



TOGETHER
for a sustainable future

OCCASION

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



TOGETHER
for a sustainable future

DISCLAIMER

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

FAIR USE POLICY

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

CONTACT

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

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

21176

Distr.
RESTRICTED

ISED/R.42
4 July 1995

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ORIGINAL: ENGLISH

**TECHNICAL ASSISTANCE MISSION FOR THE INDUSTRIAL UTILIZATION
OF MEDICINAL AND AROMATIC PLANTS IN BOLIVIA**

BOLIVIA

Technical report: Findings and recommendations*

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

*Based on the work of H. A. Dadoun,
UNIDO consultant*

Backstopping Officers: T. De Silva, ISED/CHEM
A. Sabater de Sabates, ISED/AGRO

* This document has not been edited.

V.95 55789

CONTENTS

Report of the Consultancy assistance mission

Chapter 1.	Introduction	01
Chapter 2.	Present country situation	02
	2.1. Features of the industry	02
	2.2. The Bolivian situation in context	03
	2.2a. Available data on medicinal plants	03
	2.2b. Public and Private institutions leading with medicinal and aromatic plants	04
	2.2c. The Bolivian medicinal and aromatic plants industry	06
Chapter 3.	Identification of medicinal and aromatic plants for agrotechnology and industrial processing	08
Chapter 4.	Product nature and development	12
	4.1 Agrotechnology features	12
	4.2 Process technology features	12
Chapter 5.	Market potential for processed products	14
	5.1 The present situation	14
	5.2 Market trends for the selected products	15
	5.2a Black pepper	15
	5.2b Ginger	16
	5.2c Vetiver	18
	5.2d Capsicums/chilies/Paprika	19
	5.2e Turmeric	21
	5.2f Ipecac	22
	5.2g Aromatic and culinary herbs: mint; sage; oregano	22
Chapter 6.	Optimal cultivation methods for the selected plants	25
Chapter 7.	Pre-feasibility study for an industrial medicinal herbs processing plant	27
	7.1 The nature of the task	27
	7.2 Industrial plant processing unit	30
	7.3 Pilot plant unit for medicinal plant processing	32
	7.4 Processing equipments of culinary herbs	33
	7.4a Technical operations	33
	7.4b List and prices of equipments	34
	7.5 Total investments	35

7.5a	Medicinal herbs processing plant	35
7.5b	Post-harvest costs for culinary herbs	36
7.6	Market perspective	36
Chapter 8.	Conclusions and recommendations	38
 Annexes		
Annex 1	Job description	40
Annex 2	Mission programme	42
Annex 3	List of individuals and institutions consulted by the mission	46
Annex 4	The Agroquimico-Programme at the University of Cochabamba	49
Annex 5	University of La Paz-Faculty of Pharmacy: The Ethnobios S.A association	57
Annex 6	Bolivian Imports data on aromatic and medicinal plants	64
Annex 7	List of Bolivian Laboratories (Medicinal Plants)	65
Annex 8	Letter of the President of Bolivian Association of Industrial Pharmaceutical Laboratories (ALIFABOL)	66
Annex 9	Cultivation Techniques for the selected plants	68
Annex 10	Distillation/Extraction Pilot plant Diagram	93

ABSTRACT

The consultancy assistance mission headed by Mr. Henri A. Dadoun was to evaluate the potential for the industrial utilization of medicinal and aromatic plants of Bolivia. The mission completed the work as detailed in the job description. The plants to be used for this purpose were rank listed. After assessing the current state of development and research and processing in the field of medicinal and aromatic plants, the consultant recommended the institutional requirements for the development of this sector and strategy for a future industrialization of medicinal and aromatic plants in the Chapare region of Bolivia.

1. INTRODUCTION

The purpose of the consultancy assistance mission as designed in the job description (*Annex 1*) was to prepare investment-oriented proposals for the systematic cultivation and processing of medicinal and aromatic plants in the Chapare region of Bolivia.

Accordingly the terms of reference of the mission included the following:

1. Collation of available data on medicinal and aromatic plants of Chapare region of Bolivia.
2. Assessment of the potential for intensive cultivation, industrial processing and product development, including infrastructure features and the country's capability in the relevant discipline areas.
3. Preparation of a rank ordered list of plants suitable for cultivation and further processing at an industrial scale.
4. Investigation of the market potential, local as well as regional and international, for the selected plants.
5. Advising on optimal cultivation methods and industrial processing of the selected plants.
6. Elaboration of a pre-feasibility study for an industrial medicinal herbs processing plant.

The mission was briefed on technical aspects by the UNIDO Backstopping officers (Mr. Sabater de Sabatés and Mr. T. de Silva), at Headquarters in Vienna, prior to departure for Bolivia.

The field work of the mission took place during 30th March to 16th April 1995 (*Annex 2*).

The report mission had been set up in Brazil from 17th to 21th April 1995.

The mission was able to propose a rank-ordered list of medicinal and aromatic plants as well as of culinary and spices herbs. The selected plants present good market opportunities and their cultivation in the Chapare region could be initiated for a viable industry. Proposals for their processing at a pilot plant scale were made. The private sector relating to this field was contacted for future participation at an industrial level. Visits to the ongoing UNIDO project as well as to local

and international institutions willing to collaborate with the proposals of the mission, had been made in two important agro-industrial centres bordering the Chapare Region and in La Paz.

Annex 3 gives the names and addresses of the established contacts during the mission.

The mission proposed its finding and recommendations to all interested parties before departure from Bolivia.

