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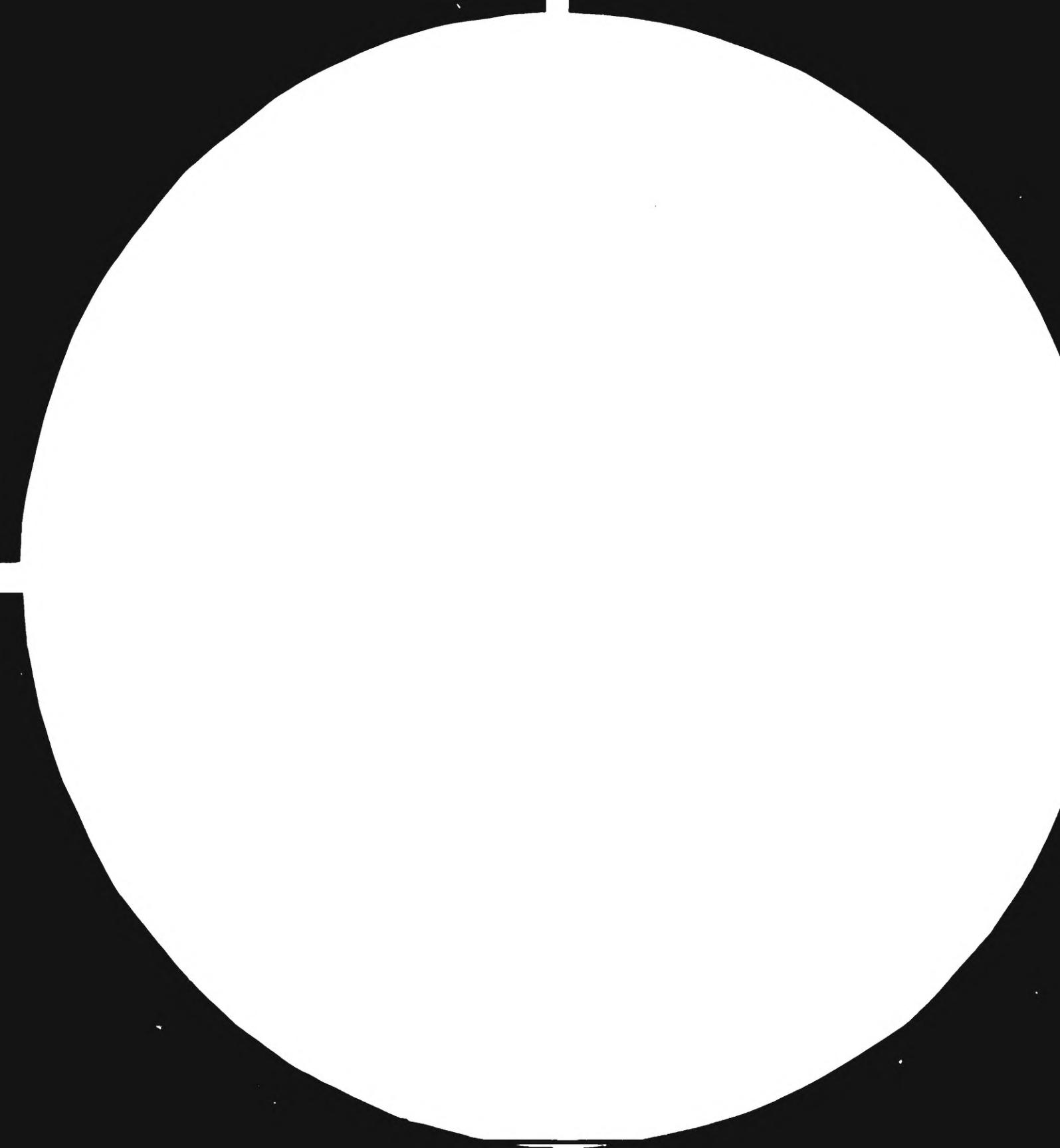

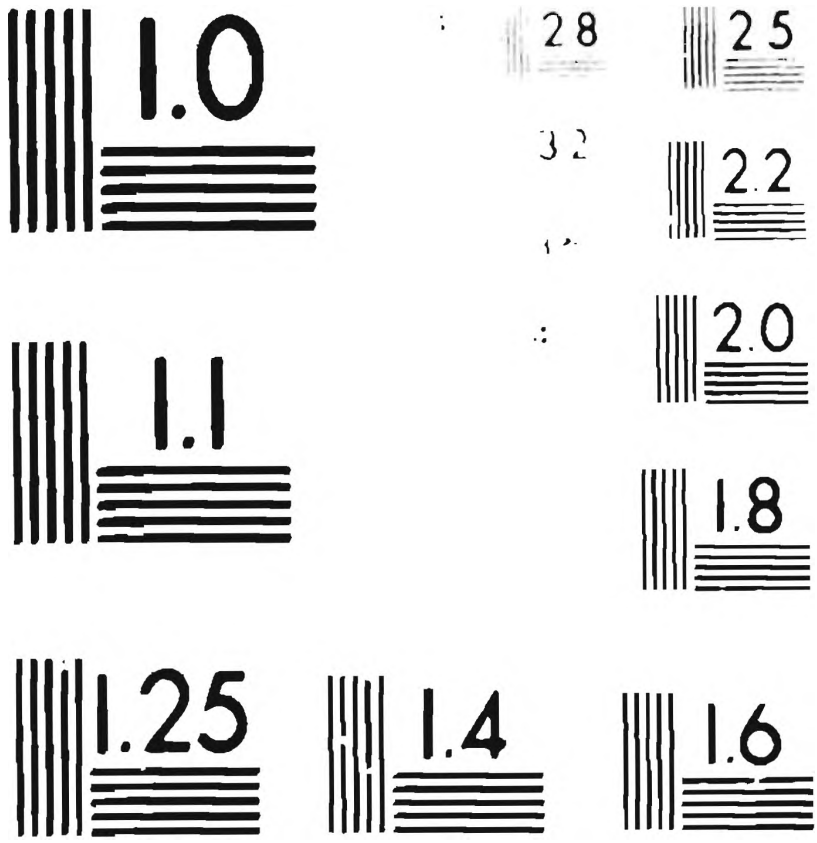

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Tanzania.

ASSISTANCE FOR THE PRODUCTION OF PLANT-DERIVED PHARMACEUTICALS

DP/URT/81/026

TANZANIA

Terminal report *

Prepared for the Government of Tanzania
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Dr.Emil Paun,
expert in the field of botany/agronomy

United Nations Industrial Development Organization
Vienna

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INTRODUCTION

The UNITED REPUBLIC OF TANZANIA represents a very large territory, of 941, 997 KM^2 (including Zanzibar = 2542 KM^2), with an elevation between zero at sea level and 5870M/at Kilimanjaro (Africa's highest mountain). The population of the United Republic of Tanzania is 19,150,000 according to a 1978 census, 20.3 inhabitants/square kilometre from which approximately 13% live in towns, while the majority of the population (87%) live in the villages.

