OD WITH CENTRAL HOLE 76 ϕ	01
141	TUBE, ALUMINIUM, 19 OD × 1506 LONG WALL THICKNESS 08 mm	07
142	FEEDWATER TANK 250×300×HT 150 FROM 3 THK PLATE C/W 15 ϕ FLOAT VALVE, CONN NS AND SUPPORT LEGS	01
143	GRID SUPPORT 20×20×3 THK RSA HOOP, WELD TO 126	01
144	EXPANDED METAL GRID, OD 565 SEE DETAIL-G	01
145	CONNECTION, 25 NB SOCKET, WELD TO ITEM 126	01

TITLE

DISTILLATION PLANT TYPE BT

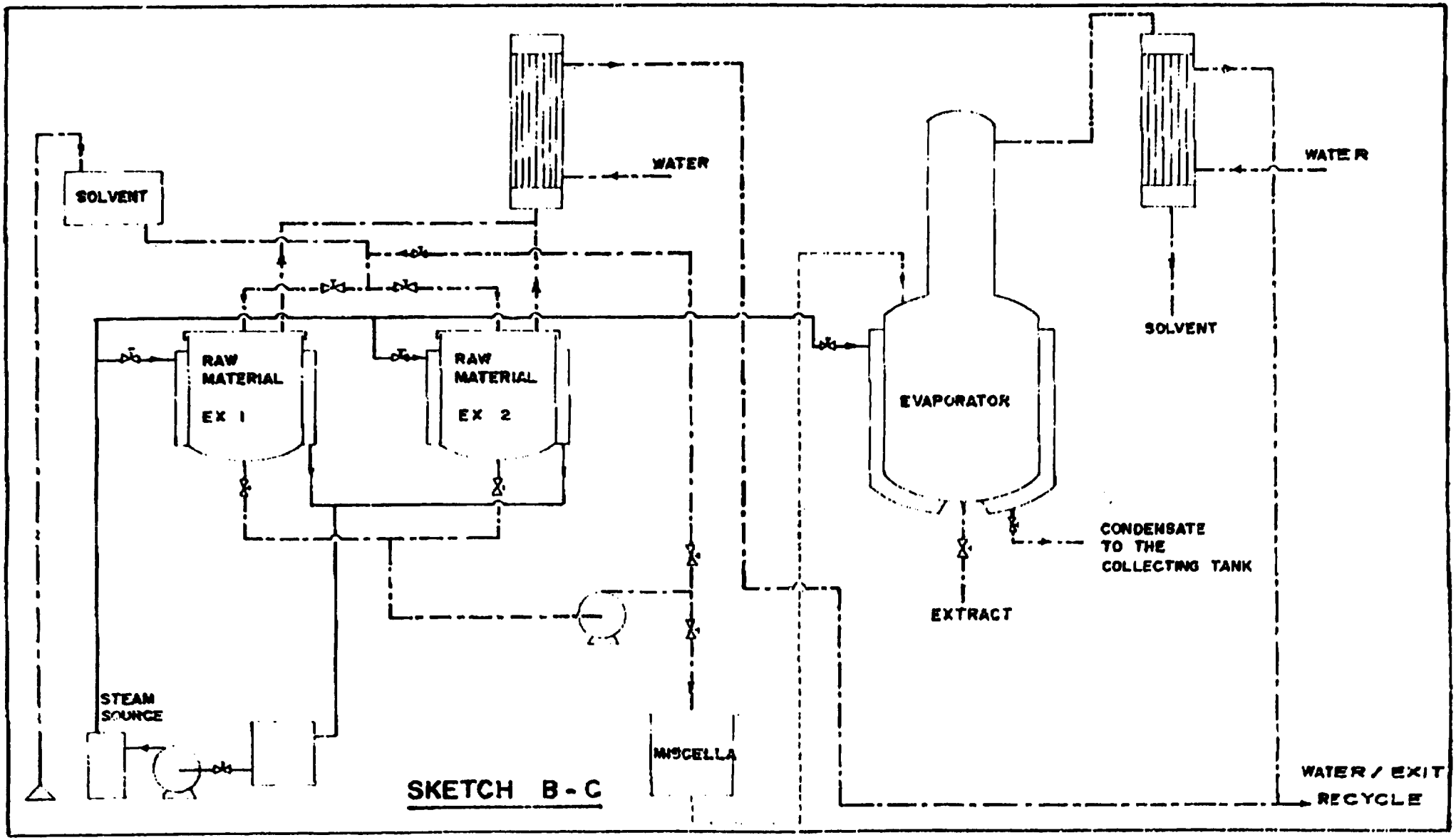
INTECNOS ASSOCIATES

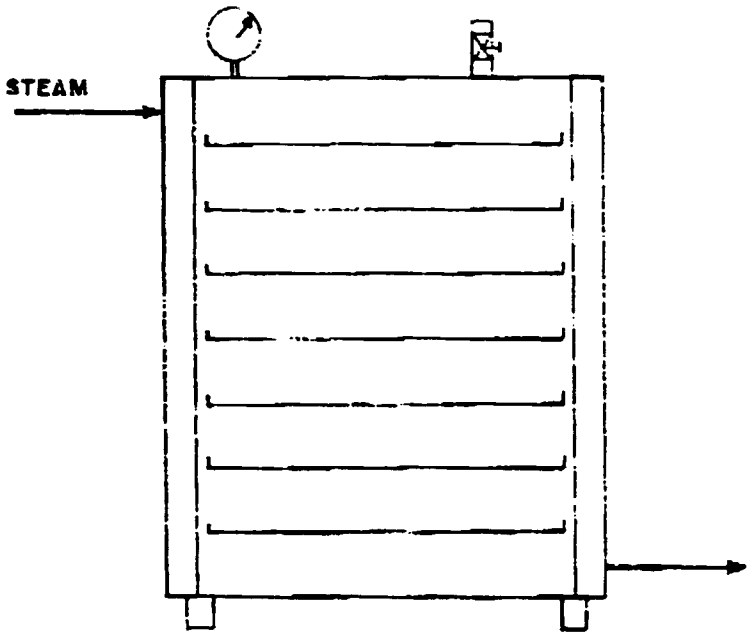
INDUSTRIAL CONSULTANTS
38, BEDDEGANA ROAD SOUTH
PITAKOTTE, SRI LANKA
TEL- 565242

DRAWN- C M R	TRACED- G AMMIKA	SCALE -STATED	DATE -92·08·31	DRG NO 01-BT-01

SKETCH FOR EXTRACTION/PERCOLATION UNIT

Annex 12





VACUUM OVEN

SKETCH D

SKETCH FOR A DRYING CABINET

Annex 14

SPECIFICATIONS FOR EQUIPMENT (NON-EXPENDABLE)

A. Analytical Instrumentation

01 1 GLC unit complete with 5 x columns for analysis of essential oils. FID detector. Capillary capability with SE30 columns (2x) Integrator and compatible computer

02 TLC equipment complete set with desintometer and accessories.

B. Pilot Plant Scale Equipment (Preferable to be locally fabricated with stainless steel)

1 No. complete steam distillation assembly of BT type (Refer sketch A)

1 No. Assembly for solvent/water extraction (refer to sketch B)

1 No. Reboiler unit for solvent recovery (as per sketch C)

1 No. Tray Drier (Sketch D)

1 No. steam generator cap.-100 kg/hr.

LIST OF EQUIPMENT - CONSUMABLES

1. Stainless steel sheeting for construction of pilot scale equipment (in part).

2. Accessories for pilot scale equipment - steam cocks, guages, piping, insulation material, etc.

3. Solvents (assorted) and chemicals

4. Special reagents for laboratory.

Annex 15

THE PROPOSED CENTRE FOR MEDICINAL & AROMATIC PLANTS INDUSTRIAL TECHNOLOGY DEVELOPMENT (MAPTECH)

1. Goals and Objectives of the Centre

1.1 The Centre MAPTECH is to serve as a mechanism by which indigenous technology generation will be facilitated. The technology so generated should be feasible and relevant to the processing of primary products from plant material used for their aromatic or medicinal characteristics.