2. PRESENT COUNTRY SITUATION

WITH RESPECT TO THE MEDICINAL AND AROMATIC PLANTS AGRO-INDUSTRY

2.1 Features of the industry

Plant based medicines and cosmetics presents a great interest for the populations of the modern industrial world as well as for the non-industrial country people. The increased demand of these natural products in the former countries during the last twenty years, provoked the continuous devastation of natural flora especially in the tropical countries. Too many plant species are rendered extinct throughout the world by such an exercise. Also from an industrial standpoint it is far more advantages to cultivate the required plant species. The cultivation will ensure good plant raw materials and will provide them on a regular basis to the industry. Moreover, it also permits to protect the soils from erosion and to offer good alternative financial resources for the people in rural areas.

The cultivation of aromatic plants and spices plays an important socio-economic role in rural areas. A large number of spice crops is characterized by low overhead costs, short duration operation due to short vegetative stages (annual crops) which implies a quick cash turnover. Additionally, spices in nature and some aromatic plants processed as essential oils have high export potential. This situation makes these plants attractive to large scale investors in various sectors of interlinked activities. To maintain export quality standard, the quality control notion should be initiated at the farm stage and prolonged through the system of warehousing and packaging. When the spices and aromatic plants are processed to obtain essential oils, oleoresins,

or total extracts, the technology processes should be well established.

The aromatic and medicinal plant producers need a strong institutional support in areas such as agro-technology, industrial equipment, techniques of processing, market facilities, information and quality assurance. These incentives should by all means be sustained, if the potential benefits of the sub-sector are to be fully exploited.

2.2 The Bolivian situation in context

2.2a) Available data on medicinal plants

In Bolivia, there is a social acceptance of herbal products. The traditional pharmacopoeia is well documented in some books written by herbal healers or by national and foreign scientists. Three more important ones are:

- "KALLAWAYA", Curanderos itinerantes de los Andes-Investigación sobre prácticas medicinales y mágicas, by LOUIS GIRAULT (1987), in collaboration with ORSTOM.
- "EL VERDE DE LA SALUD", Plantas medicinales de Valle Alto y de Cochabamba, by JAIME ZALLES ASIN y MANUEL DE LUCCA (1991), in collaboration with GTZ and WHO.
- "UTASAN UTJIR QOLLANAKA", by JAIME ZALLES ASIN y MANUEL DE LUCCA, (Uses and descriptions of medicinal plants from Highlands of Bolivia), 1993 ; in collaboration with GTZ and WHO.

Three important associations of medicinal plants users were recorded: the "Bolivian Society of Traditional Medicine" (SOBOMETRA), the "Fund for the Development of Indigenous Populations from Latin America and Caribbean regions", and the "National Council of Medicinal Plants (CONAPLAN).

2.2b) Public and Private Institutions dealing with medicinal and aromatic plants

UNIVERSITIES AND RESEARCH DEVELOPMENT CENTERS

The country possesses in the Mayor San Simón University (UMSS) at Cochabamba a facility dedicated to the development of applied research into the cultivation and processing of aromatic and insecticide plants. The "Agroquímico-Program", leaded by Ing. E. ZAMBRANA, realized several technical studies on equipment construction (2.000 liters still distillation units), on agrotechnology and distillation processes for *Mentha arvensis* (Japan mint), *Eucalyptus globulus*, *Cymbopogon citratus* (lemongrass). The consultant noted the presence of well equipped laboratories for chemical analysis and instrumental quality control. Detailed information on this programme are given in *Annex 4*.

This technico-scientific team collaborated in the past with the UNDCP/OPS project AD/BOL/88/412. This project is now under UNDCP/UNIDO responsibility (AD/BOL/93/818) but the collaboration with UMSS-Agroquímico-Program ceased since 1992. The UNDCP/UNIDO project (AD/BOL/93/818) inherits three 2.000 liters distillation still units and several aromatic crops for propagation. Unfortunately all the crops (lemongrass, mint, ...) died during the last years (1992-1994) due to several pests and diseases. Consequently, the essential oil production on behalf of the project decreased dramatically and the units are now oversized due to the lack of raw material production. Moreover the constructed distillation still units are not operating well due to some faults in the condensers and florentine flasks designs. Because of these problems the essential oil production is not significant at the present time.

New crops of Vetiver, Mint, Palmarosa, Eucalyptus had been cultivated recently (1995). The planted area is not significant for a future industrial processing with the existing stills.

In La Paz, the University Mayor de San Andres (UMSA) is well structured and possesses several departments dealing with agroindustry (Institutos de Investigaciones Industriales), ecology (Instituto de Ecología), chemistry and pharmaceutical technology (Institutos de Investigaciones Químicas y Farmaco-Bioquímicas). A group of researchers in the field of medicinal plants created

a young company (Ethnobios S.A.) with the aim to industrialize medicinal plants (*Annex 5*).

AGRONOMIC CENTERS

The country possesses also several agronomical institutions like:

- Instituto Boliviano de Tecnología Agropecuaria (IBTA), with a station at La Jota near Chimoré where operates the UNIDO project AD/ BOL/93/818.
- Centro de Investigaciones en Agronomía Tropical (CIAT) in Santa Cruz.

The IBTA is financially supported by the Bolivian government and USAID to develop the cultivation of alternative crops. It possesses nurseries of black pepper (Balamcotta, Guajarina, Bragantina and Singapur varieties), passion flower, pineapple, citrus fruits, palmarosa, etc.