In the territory of the United Republic of Tanzania, four major topographical types predominant: the coast, the flat plains of the main river systems, the vast inland plateau and the highlands. Of considerable local climatic importance are the three largest African lakes: Victoria, Tanganyika and Nyasa. The temperature (in some regions) and water, and hence rainfall are a major limiting factor in agricultural practices.

This vast territory, characterized by very different pedoclimatical conditions, is covered with various flora in which many species are medicinal and aromatic plants which are not used as yet for the preparation of pharmaceutical products. Many of these species are used by folk medicine and some of them are exported (e.g. GINGER = Zingiber officinale; ALOES = Aloes sp; PAPAIN = Carica papaya; CINNAMOM BARK = Cinnamomum zeylanicum; CINCHONA BARK = Cinchona succirubra; COCOA BEANS = Theabroma cacao; GUMARABIC = Acacia sp; KAPOK = Sterculia foetida; NUTMEG = Myristica fragrans, etc).

I. NATURAL RESOURCES

1. SPONTANEOUS FLORA

The information in the report is based on the following:

- The UNIDO - Expert's own experience and observation during the previous (1980) and present trips from Kobero, Biharamulo, Geita, Mwanza, Seronera (Serengeti), Arusha (Olmotonyi), Moshi (Mawa-Kilema, Lyamungu), to Dar es Salaam (1560 KM), as well as other trips to Morogoro (200 KM), Lushoto, Amani, Muheza (600km) in Tanga region and in the vicinity of Dar-es-Salaam and Coast region (Kibaha).

- on considerable literature about grasses, herbs, trees, shrubs and poisonous plants growing in the East African region.

- and with assistance from Mr.E.N.Mshiu - Director and Senior Research Fellow ,Mr.R.L.A. Mahunnah - Assistant Research Fellow (both from Traditional Medicine Research Unit (TMRU) and Mr.Boniface Mhoro Herbarium Technician - University of Dar-es-Salaam.

The UNIDO expert found that in the spontaneous flora of the United Republic of Tanzania are growing a big variety of medicinal and aromatic species but the majority are not chemically studied though they are used in the traditional medicine.

The multitude of medicinal and aromatic species growing in the spontaneous or cultivated flora of Tanzania could be divided into the following five groups:

1.1 The first group and in factthe most important group includes 31 medicinal and aromatic species growing in sufficiant quantities in the spontaneous or cultivated flora of Tanzania (Appendix 1).

It is possible to use directly these medicinal and aromatic species because they are well studied and they are recognised by international pharmacopoeias.

All these medicinal and aromatic plants are not used by the pharmaceutical industry of Tanzania; instead some of them are exported by General Agricultural Products Export (GAPEX) but at the same time the National Pharmaceutical Company (NAPCO) and Central Medical Stores (CMS) import pharmaceutical products like powders, tinctures, oils and pure substances (Appendix 2) .
Some of them could be produced by the local industry without applying sophisticated and expensive equipment, for instance:

powders, extracts, tinctures, syrups and oils

Therefore these species can be used for the local preparation of medicines without carrying out any further research on them.

1.2 The second group comprising 18 genera and numberous species is listed in Appendix 3 .
These medicinal and aromatic plants are growing in the spontaneous flora, and used in folk medicine and which should be tested from therapeutical point of view.

These species could substitute the species of the same genus which are recognised by international pharmacopoeias, but not growing in the spontaneous or cultivated flora of Tanzania.

1.3. The third group includes 11 medicinal species, currently used in traditional medical therapy and with promising clinical effects.

The most part of these species included in Appendix 4, are few and not at all tested for their chemical and therapeutical characteristics. These species must be tested from chemical and therapeutical point of view, because they are indicated for parasitic diseases, which may be very important for United Republic of Tanzania.

1.4. The fourth group includes 27 genera comprising of many medicinal species, growing in the spontaneous flora in Tanzania and used in the traditional medicine (Appendix 5). Many of these species have content of alkaloids, glucosides, acids, saponins and other useful substances and it may be possible to use them for pharmaceutical products. In the first phase, the research must be guided for the determination of chemical and pharmaceutical characteristics.

1.5. The fifth group includes only 9 aromatic species which contain essential (volatile) oils (Appendix 6). These aromatic species and the others included in Appendix 1 can offer to the Tanzanian industry sources of the essential oils necessary for perfumery, cosmetic, detergent and especially in the soap industries.

Most of the medicinal and aromatic species, growing in spontaneous flora of the United Republic of Tanzania can be harvested in commercial quantites for the preparation of pharmaceutical products and to obtain essential oils.

2. CULTIVATED FLORA

Medicinal and aromatic plants are not deliberately cultivated for medicinal purposes but certain species of pharmaceutical importance are cultivated for other purposes for example:

-Agavae sisalana - which is cultivated for the fibre sisal.

-Capsicum annum - which is cultivated as a spice plant
-Citrus aurantium - which is cultivated as a food plant
-Carica papaya - which is cultivated as a food plant
-Elettaria cardamomum - which is cultivated as a spice and for export
-Eucalyptus globulus - which is cultivated for wood
-Catharanthus roseus - which is cultivated as a decorating flower.

Many of these species are not used for pharmaceutical products, but some of them are exported (e.g. Capsicum annum, Carica papaya, Elettaria cardamomum).

2.2. However for the development of a national pharmaceutical industry and for the enlargement of a range of pharmaceutical products based on local resources it would be advisable to introduce in cultures and acclimatise new species of medicinal and aromatic plants, which are not growing in Tanzania and are recognised by International Pharmacopoeias. This development is favourable because the United Republic of Tanzania has large area of land available which is not cultivated and the necessary labour power.

2.3. For this the UNIDO - Expert brought from Romania and handed to Mr. E.N. Mshiu - Director of the Traditional Medicine Research Unit 31 medicinal and aromatic plant species. These are included in Appendix 7 and some of the species brought by UNIDO - Mobile Unit Team in January 1980. In the same Appendix 7 are included. "The main elements of cultivation technology". Also, the UNIDO - Expert brought and handed to Mr. E.N. Mshiu the technology for the cultivation of 52 medicinal and aromatic plant species cultivated in Romania.

2.4. The UNIDO - Expert, accompanied by Mr. R.L.A. Mahunnah- Assistant Research Fellow, made a trip to Northern Tanzania to find places with similar pedo-climatic European conditions; for starting research in the cultivation of medicinal and aromatic plants.