The Centre may investigate such plants at laboratory, bench and pilot scale. The Centre would also extend their activity to plants that will generate other economic products such as oleoresins, tannis, dyes, pigments,etc.

1.2 The Centre will stimulate and conduct research and development activities on plants with a view to:

a) Processing of essential oils from aromatic plants, entrally as well as in chosen rural sites.

b) Processing of extracts from selected plants with established medicinal value with the prospect of delivering to the traditional healers preparations such as standardised extracts and dosage forms for use in their health care system.

c) Developing acceptable methods for cultivation of important plant species on a scale suitable for industrial processing.

d) Developing methodology for domestication and propagation of plant species selected from the spontaneous flora.

e) Developing methodology to enable the sustainable harvesting of selected plant species from the wild flora.

f) Formulating suitable analytical methods for the assessment of quality in raw materials.

g) Acquiring the facility for the design and fabrication of process equipment, or promoting such a development in a chosen situation.

h) Gathering and collating ethonomedical information on swazi medicinal and aromatic plants.

2. Structure of the Centre

2.1A Location

The Centre will be located in the University of Swaziland and the hardware may be distributed in the two faculties of Science and Agriculture as is deemed logical and facile.

2.1B Participating entities

The participating entities will be:

The University of Swaziland
The Association of Traditional Healers of Swaziland
The Ministry of Commerce and Industry
The Ministry of Agriculture through the Malkers Research Station