The CIAT is financially supported by various donors (USAID, Great Britain ...). The main activity of this centre in Santa Cruz is to develop new crops of soya, maize, palm tree and papaya fruits.

No significant cultures of medicinal, aromatic and spice plants were detected in the Chapare. The IBTA in collaboration with USAID began the propagation of black pepper (Balamcotta variety). An area of 32ha is being cultivated and the prospects for 1995 are to reach 200ha. The extension of the cultivated area is urgent to supply in the first instance the local consumption of this spice, actually imported from Brazil and Indonesia.

We should note that the actual plantations of Passion flower (70ha), banana (2.911ha), and pineapple (2.608ha) could offer the raw materials necessary for medicinal extract production (passion flower) and aroma extracts (banana, pineapple). This alternative could be successful when the cultivated area will be increased.

FUNDACION BOLIVIA EXPORTA

The Bolivia Exports Foundation (FBE) is a private entity created in 1991. It is acting in Agro-industry development and in the promotion of investments in this sector. The general objective of the FBE is the increase and diversification of non-traditional exports. Its specific objective is to develop and expand productive companies fostering transformation and/or commercialization in the Agro-industry area.

Its financial resources are provided by the World Bank, Switzerland and the Netherlands. The FBE substitutes direct investment for financing, that is, instead of granting loans to potential investors and export-producers, it invests with the producing units when the profitability of investments is guaranteed. These investments could be done at different levels: financial association, shares purchase, associations with institutions or entrepreneurs to promote pilot projects in reference to the research, technology, productivity and market research.

During a meeting with Mr. Erick Ponce, the FBE's project coordinator, the consultant was informed that industrialization of medicinal and aromatic plants is one of the priority sectors and that FBE will be prompt to consider co-financing of a pilot project in this sector.

2.2c) The Bolivian medicinal and aromatic plants industry

Generally in Bolivia the development of plant-based industry is poor. The local production of essential oils and spices in crude form is very incipient. The analysis of export-import data for these products shows a great increase in the imports of crude spices and essential oils for perfumery from 1989 to 1993 (*Annex 6*). In 1989, the total imports reached approximately 580 tons amounting to US\$ 1,150,000.00 (FOB prices). In 1993, the increase in quantity (712 tons) and value (US\$ 2,100,000.00) seems to indicate a rapid growth of the internal consumption. The main products consumed locally in 1993, are black pepper (36 tons), cinnamon (52 tons), cumin (313 tons), diterpened essential oils (16 tons) and mixed essential oils used in perfumery (277 tons). Unfortunately the national statistics do not identify specifically the essential oils of this last item.

The exportation of crude spices and essential oils is not significant. In 1992 the total amount exported reached US\$ 10,000.00. Commercial samples of eucalyptus and mint oils were exported to Peru, Paraguay and Brazil. The exportation of these two oils did not proceed in 1993 and 1994.

In Bolivia, the medicinal plants are used in crude form or in small "tea-bags". Several shops and pharmacies sell the medicinal plants without any respect for official regulations when it exists. The medicinal plants are not cultivated and the main part required is picked-up from native flora or imported. A limited number of small companies dealing with medicinal plants exists in La Paz, Cochabamba, Santa Cruz (*Annex 7*).

The pharmaceutical production of drugs and/or plant-based drugs (chemicals and phytopharmaceutical products) has been initiated by several laboratories. They are grouped in one professional association ALIFABOL (Asociacion de Laboratorios Industriales Farmaceuticos da Bolivia).

The general manager of ALIFABOL, Dr. Luis Rivera Cortes, expressed by letter the interest of the association in developing preliminary studies on processing of medicinal plants at a pilot plant scale before industrial scale-up. The extracts obtained would be processed again to obtain standardized extracts ready for use in dosage forms. Dr. Luis Rivera Cortes emphasized the necessity to introduce better technology and quality control standards for the processing of medicinal plants. The needs for better technology and human resources training are tremendous due to the lack of skills in this area. The UNIDO contribution, in conjunction with other international institutions and Research and Development Centres at Bolivian Universities was requested by Dr. Luis Rivera Cortes (*Annex 8.*)

The recent interest of the Bolivian entrepreneurs for the medicinal and aromatic plants industry had been confirmed by the Presidents of the Industrial and Commerce Chambers in La Paz, Cochabamba and Santa Cruz. Mr. Hugo Penã, the President of Industrial Chamber of Cochabamba pointed out the necessity to create in the region an Industrial Park where the private companies

could have access to agrotechnology and industrial processing of medicinal and aromatic plants. The diversification of the agricultural productions could be a good opportunity for the coca leaves production. Therefore we should note that exists several unsolved problems in the region: no land-registry, young people addicted and difficult relation-ship between the farmers and the industrial entrepreneurs.

The Bolivian entrepreneur's representatives from the Cochabamba and Santa Cruz areas showed their interest for the development of the medicinal and aromatic plants industry in the region.

In Santa Cruz City, the first industrial one in Bolivia, the traditional agro-industry is well developed (animal breeding, milk and meat production, soja, maize...). The "Compañía Agropecuaria del Oriente" (CAO) is a very influential association of local entrepreneurs. During a meeting with Mr. Edwin Reck (manager-director) and Mr. René Salomao (executive secretary), the consultant noted a real desire to diversify the agro-industrial activities of the CAO's members. A market interest was shown for spices (black pepper), essential oils and papain, extracted from "Carica papaya", abundant in Bolivia. The UNIDO assistance was requested for preliminary studies on agro-technology, process-technology and access market for all these products.