2.5. The best places for the cultivation of European medicinal and Aromatic species are those which have high altitude (1500-2000m), low temperature and high rainfall. These places are Lushoto, Olmotonyi (Arusha) and Kilimanjaro - (Mawa-Kilema).

2.6. Since the number of medicinal and aromatic species brought by UNIDO - Expert is too big, it was decided to start with the most important plants which are necessary for the pharmaceutical industry in Tanzania. These species are listed in Appendix 8. In Appendix 9, are indicated the species from which it is possible to prepare simple medicines (like tincture, extracts, infusions) and in Appendix 10 is indicated the mode of preparation of some medicinal teas.

2.7. In order to understand the economic and phytochemical value the vegetation period of the experimental plants must be observed and recorded as indicated in Appendix 11.

3. TRAINING OF LOCAL PERSONNEL

3.1. During the trips, the UNIDO - Expert was accompanied by Mr. E.N. Mshiu and Mr. R.L.A. Mahunnah. The UNIDO - Expert taught Mr. R.L.A. Mahunnah, concerning the methodology of harvesting, preparation and labeling of the samples for analysis.

3.2. Also, the UNIDO - Expert taught the following Tanzanian specialists: H.P. Msanga - Lushoto, M.S.B. Minja - Olmotonyi (Arusha) and E.S.H. Shundo - Kibaha, how to prepare the soil, how to sow, how to harvest (period of harvesting, part of the plant used), how to dry and how to determine the yield of fresh and dry mass per hektare.

3.3. For the begining, was selected three research points Lushoto, Olmotonyi (Arusha) and Mawa Kilema. For each point the UNIDO - Expert handed to the local personnel 11 species of the most important medicinal and aromatic plants cultivated in Romania.

3.4. In the end of his mission the UNIDO - Expert handed to Mr. E.N. Mshiu "the main elements of cultivation technology" who will send them to all researchers.

The persons met by the UNIDO - Expert during his mission in the United Republic of Tanzania are indicated in Appendix 12.

II. FINDINGS

1. The United Republic of Tanzania has a very rich spontaneous and cultivated flora of medicinal and aromatic plants but there is no reliable data about their quality content.

2. There is no data available on the quantity of medicinal and aromatic plants from spontaneous flora which can be harvested annually.

3. There is no organization specialized in the exploitation of spontaneous flora for pharmaceutical purposes. There are many local healers who prescribe medicinal plants to cure some specific diseases but the plants have not been checked up for their chemical content and therapeutical effects. The "Traditional Medicine Research Unit" has just started such a kind of research but the research work need to be carried out for a long time and adequate technical means are necessary.

4. There are some local pharmaceutical plants, but all raw materials are imported. Over 90% of the total consumption of pharmaceuticals is imported as finished products.

5. There is an organization - General Agriculture Products Export Corporation (GAPEX) which collects and exports many medicinal and aromatic plants.

6. All the pharmaceutical products are imported by Central Medical Stores (CMS) - and National Pharmaceutical Company. Some of these pharmaceutical products are made from exported raw materials by GAPEX.

7. There is good organization of research for food, vegetable, forest and others crops but there is no organized preoccupation acclimatize and to introduce in culture valuable species of medicinal and aromatic plants to enlarge the range of natural resources.

8. There is no National quality control for the imported drugs or for the prescribed medicinal plants by the local healers.

9. The "Traditional Medicine Research Unit" has a new building with good laboratory but the apparatus and personnel are not sufficient.

III. RECOMMENDATION

1. FOR TRADITIONAL MEDICINE RESEARCH UNIT (TMRU)

1.1. To set up a section specialised in the valorization of medicinal and aromatic plants which are growing in the spontaneous flora.

The main objectives of this section will be the following:

- identification of the necessary species, for the pharmaceutical industry, growing in the spontaneous flora of the country, starting with the species from which CMS imports simple medicines (tinctures, extracts, etc)

- evaluation of the quantities which can be harvested yearly.

In this work the "Traditional Medicine Research Unit" must be assisted by Department of Botany, Division of Pharmacy and Faculty of Agriculture (University of Dar es Salaam) with their students, during holiday period.

- to have a collection of medicinal and aromatic plants which are growing in Tanzania, recognised or unrecognised by international pharmacopoeias but used in the folk medicine. To use this collection for training the personnel who will work in this special domain.

- to issue some guides (leaflets) describing the plant, the parts of the plant to be harvested, the period of harvesting, the mode of drying with drawings and in the vernacular language of the respective area to guide the harvesters.

1.2. To set up a section specialised in Agrobiological Research for cultivated flora. The main objectives of this section will be the following:

- to maintain a small collection of the most important medicinal and aromatic species which do not grow in Tanzania,

- to coordinate all experimental points of the country on the bases of the same single research plan.

- to try to introduce in culture the most important and necessary species for Tanzania, recommended by Ministry of Health.

1.3. To analyse all samples gathered from wild and cultivated flora and to continue to analyse the herbs and mixtures prescribed by the local healers. In order to prohibit the use of toxic species and for the selection of new species necessary for the pharmaceutical industry.

1.4. To start to produce simple medicines and essential oils, using the pilot unit for extraction and distillation, which will be set up very soon.

2. FOR MINISTRY OF AGRICULTURE AND FORESTRY

2.1. To ensure that the "Traditional Medicine Research Unit" get the following:

- the necessary surface of land in regions with the suitable pedo-climatic conditions.

- the necessary personnel for the research programme.

3. FOR MINISTRY OF INDUSTRIES

3.1. To offer financial assistance to the Keko Pharmaceutical Plant Dar es Salaam to do the following:

3.1.1. To set up a unit for medicinal and aromatic plants from from wild and cultivated flora

The main objectives of this unit shall be the following:

- to organise a network for the harvest of the plants necessary in the production of pharmaceutical products and essential oils based on the scientific results obtained by the Traditional Medicine Research Unit

- to conctract some of the cultivated medicinal and aromatic plants.

- to transport and to process all these plants (breaking up, packaging and storage).

3.1.2. To set up a unit specialized in the production of simple pharmaceutical products (tinctures, syrups, extracts,tablets) and essential oils also based on the scientific results obtained by the Traditional Medicine Research Unit.

4. FOR MINISTRY OF HEALTH

4.1. To set up a Quality Control Laboratory

The main objectives of this quality control laboratory shall be the following:

- to analyse all the imported medicines and raw materials used by pharmaceutical industry of Tanzania.

- to analyse all medicines which are made by local pharmaceutical plants to analyse all pharmaceutical products, which are made of medicinal and aromatic plants.

5. FOR UNIDO

5.1. To continue to train the local specialists, who will work in the field of medicinal and aromatic plants valorization, in the following programme:

- one botanist = 3 months in the country with similar pedoclimatic conditions.