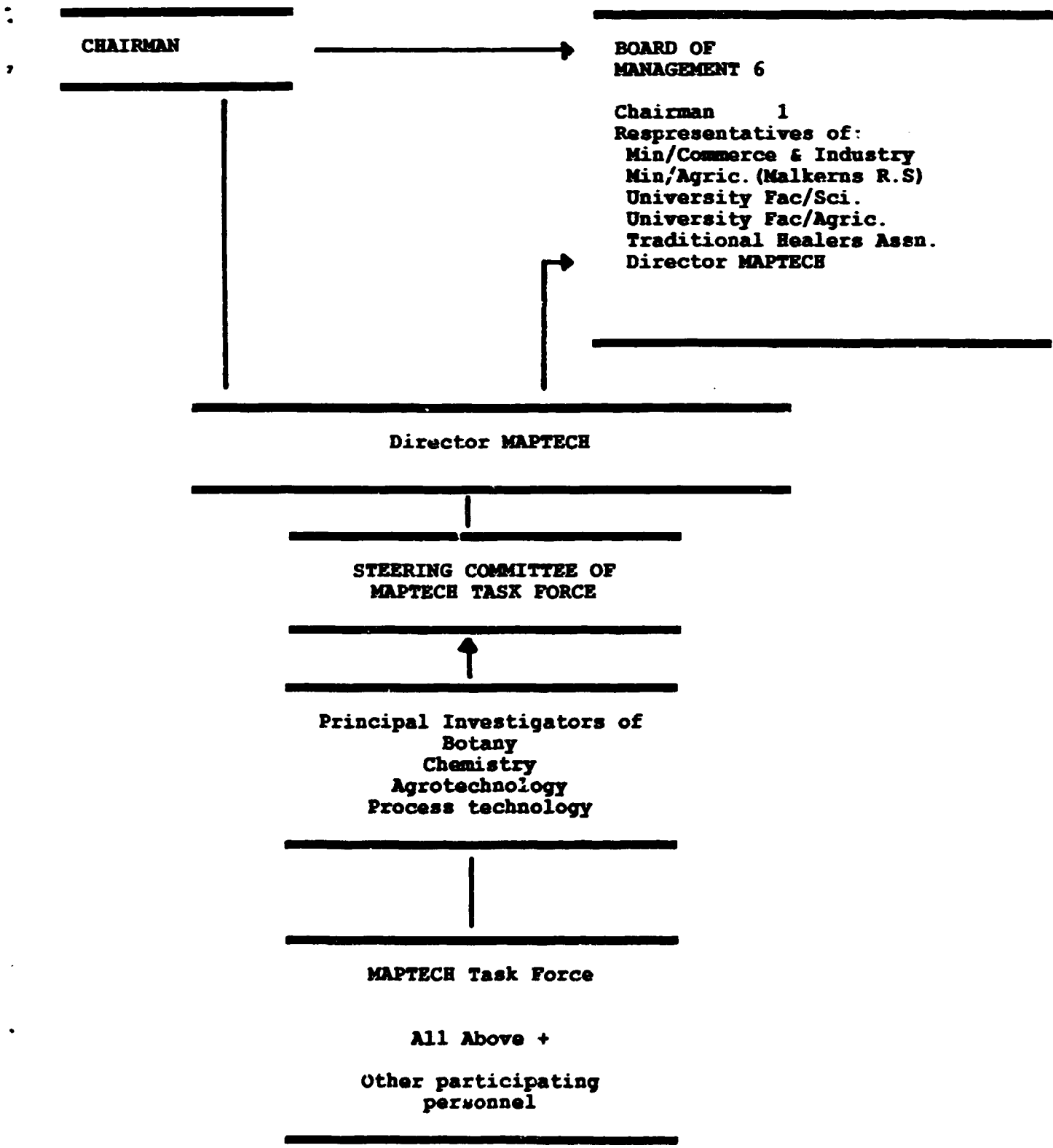
2.2 Management

The Centre would be managed by a Board of Management constituted of the following:

The Vice Chancellor (Chairperson)
The Dean of the Faculty of Agriculture
The Dean of the Faculty of Science
Representatives of: (One each)
- The Ministry of Commerce and Industry
- The Traditional Healers
- The Chief Research Officer (Malkerns R.S.)

The Appointed Director of MAPTECH

3. MAPTECH
MANAGEMENT AND TASK FORCE



4. Plan of work suggested for MAPTECH

Activity	Responsibility	Time Frame
1. Selection of priority list of plants for development	MAPTECH/TF	0-3M
2. Literature surveys on 5/6 of species, complete with any data on processing/industrial use	MAPTECH/TF The assistance of data bases like NAPRALERT may be sought. Also PID-CSIR New Delhi, CSIR-RSA.	0-6M
3. Finalization of all laboratory methods on 3/4 candidate	MAPTECH/TF with help from international colleagues	0-12M
4. Plan for acquisition/installation of pilot plant + steam distillation assembly	MAPTECH/TF/UNIDO	
5. Delivery and installation of pilot plant assembly	UNIDO + MAPTECH/TF	12-24M
6. Commencement of plant propagation trials on selected species	MAPTECH/TF	03-18M
7. Develop methodology for supply of adequate raw materials on 3/4 selected species for pilot scale processing trials	MAPTECH/TF	18-24M
8. Develop QA/QC methods for any products - follow up of 3 above	MAPTECH/TF	18-24M
9. Training programmes in operation	UNIDO + MAPTECH	06-24M
10. Review of all systems	UNIDO + MAPTECH /TF	24-36m

Backtopping Officer's Technical Comments
based on the work of Mr. R.O.B. Wijesekera

The report is comprehensive and contains an assessment of the current status of activities in this area. The consultant has visited all institutions presently engaged in activities related to natural products and recommended the roles to be played by them to support the establishment of a Medicinal and Aromatic Plants Technology Development Centre (MAPTECH). The needs for a technical assistance programme for the development of the subsector has been evaluated and a draft project document has also been prepared. The consultant also has discussed his findings and recommendations with the government authorities and the UNDP. He has fulfilled his obligations very successfully. It is hoped that initiatives will be taken to implement these recommendations. An official government request is required for futher assistance from UNIDO.