In accordance with the above considerations the mission felt that there is a good potential for the development of medicinal and aromatic spices industry in terms of market and access to technological processes. However serious efforts should be made to introduce updated agro-technology and to attract the private sector in the Chapare region. Some recommendations in this regard are given at the end of this report.

3. IDENTIFICATION OF MEDICINAL AND AROMATIC/SPICES PLANTS FOR AGRO-TECHNOLOGY AND INDUSTRIAL PROCESSING

The selection of priority plants was based on several criteria:

- a) The plant can be obtained in abundant quantity as it is currently being cultivated or could

be cultivated in the Chapare region.

- b) The end-product after processing will have a market demand at local, regional or international levels.
- c) The end-product will have good prospects of alternative development to the coca production in the Chapare region in a relatively short term.
- d) The processing of medicinal aromatic/spices plants could be realized with relatively simple technology: maceration-percolation with aqueous or ethyl alcohol solvent; steam distillation; quality control and standardization.
- e) The institutional support offered by Universities, Research Centers or International Organizations has to be secured at all stages of the production of the end-product.

A rank ordered list of sixteen selected medicinal and aromatic plants is given:

- Plants 1-12 are ranked as priority plants for their high potential market (Priority 1).
- Plants 13-16 needs more information on agrotechnology except for Eucalyptus.

ENVIRONMENTAL IMPACT OF INTENSIVE CULTIVATION IN THE CHAPARE REGION

The Chapare region is of amazonian type. It is characterized by a high humidity level (>90%) and native plants are very diversified. The soils are characterized by a thin fertile layer (40 to 60 cm) which is often destroyed by the heavy rainfalls. The cultivation of these native plants or new introduced plants which could support such tropical conditions, will protect the soils from erosion and will permit agricultural activities in the region. A list of some aromatic and medicinal plants, most of which are of tropical origin and which can be introduced without any damage for the environment is given in Chapter 6.

In the subsequent chapters all market information and technology processes (agrotechnology, medicinal extracts and essential oil production..) are given.

**LIST OF CANDIDATE PLANT SPECIES SELECTED AS A PRIORITY LIST FOR ATTENTION OF
"BOLIVIAN ALTERNATIVE DEVELOPMENT PROGRAM" (1995)**

PLANT NAME	LOCAL NAME	PART USED	VEGETATIVE CYCLE	PROCESSED FORM	INDUSTRIAL USES	PROSPECT MARKETS 1995
PRIORITY I						
01. Piper nigrum	Pimienta	Fruit	Perennial	Crude / Essential oil	Spice/Aliment/Ecology	International, Local, Regional
02. Zingiber officinale	Genjibre	Rhizome	Annual	Crude / Essential oil	Spice/Aliment	International, Local, Regional
03. Vetiver zyzanoides	Vetiver	Roots	Bi-annual	Essential oil	Ecology/Perfum.	International, Local, Regional
04. Capsicum annum	Chillie, Paprika	Fruit	Annual	Whole dried form/Extract / Ground capsicum	Spice/Coloring agent/ Alimentation	Intern , Local, Moderate market
05. Curcuma longa	Turmeric		Annual	Olearesin / Extract	Coloring agent/ Antiinflammatory drug	International, Regional
06. Cephaelis ipecacuanha	Ipeca	Roots	Annual	Total extract	Pharmacy: Antibacterian Anticough products	Intern., Local, Moderate market
07. Passiflora incarnata	Maracuyá	Aerial parts	Perennial	Total extract / syrup	Pharmacy: Sedative	Local Market - Steady
08. Citrus aurantium	Naranja	Peel	Annual	Aqueous extract/syrup	Pharmacy: Veinous regul.	Local Market - Steady
09. Crystallized fruits: citric, grapes, banana, pineapple, apple, mangoes, papayas	Fruits	Annual	Annual	Dried fruits-crystallized	Pastries, sweeteries	Local & Regional markets to prospect
10. Aromatic and Culinary Herbs						
10a. Mint	Mentha	Leaves	Annual	fresh and dry herb	Culinary. Food aroma	Firm
10b. Oregano	Oregano	Leaves	Annual	fresh and dry herb	Culinary. Food aroma	Firm

10c. Sage	Salvia	Leaves	Annual	fresh and dry herb	Culinary. Food aroma	Firm
10d. Basil	Albahaca	Leaves	Annual	fresh and dry herb	Culinary. Food aroma	Steady
11. Mentha arvensis, M. piperita	Mentha	Leaves	Annual	essential oil, Menthol	Pharmacy. Food industry	Firm
12. Matricaria camomilla	Manzanilla	Flowers	Annual	dietetic tea; essential oil	Pharmacy	Firm
PRIORITY 2						
13. Eucalyptus globulus	Eucalipto	Leaves	Annual	essential oil; Eucalyptol	Pharmacy	Steady
14. Peumus boldus	Boldo	Leaves	Annual	medicinal extract; Dietetics	Pharmacy	Steady
15. Plantago major	Lantilanti	Seeds	Annual	medicinal extract	Pharmacy	Steady
16. Pogostemon patchouli	Patchouli	Leaves	Annual	essential oil	Perfume industry	Firm

NOTES: Priority 1:

- *Plants to be cultivated in good conditions in the Chapare Region.
- *Simple technology processes since the adapted equipment should be imported or manufactured locally.
- *Good prospects markets for the next three years.
- *Good revenues for agricultors and private companies interested to manufacture or commercialize the end-products
- *Agrotechnology, technology processes, quality control and packaging should be reasonably implanted within two to three years.