- one agronomist= 3 months in the country with good experience in the cultivation of medicinal and aromatic plants (in the period 15 April - 15 July)

- one pharmacist = for 3 months to study analytical methods.

- one pharmacist = for 3 months to study the technology of preparation of pharmaceutical products from medicinal and aromatic plants.

5.2. To assist URT with the international experts in the following domains:

- <u>one pharmacist - technologist</u> = for 6 months, after the arrival of the pilot unit for extraction and distillation.

- <u>one pharmacist</u> = 6 - 12 months, for quality control laboratory, after being set up by Ministry of Health.

5.3. To equip the research points for the cultivation of medicinal and aromatic plants, with the minimum and necessary equipment, which is estimated at US$ .4120.. (Appendix ..14...)

5.4. To ensure that the Project Vehicle is supplied with some necessary spare parts (Appendix .15....) valued at US$ .597....

5.5. To complete equiping the analytical laboratories of Traditional Medicine Research Unit with the necessary equipment. These equipment must be selected and estimated by UNIDO - Expert.

5.6. To equip the quality control laboratory, which will be set up by Ministry of Health, with the necessary apparatus. This equipment must be selected and estimated by the UNIDO - Expert in this particular field.

Appendix 1

LIST OF MEDICINAL AND AROMATIC PLANTS GROWING IN SUFFICIENT QUANTITIES IN THE SPONTANEOUS AND CULTIVATED FLORA OF TANZANIA AND RECOGNISED BY INTERNATIONAL PHARMACOPOEIAS

NO.	BOTANICAL NAME	PART OF PLANT USED	CONTENT	THERAPEUTICAL EFFECT	MODE OF PREPARATION
1	Acacia catechu	gum	catechic tannins mucilages	- astringent	tincture
2.	Acacia senegal (Syn. A. verek)	gum	arabin arabic acid enzymes	- for preparation of tablets	-
3	Agave sisalana	juice	hecogenin	- steroid hormones (cortizone)	-
4.	Aloe sp. (A.ferox)	juice	aloin	- purgative - carminative	tincture extract
5	Balanites aegyptiaca	fruits	diosgenin yamogenin	- steroid hormones (cortizone)	-
6.	Capsicum annum	fruits	capsicin ascorbic acid	- antirheumatic - lumbago	tincture extract
7	Carica papaya	fruits (unripe)	proteolytic enzyme	- in dyspepsia and gastris - in dental practice	-

Appendix 1 (Con'd)

o	1	2	3	4	5
8 9	Cassia angustifolia C. acutifolia	leaves	sennoside	- laxative - purgative	infusion
10	Catharanthus roseus	twigs	vincristine vinblastine	- in Hodgkin's disease - in children leukaemia	-
11	Chenopodium ambrosioides	herbs	essential oil ascaridol	- anthelmintic	-
12	Cinchona succirubra	barks	quinine quinidine	- bitter tonic - stomachic - antimalarial	tincture extract infusion
13	Cinnamomum camphora	Wood	camphor	- rubefacient - antiseptic - carminative	-
14	Cinnamomum zeylanicum	barks	essential oil aldehyde	- flavouring - astringent	tincture
15	Citrus aurantium	peels	essential oil	- flavouring - bitter tonic	tincture extract
16	Cola nitida Cola acuminata	seeds	caffeine theobromine theophilline	- nervous - excitant	tincture extract
17	Datura innoxia	leaves	scopolamine	- antispasmodic - antiparkinson	-
18	Datura stramonium	leaves	hyoscyamine atropine	- antispasmodic - antiparkinson	tincture extract

Appendix 1 (Cont'd)

o	1	2	3	4	5
20	Elettaria cardamomum	fruits seeds	essential oil cineole	- flavouring	tincture
21	Eucalyptus globulus	leaves	essential oil cineole	- antibronchitis	tincture
22	Eugenia caryophyllus	flower buds	essential oil eugenol	- stimulant - antiseptic	
23	Foeniculum vulgare	fruits	essential oil anethol	- carminative - antispastic	tincture
24	Myristica fragrans	seeds	essential oil pinene	- flavouring - carminative	-
25	Plantago lanceolata	leaves	aucubine tannin	- emolient - haemostatic	-
26	Rauwolfia vomitoria	roots	reserpine	- hypertension - neuropsychiatric	-
27	Ricinus communis	seeds	fixed oil ricinoleic acid	- purgative	-
29	Strophanthus kombe	seeds	strophantin	- cardiatonic	tincture
30	Theobroma cacao	seeds	theobromine caffeine	- diuretic - suppository base	-
31	Zingiber officinale	rhizome	essential oil comphene	- stimulant - carminative	tincture

NOTE: All mode of preparation of the tinctures, extracts and infusions are described in the international pharmacopoeias

Appendix 2

IMPORTED PHARMACEUTICAL PRODUCTS BY CENTRAL MEDICAL STORES (CMS) AND PLANT SPECIES OF WHICH THESE PHARMACEUTICAL PRODUCTS ARE MADE, UNUSED OR EXPORTED BY GENERAL AGRICULTURAL PRODUCTS EXPORT (GAPEX)

NO	IMPORTED PHARMACEUTICAL PRODUCTS BY CENTRAL MEDICAL STORES (CMS)	PLANT SPECIES OF WHICH THESE PHARMACEUTICAL PRODUCTS ARE MADE (UNUSED OR EXPORTED BY GAPEX)
1	Acacia powder	Acacia senegal (A.catechu)
2	Castor oil	Ricinus communis
3	Chalk mixture with cotechu	Acacia catechu
4	Cardamomum tincture	Elettaria cardamomum
5	Chenopodium oil	Chenopodium ambrosioides
6	Clove oil	Eugenia caryophyllus
7	Chloroquine + Quinine	Cinchona succirubra
8	Eucalyptus oil	Eucalyptus globulus
9	Hydrocortisone	Agave sisalana Solanum incanum
10	Senna	Cassia acutifolia Cassia angustifolia
11	Reserpine	Rauwolfia vomitoria
12	Stramonium tincture	Datura stramonium
13	Tragacantha powder	Sterculia foetida
14	Vincristine	Catharanthus roseus

Appendix 3

LIST OF PLANT SPECIES WHICH ARE GROWING IN THE SPONTANEOUS FLORA, USED IN FOLK MEDICINE AND WHICH SHOULD BE TESTED FROM THERAPEUTICAL POINT OF VIEW TO SUBSTITUTE THE SPECIES RECOGNISED BY INTERNATIONAL PHARMACOPOEIAS

SPECIES WHICH ARE GROWING IN THE SPONTANEOUS FLORA			SUBSTITUTE SPECIES RECOGNISED BY INTERNATIONAL PHARMACOPOEIAS BUT NOT GROWING IN TANZANIA		
NO	BOTANICAL NAME	PART OF PLANT USED	BOTANICAL NAME	CONTENT	UTILIZATION
1	Argemone mexicana	seeds	Papaver somniferum	morphine	hypnotic
2	Berberis aristata	bark	Berberis vulgaris	berberin berbamin	colagog coleretic
3	Citrullus lanatus	fruits	Citrullus colocynthis	colocin-trin elaterin	purgative
4	Discorea sp. (13 species)	tubers	Dioscorea mexicana	diosgenin	cortisone
5	Dryopteris sp. (5 species)	rhizome	Dryopteris filix-mas	phloro-glucinol filixic acid	anthelmintic
6	Euphorbia sp (45 species)	juice	Euphorbia resinifera	euphorbon	nervous and cardiac stimulant
7	Gomphocarpus fruticosus	seeds	Digitalis sp.	glikosi-des	cardiotonic
8	Gloriosa superba	root	Colchicum autumnale	colchicin	antigout to produce polyploidy
9	Lobelia sp. (5 species)	herbs	Lobelia inflata	lobeline	asthma bronchitis

Appendix 3 (Cont'd)

SPECIES WHICH ARE GROWING IN THE SPONTANEOUS FLORA			SUBSTITUTE SPECIES RECOGNISED BY INTERNATIONAL PHARMACOPOEIAS BUT NOT GROWING IN TANZANIA		
NO	BOTANICAL NAME	PLANT OF PLANT USED	BOTANICAL NAME	CONTENT	UTILIZATION
10	Polygala sp. (6 species)	root	Polygala senega	saponins	expectorant
11	Pelargonium alchemilloides	herbs	damascena	geraniol citronellol	parfumes cosmetics
12	Passiflora sp. (4 species)	-	Passiflora incarnata	passiphlo-rine	nervous sedative antispasmodic
13	Scopolia sp. (4 species)	rhizome	Scopolia carniolica	atropine hyoscia-mine	sedative
14	Sophora sp. (2 species)	flower buds	Sophora japonica	rutine	in hyperten-sion
15	Solanum incanum	fruits	Solanum laciniatum	solasodin	cortisone
16	Valeriana sp. (3 species)	rhizome	Valeriana officinalis	essential oil	sedative
17	Scila sp. (5 species)	bulbs	Scila maritima	scillaren	cardiatonic
18	Smilax peguana	roots	Smilax regelii	steroidal saponins	antisyphili-litic antirheumatic

Appendix 4

LIST OF PLANT SPECIES, WHICH ARE GROWING IN THE SPONTANEOUS FLORA OF TANZANIA, WITH PROMISING CLINICAL EFFECTS (CURRENTLY USED IN TRADITIONAL MEDICAL THERAPY)

NO	BOTANICAL NAME	PART OF PLANT USED	INDICATION IN PARASITIC DISEASES
1	Anacardium occidentale	kernal	antiamoebic
2	Centella asiatica	herb	in skin diseases
3	Crossopteryx febrifuga	-	antimalarial
4	Cucurbita maxima cultivated	seeds	tapeworm
5	Khaya senegalensis	-	antimalarial
6	Mitragyna sp.	leaves	antimalarial
7	Phytolacca dodecandra	roots	antihelmintic
8	Punica granatum	bark	tapeworm
9	Securidaca longipedunculata	roots	antihelmintic
10	Securinega virosa	leaves twigs	schistosomiasis (bilharziasis)
11	Zizyphus mucronata	roots	schistosomiasis (bilharziasis)

LIST OF PLANT SPECIES GROWING IN THE SPONTANEOUS FLORA IN TANZANIA, USED IN THE FOLK MEDICINE AND WHICH SHOULD BE TESTED FROM THERAPEUTICAL POINT OF VIEW

NO	BOTANICAL NAME	PART OF PLANT USED	CONTENT	FOLK MEDICINE USE FOR
1	Achyranthes aspera	roots	saponin	- in leprosy - vasoconstrictor
2	Adansonia digitata	leaves fruits seeds	ascorbic, tartric, citric, malic acids	- antidysenteric - diaphoretic - expectorant
3	Alchornea cordifolia	leaves	-	- antimalarial
4	Anacardium occidentale	bark	anacardic acid cardol	- treatment of aphthae - febrifuge - antidysenteric
5	Annona muricata	bark roots	hydrocyanic acid muricine muricinine	- anthelmintic - antidysenteric
6	Areca catechu	seeds	arecoline guvacine	- antihelmintic - antirheumatic
7	Asparagus racemosus	roots	steroids	- diuretic - antidysenteric
8	Azadirachta indica	-	-	- antiseptic - antirheumatic - antimalaria
9	Bidens pilosa	leaves herb	-	- conjunctivitis - antimalarial - antidysenteric
10	Celosia argentea	seeds	-	- anthelmintic
11	Coleus kilimandscheri	leaves	-	- hookworm - epilepsy

Appendix 5 (Cont'd)

NO	BOTANICAL NAME	PART OF PLANT USED	CONTENT	FOLK MEDICINE USE FOR
12	Cyperus rotundus	bulb (rhizome)	essential oil cyperone	- diaphoreic - vermifuge - antidysenteric
13	Haegenia abyssinica	roots flowers	-	- anthelmintic - antimalarial
14	Heliotropium indicum	roots herb	-	- treatment of yaws - ulcers
15	Iboza - multiflora - riparia	leaves roots		- antimicrobial - antimalarial - vermifuge
16	Lantana - camara - rhodesiensis - trifolia	leaves	essential oil	- coughs - conjunctivitis - gland disorders
17	Lippia javanica	leaves	essential oil	- fever - antimalarial
18	Melia azedarach	leaves root bark	terpenoides	- eczema - anthelmintic
19	Mimosa pudica	leaves roots	-	- antihemorhoids
20	Momordica foetida	roots	-	- purgative - abortion
21	Portulaca oleracea	leaves seeds roots	-	- sudorific - antiscorbutic - anthelmintic
22	Quisualis indica	seeds	-	- anthelmintic
23	Tabernaemontana (Conopharyngia) - elegans - hoestii	roots	indolil alkaloids	- pulmonary diseases - healing wounds
24	Tamarindus indica	leaves twigs	glycosides vitexin	- dysentery
25	Terminalia - brownii - kaiserana - sericea	roots	tannin oleoresin	- yellow fever - gonorrhoea - bilharzia
26	Vernonia amygdalina	root bark		- schistosomiasis
27	Zanthoxylum chalybeum	leaves root bark	rhamnoglycosides	- anticholcholera - antimalarial