Priority 2:

- *No sufficient information on Agrotechnology excepted for Eucalyptus and Patchouli.
- *No sufficient market informations.

4 PRODUCT NATURE AND DEVELOPMENT

4.1 Agrotechnology features

The agrotechnologies for Pepper, Ginger, Vetiver, Capsicum, Passion flower, Citrus, Mint and Eucalyptus are now available at IBTA-La Jota, CIAT-Santa Cruz and UNDCP/UNIDO projects in the Chapare region. Preliminary agronomic trials should be made by a qualified tropical agronomist before the extension of the cultivation for commercial purposes. The F A O projects in Bolivia could be solicited for their participation to these activities.

The introduction of new crops in the region needs the export of propagation material. The consultant informed that the Germplasm Center of the Brazilian Ministry of Agriculture (EMBRAPA-CENARGEN) would be able to furnish seeds or vegetative parts of many amazonian crops.

Annex 10 gives detailed information concerning agrotechnology for the selected plants on cultivation techniques and processing of: *Piper nigrum*; *Zingiber officinale*; *Vetiver zyzanoides*; *Capsicum annum*; *Curcuma longa*; *Mentha piperita*; *Oreganum vulgare*; *Salvia officinalis*; *Ocimum basilicum* ; *Mentha arvensis* ; *Cymbopogon winterianus*; *C. citratus*; *Pogostemon patchouli*; *Matricaria chamomilla*; *Plantago ovata* and *Eucalyptus globulus*.

4.2 Process Technology features

As mentioned above, the plant-based industry is not well developed in Bolivia. The private sector showed willingness to participate in the production of (remedies, essential oils, spices, etc.) processed products from natural resources. Public institutions like Universities or Research and Development Centers do not act intensively in this sector. Therefore the consultant would like to mention the remarkable work of "Agroquimico Project" at the Cochabamba's University, where some trials in crops propagation and essential oils distillation are developed since 1985.

The country, at the present time, is not in a condition to develop rapidly an industry in this field, and cannot gain an immediate access to the external markets. In first instance, and with the aim to help the private sector to participate at these activities (agroproduction, processing and marketing) it should be necessary to initiate trials at the pilot plant scale.

Small areas (2ha each) of selected medicinal and aromatic plants should be cultivated and monitored for their content in medicinal and aromatic components. This small agroproduction will be processed in a multipurpose pilot plant unit with a capacity charge which could vary from 50 to 100 kg of crude material. These trials at pilot-scale level could permit to follow the vegetative development of the crops and to determine the technical parameters for the production of extracts or essential oils.

The detailed engineering drawings of a multipurpose pilot plant unit had been published by UNIDO (Ref IPCT/143 Spec.) and could be fabricated locally. This unit permits to obtain medicinal extracts (aqueous or hydroalcoholic) or essential oils by steam distillation. The realization of these trials is necessary before scale-up at an industrial level.

The facilities presented at the Cochabamba's University - Agroquimico Programme, in terms of processing and quality control, could be reinforced by the installation of a modern pilot plant unit, and complementary equipments (gas chromatography, high pressure liquid chromatography, ancillary equipments for physical determinations on essential oils and spices).

The acquisition of equipments for pharmaceutical formulations (percolators, fillers, etc.) should be planned in connection with the private sector and the commodities installed at the Faculty of Pharmacy of La Paz (UMSA) or at a project site in the Chapare region.

As an indication, the following native medicinal plants could be analyzed for their content in active principles and extraction trials initiated at a bench scale. This preliminary evaluation is necessary before initiating pilot scale extraction.

1. *Cephaelis ipecacuanha* -roots (ipeca)
2. *Passiflora incarnata* -aerial parts (maracujá)
3. *Citrus aurantium* -peel (naranja)
4. *Peumus boldus* -leaves (boldo)
5. *Matricaria chamomilla* -leaves and flowers (manzanilla)
6. *Eucalyptus globulus* -leaves (eucalipto)
7. *Plantago ovata* -seeds (lanti-lanti)
8. *Cynara scolymus* -leaves (alcachofra)
9. *Taraxacum officinale* -whole plant (leche-leche, dente de leão)

5. MARKET POTENTIAL FOR PROCESSED PRODUCTS

5.1 The present situation

As mentioned above the local demand for crude spices and essential oils used in perfumery is growing. On the other hand there is a little demand for processed medicinal plants. This fact is principally due to the small production of plant-based pharmaceutical forms such as syrups, pills, etc. There is no doubt that if local pharmaceutical companies will begin such a production, the tendency will be reversed.

This situation is aggravated by the lack of sufficient medicinal and aromatic plants cultivation. The sum of these adverse conditions (lack of crops production, absence of appropriate technology and free-imports of crude spices and essential oils) limits considerably the development of these products. The local production of spices, essential oils and medicinal plants extracts is at its beginning and the introduction of these "national products" in the local or regional market will be time consuming.