Appendix 6

PLANT SPECIES GROWING IN TANZANIA AND WHICH CONTAIN ESSENTIAL (VOLATILE) OILS

NO	BOTANICAL NAME	CONTENT	UTILIZATION
1	Artemisia afra	1-1.3% in dried herb	-
2	Cananga odorata	1.2-1.4% in fresh flowers	perfumery
3	Cymbopogon citratus	1.7-1.8% in dried herb citral citronellol	perfumery industry soap
4	Lantana camara	1.8-2% in dried herb	-
5	Myrothamnus flabellifolius	0.6 - 0.8% in young twigs	-
6	Ocimum basilicum	0.7 - 0.8% in dried herb	for camphor
7	Ocimum suave	1,5-2% in dried herb	for Eugenol
8	Tagetes minuta	0,6-0.7% indried herb	perfumery soap industry
9	Tarchonanthus camphoratus	0.4-0.5% indried herb	for camphor

Appendix 7

LIST OF MEDICINAL AND AROMATIC SPECIES RECOMMENDED TO BE INVESTIGATED FOR THE INTRODUCTION IN CULTURE

(THE MAIN ELEMENTS OF CULTIVATION TECHNOLOGY)

NO	BOTANICAL NAME	PERIOD OF VEGETATION	SOIL WORKS		SOWING			MAINTENANCE WORKS	HARVEST	
			PLOUGHING DEPTH (CM)	BEFORE SOWING	QUANTITY (KG/HA)	DISTANCE (CM)	DEPTH (CM)		PART OF THE PLANT	MANNER OF HARVESTING
o	1	2	3	4	5	6	7	8	9	10
1	Calendula officinalis	Yearly	20–25	Disk Harrow	6–7	50	2–3	Hoed Weeded	Flowers	Manual
2	Coriandrum sativum	Yearly	20–25	Disk Harrow	20	25	4–5	Weeded	When 50–70% of fruits	Manual or with combine
3	Datura innoxia	Yearly	28–30	Disk Harrow	10	50	4–5	Hoed Weeded	Herbs when appears first fruit	Manual
4	Hyoscyamus niger	Yearly	20–25	Disk Harrow	6	50	1–2	Weeded	Leaves	Manual
5	Matricaria chamomilla	Yearly	15–20	Disk Harrow Roller	4–5	25	0,0–0,3	Weeded	Flowers	Manual

Appendix 7 (Cont'd)

NO	BOTANICAL NAME	PERIOD OF VEGETATION	SOIL WORK		SOWING			MAINTENANCE WORK	HARVEST	
			PLOUGHING DEPTH (CM)	BEFORE SOWING	QUANTITY (KG/HA)	DISTANCE (CM)	DEPTH (CM)		PART OF THE PLANT	MANNER OF HARVESTING
o	1	2	3	4	5	6	7	8	9	10
6	Ocimum basilicum	Yearly	20 - 25	Disk Harrow Roller	4 - 6	50	1,5-2	Hoed Weeded	Herbs	Manual with the sickle
7	Papaver somniferum	Yearly	20 - 25	Disk Harrow Roller	2 - 3	50x10-15 cm Between Plants	1 - 2	Hoed Weeded	Seeds and the capsules	Manual
8	Pimpinella anisum	Yearly	20 - 25	Disk Harrow Roller	10	50	2 - 3	Hoed Weeded	When 50% of the fruits are yellow	Manual with the sickle
9	Sinapis alba	Yearly	20 - 25	Disk Harrow	10-12	25	2 - 3	Hoed Weeded	When the plants are yellow	Manual or with combine
10	Tagetes patula	Yearly	20 - 25	Disk Harrow Roller	4-5 Manual	50	1-1,5	Hoed Weeded	Flowers	Manual
11	Althea rosea var. nigra	Perennial	28-30	Disk Harrow	6 - 8	75	2-3	Hoed Weeded	Flowers	Manual

Appendix 7 (Cont'd)

NO	BOTANICAL NAME	PERIOD OF VEGETATION	SOIL WORK		SOWING			MAINTE-NANCE WORK	HARVEST	
			PLOUGHING DEPTH (CM)	BEFORE SOWING	QUANTITY (KG/HA)	DISTANCE (CM)	DEPTH (CM)		PART OF THE PLANT	MANNER OF HARVESTING
o	1	2	3	4	5	6	7	8	9	10
12	Cynara scolymus	Perennial	28 - 30	Disk Harrow	4 - 5	75	3 - 5	Hood Weeded	Leaves	Manual
13	Foeniculum vulgare	Perennial	28 - 30	Disk Harrow	8 - 10	75	2 - 3	Hoed Weeded	When the fruits are yellowbrown	Manual or with combine
14	Lavandula angustifolia	Perennial	28 - 30	Disk Harrow	Nurseling 1,5-1,7	100x50 with 1 plant	-	Hoed Weeded	Flowers with 10 - 12 cm stem	Manual with the sickle
15	Melissa officinalis	Perennial	28 - 30	Disk Harrow Roller	Nurseling 0,7	50x20 with 2 plants	0,5-1	Hoed Weeded	Herbs in bloom	Manual with the sickle
16	Plantago laceolata	Perennial	20 - 25	Disk Harrow Roller	5 - 6	50	0,5-4	Hood Weeded	Leaves	Manual with the sickle
17	Salvia officinalis	Perennial	20 - 30	Disk Harrow	6 - 8	75	3 - 4	Hood Weeded	Leaves	Manual
18	Saponaria officinalis	Perennial	28 - 30	Disk Harrow	8 - 10	50	2 - 3	Hoed Harrow	Roots in the 2nd year	Manual with the spade

Appendix 7 (Cont'd)

NO	BOTANICAL NAME	PERIOD OF VEGETATION	SOIL WORK		SOWING			MAINTENANCE WORK	HARVEST	
			PLOUGHING DEPTH (CM)	BEFORE SOWING	QUANTITY (KG/HA)	DISTANCE (CM)	DEPTH (CM)		PART OF THE PLANT	MANNER OF HARVESTING
0	1	2	3	4	5	6	7	8	9	10
19	Thymus vulgaris	Perennial	28 - 30	Disk Harrow	Nurseling 0,4	50 x 20 with 2-3 plants	-	Hoed Weeded	Herbs in bloom	Manual with the sickle
20	Carum carvi	Two years	28 - 30	Disk Harrow Roller	4 - 6	50	1,5-2	Hoed Weeded	When 35-40% of fruits are yellow	Manual with the sickle
21	Digitalis lanata	Two years	28 - 30	Disk Harrow Roller	3 - 4	50	1-1,5	Hoed Weeded	Leaves	Manual with the knife
22	Salvia sclarea	Two years	28 - 30	Disk Harrow	6 - 8	75	2 - 3	Hoed Weeded	Flowers	Manual with the sickle
23	Mentha piperita	Yearly	28 - 30	Disk Harrow	1200 Roots	75	5 - 10	Hoed Weeded	Herbs in bloom	Manual with the sickle

Appendix 7 (Cont'd)

NO	BOTANICAL NAME	PERIOD OF VEGETATION	SOIL WORK		SOWING			MAINTENANCE WORK	HARVEST	
			PLOUGHING DEPTH (CM)	BEFORE SOWING	QUANTITY (KG/HA)	DISTANCE (CM)	DEPTH (CM)		PART OF THE PLANT	MANNER OF HARVESTING
•	1	2	3	4	5	6	7	8	9	10
24	Mentha crispa	Yearly	28 - 30	Disk Harrow	1200 Roots	75	8 - 10	Hoed Weeded	Herbs in bloom	Manual with the sickle
25	Achillea millefolium	Perennial	28 - 30	Disk Harrow Roller	5 - 6	50	0,0-0,3	Hoed Weeded	Herbs in bloom	Manual with the sickle
26	Maforana hortensis	Yearly	20 - 25	Disk Harrow	Nurseling 0,3	40x20 with 2 plants	0,0-0,3	Hoed Weeded	Herbs in bloom	Manual with the sickle
27	Nigella sativa	Yearly	20 - 25	Disk Harrow	8 - 10	50	2 - 3	Hoed Weeded	Seeds	Manual
28	Nigella damascena	Yearly	20 - 25	Disk Harrow	8 - 10	50	2 - 3	Hoed Weeded	Seeds	Manual
29	Dracocephalum moldavica	Yearly	20 - 25	Disk Harrow	6 - 8	50	2 - 3	Hoed Weeded	Herbs in bloom	Manual with the sickle

Appendix 7 (Cont'd)

NO	BOTANICAL NAME	PERIOD OF VEGETATION	SOIL WORK		SOWING			MAINTE-NANCE WORK	HARVEST	
			PLOUGHING DEPTH (CM)	BEFORE SOWING	QUANTITY (KG/HA)	DISTANCE (CM)	DEPATH (CM)		PART OF THE PLANT	MANNER OF HARVESTING
o	1	2	3	4	5	6	7	8	9	10
30	Malva glabra	Yearly	20 - 25	Disk Harrow	10 - 12	50	2 - 3	Hoed Weeded	Flowers	Manual
31	Silybum marianum	Yearly	20 - 25	Disk Harrow	10 - 12	50	3 - 4	Hoed Weeded	Seeds	Manual or with combine
32	Sotureja hortensis	Yearly	20 - 25	Disk Harrow	10 - 12	50	1 - 2	Hoed Weeded	Herbs in bloom	Manual with the sickle
33	Hyssopus officinalis	Perennial	25 - 30	Disk Harrow	Nurseling 0.5	50x20	0,0-0,3	Hoed Weeded	Herbs in bloom	Manual with the sickle
34	Papaver bracteatum	Perennial	28 - 30	Disk Harrow	Nurseling 0,2	50x25	0,0-0,3	Hoed weeded	Capsules	Manual
35	Glaucium flavum	Perennial	28 - 30	Disk Harrow	Nurseling 0.5	50x25	0,0-0,3	Hoed Weeded	Herbs in bloom	Manual with the sickle

Appendix 8

THE MOST IMPORTANT MEDICINAL AND AROMATIC SPECIES RECOMMENDED FOR CULTIVATION IN TANZANIA

NO	BOTANICAL NAME	PART OF PLANT USED	SOURCE FOR:
1	Althea rosea var. nigra	flowers	mucilages
2	Anethum graveolens	seeds herb	carvone
3	Calendula officinalis	flowers	flavonoside
4	Cynara scolymus	leaves	cynarine, poliphenoles
	or		
5	Silybum marianum	seeds	silymarin
6	Digitalis lanata	leaves	lanatoside
7	Foeniculum vulgare		
	or		
8	Pimpinella anisum	fruits	anethol
9	Hyoscyamus niger		
	or		
10	Hyoscyamus [illegible]	leaves	hyoscyamine
11	Matricaria chamomilla		
	or		
12	Achillea millefolium	flowers	chamazulene
13	Mentha piperita	herb	menthol
14	Salvia officinalis	twigs	tannin, thuion
15	Saponaria officinalis	roots	saponoside
16	Thymus vulgaris	herbs	thymol

Appendix 3

CULTIVATED PLANT SPECIES USED FOR
PHARMACEUTICAL EXTRACTS

NO	BOTANICAL NAME (FAMILY)	PART OF PLANT USED	CONTENT	MOD OF PREPARATION	THERAPEUTICAL EFFECTS
1	Matricaria chamomilla (Compositae)	Flowers	Essential oil =0,3% chamazulen	tincture extract infusion	antiphlogistic spasmolitic antispasmodic antiseptic
2	Digitalis lanata (Scrofulariaceae)	Leaves	Cardiotonic Glicosides	tincture	diuretic cardiotonic
3	Foeniculum vulgare (Umbelliferae)	Fruits	Essential oil=1-6% Anetol= 50-60%	tincture	carminative lactogog antispastic
4	Hyocyamus niger (solanaceae)	Leaves	Hyocamin Scopolamin Atrpin	tincture	hipnotic antispasmodic
5	Mentha piperita (Labiatae)	Leaves Herbs	Essential oil=1-1,25% Mentol=50%	tincture infusion	tonic-eupeptic analgesic carminative antispastic antidiaretic
6	Salvia officinalis (Labiatae)	Leaves	Essential oil=1.4% Tuion=50% Salven Pinen	tincture extract infusion	carminative antiseptic antispastic
7	Saponaria officinalis (Caryophyllaceae)	Roots	Saponins	tincture	expectorant
8	Thymus Vulgaris (Labiatae)	Herbs	Essential oil=0,9-2,5% Timol=20-40%	extract	diaforeic diuretic anthelmintic antiseptic

Appendix 10

LIST OF SOME MEDICINAL TEAS

NO	BOTANICAL NAME	THERAPENTICAL EFFECT	MODE OF PREPARATION
1	Calendula officinalis	gastrites, eczemes, burns, cicatrizant	IN: 2 teaspoons flowers for 200 ml EX: 6 - 8 spoons flowers for 1 Ltr.
2	Matricaria chamomilla	antiseptic, cicatrizant, amigdalites, enterocolites	IN: 1-2 teaspoons flowers for 200 ml EX: 3 spoons flower for 200 ml
3	Pimpinella anisum	carminative, anticolics	IN: children: 6 - 8 fruits for 100 ml adults: 1/2 tsp for 100 ml
4	Althea rosea var. nigra	antibronshitics	IN: 1 tsp. flowers for 200 ml
5	Foeniculum vulgare	carminative, anticolics	IN: children: 5 - 7 fruits for 100 ml adults: 1/2 tsp fruits for 100 ml
6	Plantago lanceolata	pectoral, antihemoragic, hipertension	IN: 1 spoon leaves for 200 ml EX: 2 spoons leaves for 200 ml (gargle)
7	Salvia officinalis	anticudorific, sedativ	IN: 2 tsps leaves for 200 ml
8	Thymus vulgaris	antihelmintic, antiastmatic, antispastic, antirheumatic	IN: 2 teaspoons leaves for 200 ml EX: 8 - 12 spoons leaves for 200 ml
9	Mentha piperita	antidiaretic, antivomitiv, antirheumatic	IN: 1 teaspoon leaves for 200 ml EX: Friction with 5 ml essential oil in 100 ml alcohol
10	Cynara scolymus	aterosclerose, diskinezies, uremie	IN: 1 tsp to 1 spoon leaves for 1 ltr before breakfast, lunch etc. At the end of 3 weeks period. After 3 weeks treatment 1-2 weeks break.