5.2 Market trends for the selected plants

Annex 9 contains a rank ordered list of aromatic and medicinal plants. At this time, the plants listed as priority 1 show good market prospects. Unfortunately these prospects may change when the Bolivian private sector will be able to produce commercial quantities of these products. There is a big gap between the actual situation of the market and the projected entrance of these products into the local or regional markets. This observation fully justifies the implementation of pilot plant scale activities before upscaling at an industrial level. The actual market prospects for the selected plants (1994 evaluation) are given below:

5.2a) Black Pepper (*Piper nigrum*)

Brazil, Indonesia and Malaysia with India are the major producers and exporters of black and white pepper. These countries are responsible for about 85% of the world production, evaluated in 1994 at about 170,000 tons. United States and European Union countries import together an average of 92,000 tons (1993 statistics)

Pepper consumption is increasing approximately at the rate of 3% annually, depending of the country. World trade in whole pepper is continuously increasing with a special demand of imports to Middle East countries. The medium prices (1993) varies from US\$/ton 2,200.00 to 2,500.00 (spot-prices London). During the first six months of 1994 these prices reached US\$/ton 3,500.00. This increase is principally due to speculative operations done at the Singapore market. Generally, pepper prices fluctuate substantially, largely because of variations in supply in major producing countries.

The easy access to international markets is conditioned by compliance to good quality standards. Classification of grades of pepper are normally based on the quality standards of the American Spice Trade Association (ASTA). The major trading centres for pepper are New York, Rotterdam, Hamburg and Singapore. Many end-users in developed countries prefer to establish direct contacts with suppliers in countries of origin, to avoid speculative operations done by brokers in

some places like Singapore and recently Kuala Lumpur

The International Pepper Community (IPC) had been constituted in 1972 to promote, coordinate and harmonize activities of the pepper industry. The community members are Brazil, Indonesia, India, Sri Lanka and Malaysia

BOLIVIAN CASE

There is no commercial production of crude black pepper. Therefore a rapid growth in the production could be reached if the existing planted areas will be expanded to a significant level. The local consumption is estimated at about 37 tons per year. The yields of crude pepper by planted hectare vary considerably depending on the soils and nutrition conditions, on the crop variety and plantation age. Generally in producing countries and during the first three years, yields of fresh black pepper vary from 10,000 kg/ha to 4,000 kg/ha. These yields vary from 3,500 kg/ha/year to 1,400 kg/ha/year for dried black pepper. In normal conditions an average of 2,000 kg/year of dried pepper can be reached. This will imply a cultivation of about 20 hectares to supply the local demand in Bolivia.

With respect to the local and external markets, there is room for new producers to supply 2,500 to 3,500 tons of dried black pepper per year. Middle East Countries and Latin America region markets could be explored.

5.2b) Ginger (*Zingiber officinalis*)

Ginger rhizomes are marketed in several forms: fresh, preserved, dried and processed ginger (essential oil, oleoresin).

The main producers of fresh ginger are Thailand, Taiwan, China and Brazil. Some countries in Latin America (Costa Rica, Nicaragua, Jamaica) supply relatively low amounts of fresh ginger.

The market of preserved ginger is limited to Asian region (2,000 - 3,000 tons). Thailand, Taiwan and China are the main suppliers of preserved ginger.

Dried ginger is marketed in the United States and United Kingdom. Other relevant markets are European Union, Canada, Japan and Middle East Countries. Average annual imports of dry ginger amount to some 25,000 - 30,000 tons.

The access to markets is conditioned by the respect to international standards (ASTA, ISO 1003-1980E) and prices. Depending on the physical state of ginger (dry, preserved, fresh, processed) the market prospects vary. Fresh and preserved ginger markets are increasing moderately in the world, dry ginger market is growing in European Union and United States.

A recent development noted in the trade of ginger has been the increasing use of oils and oleoresin, powdered and processed ginger especially in Europe and United States.

BOLIVIAN CASE:

Ginger is growing naturally in Bolivia. Therefore there is no commercial production, neither any technical information on the local product. The national imports are very low (less than 30 kg imported in 1993).

Initially, the production of fresh ginger should be started on a small scale. Assessment should be made of the agronomic growing conditions, variety and analysis of the fibre content, before undertaking the production of the fresh and dry ginger. Oil content and chemical characteristics of the oil, should be evaluated at a pilot plant level before any decision concerning the oil-production.

5.2c) Vetiver (*Vetiveria zizanioides*)

Vetiveria zizanioides has been valued for two reasons: firstly, its essential oil finds its main application in the higher-priced range of perfumes, skin-lotions, soap and other cosmetic products; secondly, its roots has been used as a very effective vegetative hedge in several countries (Philippines, Sri Lanka, Madagascar, China and Nigeria). Vetiver Programs to control soil erosion and to improve water infiltration had been implanted. Other positive characteristics of vetiver grass should be mentioned: it is used in medicine and has a repellent effect against insects; it is fire resistant and makes excellent mulch, thatch and brooms.

Haiti, Indonesia, China, Brazil, Java and India are the main producers of essential oil. The French island of La Reunion produced in a recent past, Bourbon variety of essential oil. Its production decreased during the last five years.

Total exports are estimated to be over 400 tons per year with the United States and France as the main markets.

Vetiver oil demand is growing since 1993 and prices remains firm, due to the short supply and in some cases, no supply from key countries (Haiti, La Reunion, Java). Bourbon vetiver oil supplies from La Reunion and Madagascar are tight. As a result, the brokers say buyers have been bidding up prices from China and Java, both of which have been filling the void in the market. Chinese product was \$ 28.00 cif per kilo in January 1993. In June 1994, this same product reached \$ 42,00 per kilo, cif.