IN: used internally
EX: used externally
Every tea must beprepared in the indicated quantity of hot water

IMPORTANT OBSERVATION IN THE VEGETATION PERIOD

1. For each species the following observations must be done during the vegetation period:

- Date of sowing
- Date of spring
- Date of flowering
- Date of harvesting
- Yield per ha in ka:
  - fresh
  - dry

2. The weight of the samples for analysis must be of the following [fresh]weight:

- for seeds, fruits, capsules	:	150 - 200 grams
- for flowers	:	350 - 400 grams
- for leaves	:	300 - 350 grams
- for herbs	:	400 - 500 grams
- for roots	:	200 - 250 grams

NOTE: the samples must be dried in shade

3. The part of the plant used, the period and the manner of harvesting are indicated in Appendix 7.

4. All the samples must be put in paper or cloth bags and sent to the Traditional Medicine Research Unit - Dar-es-Salaam for analysis.

Appendix 12

LIST OF PERSONS MET BY THE UNIDO-EXPERT

1. Mr. Saad Henein SIDFA
2. Mr. Erling Skjonsberg J.P.O.
3. Mr. Daniel Magawa - Forest Project Officer, Kibaha
4. Mr. Edwin S.N. Shunda - Forestry Research Activities - Kibaha
5. Mr. E. Msibua - Director of the Kibaha Education Centre
6. Mr. A.G. Ualaghe - Forest Research Officer - Lushoto
7. Mr. H.P. Msanga - Forest Research Officer - Lushoto
8. Mr. R.J.C. Ndango - Principal Forestry Training Institute Olmotonyi Arusha
9. Mr. M.S.B. Minja - Instructor Forestry Training Institute Olmotonyi - Arusha
10. Mr. Daniel L. Kessy - Assistant Director, Research Institute Lyamungu - Moshi
11. Miss Rose Shija - Pharmacist - Central Medical Stores
12. Mrs C. Kilindu - Commercial Director - GAPEX
13. Mr. W.L. Nyachia - Ag. Director for Industrial Investments and Project Implementation (Ministry of Industries)
14. Mr. Dr. V.W.K. Pupi - Chemical Industries (Ministry of Industries)
15. Mr. Prof. Martin L. Kyomo - Faculty of Agriculture, Forestry and Veterinary Science - Morogoro.

Appendix 13

LIST OF RECOMMENDED REFERENCE BOOKS

1 Check lists of the Forest Trees and Shrubs of the British Empire; Nr. 5 Tanganyika Territory; by J.P.M. Brenan in collaboration with P.Y. Greenway Oxford, 1949

2. Pharmacognosy by G.E. Trease and W. Ch. Evans 10th Edition; Abudeen, 1973.

3. Flora of Tropical East Africa Editors: E. Milne-Redhead and R.M. Polhill 1960 - 1975.

4. National List of Essential Drugs by Ministry of Health Tanzania 1981

5. Technology Policies in the Pharmaceutical Sector in the U.R. of Tanzania; study prepared by the UNCTAD Secretariat in Collaboration with the MDC; 1980.

6. Report on Preliminary Survey of Medicinal Plants in Tanzania; by Chinese Research Group in Collaboration with the Government Chemical Laboratorie; Dar es Salaam, October, 1974.

7. Report of the Technical Consultation of Production of Drugs from Medicinal Plants in Developing Countries; UNIDO; Lucknow, India; 13 - 20 March 1978.

8. New Natural Products and Plant Drugs with Pharmacological, Biological or Therapeutical Activity; by H. Wagner and P. Wolff; Springer-Verlag Berlin Heidelberg New York, 1977.

9. Extracte farmaceutice vegetale; by St. Ionescu Stoian and Emil Savopol; Edit. Medical Bucuresti, 1977.

10. The Medicinal and Poisonous Plants of Southern and Eastern Africa, by J.M. Watt and M.G. Breyer - Brandwijk; Edinburgh and London, 1962.

11. Medicinal Plants of East Africa by Y.O. Kokwaro; General Printers Ltd., Nairobi, Kenya 1976.

Appendix 14

LIST OF FIELD EQUIPMENTS

NO	NAME	NO OF UNITS	PRICE US$ (APPROXIMATE)	TOTAL US$
1	KUBOTA R = 120 with accessories (plough, disc, cultivater, seeder, trailer etc) from Japan or similar from Yugoslavia, Poland etc	2	1250	2500
2	Salter spring balance M 235/ to 1 kg or similar	3	115	345
3	Salter Spring balance = to 25Kg or similar	3	85	255
4	Averi counter scale or similar	3	215	645
			TOTAL	3745
			10% TRANSPORT	375
			GRAND TOTAL	4120

Appendix 15

LIST OF SPARE PARTS FOR LANDROVER

- Year of Engine 1983
- Manufacturers - Rover Co
- Chassis No. 195347
- Engine No. 36132259 (B)

NO OF UNITS	NAME	APPROXIMATE TOTAL PRICE US$
1	Water Pump Kit RTC 3072	60
1	Crankshaft oil seal UKC 467	10
1	Clutch Master Cylinder Kit 601611	10
4	Universal Joints GUJ 117	40
4	Hub Seals GHS 202	40
2	Pinion oil seals - AEU 2515	20
1	Steering Column bearing RTC 324	10
1	Slave Cylinder Kit SG 8600	4
2	Swivel Pin Seals GHS 1003	10
1	Brake Master Cylinder kit 606415	12
1	Carburetter overhand kit 605092	50
2	Set points - GCS 125	14
8	Spacking plugs GSP 131	24
1	Set Starter brushes GSB 112	10
2	Sealed beams GLU 104	30
1	Flasher Unit GFU 124	12
3	Tie rod ends GSJ 137	75
3	Tie rod ends GSJ 153	75
2	Out put oil seals ERC 1780	16
2	Fan belts GFB 124	10
	TOTAL	542
	10% TRANSPORT	55
	GRAND TOTAL	597