During this period, the spot price rose from 34,00 \$ to 40,00 \$cif per kilo. During the last semester of 1994, this rising tendency was confirmed for:

- Java and Japanese vetiver oil (72,00 \$ and 75,00 \$cif per kilo.)
- Bourbon vetiver oil is selling at 136,00 \$fob per kilo.
- Brazilian vetiver oil, of lower quality is selling on a forward contract basis for 66,00 \$ and 43,00 \$c.f.r. per kilo

The total imports of vetiver oil in 1994 reflected the severe shortage in the market and the drastic price increases, while there is the possibility that Haiti's return to the market may affect price down

BOLIVIAN CASE

There is no significant cultivation of vetiver in Bolivia. This plant could be introduced in several parts of the country with two main purposes -firstly, to fight against soil erosion of the slopes of the Yungas of La Paz and Chapare; -secondly to begin the introduction of Bourbon and Java varieties for essential oil production

Small areas are planted near Cochabamba and Chapare, with the Bourbon and Brazilian varieties, on the behalf of UNIDO Project AD/BOL/93/818 and of the Agroquimico-Programme developed by the University Mayor de San Simon in Cochabamba

The first results of a larger cultivation programme will appear one year after planting. The first trials on essential oil distillation should be made at a pilot plant scale. An immediate result could be obtained in a conservation soils programme

5.2d) Capsicums/Chillies (*Capsicum annum*, *C. chinense*, *C. frutescens*)

Capsicums are the dried fruits of several *Capsicums* sp. Chillies are selected for hotness (pungency), paprika for yellow color and capsicums for intermediate hotness and color.

Both the fresh and dried spices are used, for their colouring power and pungency, in cooking. The pungent types are also used medicinally in the pharmaceutical industry.

Chillies are traded on the international market in both ground and whole forms. A precise analysis of the international trade in *Capsicum* is difficult because the trade statistics of most importing countries do not distinguish between imports of chillies and paprika. Therefore 70% of

the market refers to paprika and milder forms of chillies. The main producers of paprika are Spain, Morocco, Hungary, Israel, South Africa and Brazil. There is at the present time (1994-95) an oversupply of this product in the world market causing prices to decrease.

Hotter chillies are generally of tropical origins and the traditional suppliers are India, China, Pakistan and Thailand. The main importers are European Union, Middle East Countries and the United States. In the European Union, the market for whole dried chillies is small and growth is very slow. The market for ground *Capsicum* is much larger and appears to be growing at a slightly faster rate due to the growth in demand from the food processing industry.

Trade sources estimate that worldwide demand for whole dried chillies is growing at 1.0 - 1.5% per year. Paprika powder is increasingly being used by the food industry as a natural food colorant. The costs of grinding the chillies in Europe continue to rise and therefore the majority of *Capsicum* imports are already ground. Exporters to the United States and European Union, faces strict sanitary regulations concerning whole and ground *Capsicums*.

The price of chillies depend on variety, size, colour and pungency. Prices could vary from 400.00 \$/T.M. for a large chilli with stem and poor colour, to 4,000.00 \$/T.M. for a top quality. Paprika powder prices vary from 900.00 \$/T.M. to over 4,000.00 \$/T.M. for the better quality. Chilli powder prices vary from 600.00 \$/T.M. to over 3,000.00 \$/T.M. depending on the quality.

BOLIVIAN CASE:

The Bolivian imports of *Capsicum*, as a whole, reached 1.5 tons in 1993 at a medium price of 4,300.00 \$/T.M. -FOB. These quantities are lower than in 1989 (94 tons at a medium price FOB 280 \$/T.M.). The Bolivian importers are searching for a better quality.

There is no significant cultivation programme in Bolivian. *Capsicum* cultivation could be started to produce commercial samples with selected strains. Sample sizes should be one kilogramme in weight and the most important requirements are that the chillies products are clean.

and free of microbial contaminants. Moreover, a future exporter candidate should be able to produce and supply regularly the buyers.

5.2e) Turmeric (*Curcuma longa*)

The turmeric of commerce is a spice obtained from the rhizomes of *Curcuma longa*, a perennial plant growing widely throughout Asia. It is also cultivated in some South American Countries.

Turmeric is marketed in three main physical forms: fingers, bulbs and splits. Fingers forms are regarded as the best quality and command the highest price. Before it can be traded, turmeric must first be cured by boiling and then drying. Several types of turmeric are traded internationally. Allepey turmeric is the preferred type in the United States.

The content of coloring matter (curcumin) varies from 6.5 to 3.5% by weight of fresh material. Prices are quoted with respect to the curcumin content.

The main producers of turmeric are India, Pakistan, Jamaica, China, Thailand and Peru. It is estimated that international trade in turmeric is between 15,000 to 20,000 tons annually. The spice is extensively used to give colour and flavour to meat and rice preparations (curry powder).

The main importers are Iran, Japan, United States and European Union. The increase in the popularity of curry powder and other spice blends have boosted the demand for turmeric as is the case in the United Kingdom.

Spot prices in New York for Allepey type are quoted by their content in curcumin, the colouring agent. In 1994, prices vary from 1,280.00 \$/t_m to 1,350. \$/t_m.

The prospects for increased trade in turmeric in the future appear good in view of the higher demand for curry powder. The Indian production is locally consumed. Its exports of turmeric

has declined in favour of processed and blended spices. This should provide opportunities for other countries that produce crude turmeric to make up at least part of the shortfall arising from the decrease in supplies of Indian turmeric as a single spice on the world market. Importers are seeking alternative sources of supply in order to diversify their requirements.

BOLIVIAN CASE

Bolivia exports annually 10 to 12 tons of turmeric, at a medium price of 0.85 \$/kg. This price is lower than in other countries (1.28 to 1.35 \$/kg). There is no available data concerning the quality and curcumin content of the Bolivian turmeric.

5.2f) Ipecace (Cephaelis ipecacuanha)

Ipeca is a medicinal plant used for its emetic and antiparasitary properties. It is marketed as crude roots or total extract. The world wide production is approximately 100 tons per year. Europe is the major consumer market; Germany, France and Great Britain are major importers.

The main producers are Costa Rica, Guatemala and India. The raw roots are traded at 23.00 - 25.00 \$/kg, depending on the emetic-alkaloid content. The liquid extract (alkaloid extract) is traded at 50.00 - 55.00 \$/litre.

5.2g) Aromatic and Culinary Herbs

Several aromatic and culinary herbs had been identified in the Cochabamba - Chapare Region of Bolivia.

The climatic and soils conditions encountered are acceptable for their cultivation. List of the plants with their botanical and local names is given below.

1. *Mentha piperita* (menta)

- 2 *Salvia haenkeni* (salvia)
- 3 *Oreganum vulgare* (oregano)
- 4 *Ocimum basilicum* (albahaca)
- 5 *Rosmarinus officinale* (romero)
- 6 *Lippia citriodora* (cedron)
- 7 *Cuminum cuminum* (comino)
- 8 *Apium alveoleus* (ápico)
- 9 *Mintostachys mollis* (orgo munã)

In order to obtain the highest possible revenue for farmers, the selection of herbs to be cultivated is of essential importance. The highest market prices of mint, sage, and oregano derived the consultant's selection of these herbs. It was found that agronomical trials with mint in the Cochabamba and Chapare Region were initiated in 1992. The possible exports of dried, whole or crushed herbs could be envisaged, on the condition that best quality and highest yielding varieties of these herbs are cultivated, harvested and processed accordingly to the best cultivation and processing practices.

Herbs are also widely used for their medicinal properties. The pharmaceutical industry uses large quantities of herbs in medicinal preparations.

The aromatic and culinary herbs proposed in this study (mint, sage, oregano) could be usefully cultivated in Bolivia. International prices for these herbs are relatively high, due to an increased demand from the European Union (Germany, France, United Kingdom and Netherlands). The imports of the main European countries and prices spot (New York) for the selected herbs are presented below (source: New York market area spice brokers).

DRIED HERBS	TOTAL IMPORTS EU (Q 1) 1992	SPOT-PRICE NEW-YORK (CIS - CH) (1993)	
Mint leaves	2,250 00 (France 90%)	Peppermint (whole)	2 400 00
		Peppermint (crushed)	950 00
		Spearmint (whole)	1,900 00
		Spearmint (crushed)	850 00
Sage	1,750 00	Variety	
		Albanian	2,625 00
		Dalmatian no 1	3 970 00
Turkish	1,985 00		
Oreganum	1 600 00-1 750 00	Variety	
		Greek (m)	3,085 00
		Mexican (whole leaf)	4,408 00
Turkish (m)	2,865 00-3 745 00		

The quality factors which determines the price of most herbs are

- The volatile oil content, which gives the flavour strength
- The content of extraneous matter such as stems
- The absence or tolerated amount of microbial contaminants

- The shipping costs, port and handling charges
- The trader's profit margins which could vary from 1 to 10 times the exporters' FOB prices

Others techno-economical factors play an important influence on the production costs. These costs per hectare are generally distributed as follows (basis 100 per ha)

- Land preparations: 4%
- Planting material 20%
- Fertilizers 24%
- Planting 6% (could vary depending on the labour charges)
- Irrigation 12% (when necessary)
- Weeding 24%
- Harvesting 6% (manual harvesting)
- Plant protection 2%
- Other expenses 2%

The total duration-time of the cultivation is another economical factor which could influence the total production costs. All these costs should be well established and could vary from one country to another.

We should stress that the cultivation and production techniques have a direct impact on the quality of the commercial products: type of strains, climatic conditions, weed-killing, avoiding the use of pesticides, drying-techniques, processing of the final product and storage conditions are the main factors. The final selling price of the raw or processed herb should take into account all the parameters listed above.

6 OPTIMAL CULTIVATION METHODS FOR THE SELECTED PLANTS

Detailed agronomic techniques, post harvesting practices and technological information concerning the following selected plants are presented in Annex 9.

- 1 *Piper nigrum* (black pepper)
- 2 *Zingiber officinale* (ginger)
- 3 *Capiscum* sp (chillie, paprika)
- 4 *Curcuma longa* (turmeric)
- 5 *Mentha piperita* (mint herb)
- 6 *Oreganum vulgare* (oregano)
- 7 *Salvia officinalis* (sage)
- 8 *Ocimum basilicum* (sweet basil)
- 9 *Matricaria chamomilla* (chamomile)
- 10 *Pogostemon patchouli* (patchouli)
- 11 *Cymbopogon winterianus* (citronella)
- 12 *Cymbopogon citratus* (lemongrass)
- 13 *Mentha arvensis*; *M. piperita* (mint oils)
- 14 *Vetiver zizanioides* (vetiver)

The cultivation of these aromatic and culinary herbs should be made with the help of qualified agronomists provided by local agronomical centres and by international agencies like FAO and UNIDO. The agronomical team should begin the trials at a semi-commercial scale (1 to 3 hectares).

The consultant noted during the mission that several trials at a larger scale (10 to 60 hectares) made for citronella, lemongrass and mint had been totally destroyed by several pests and diseases. This seems due to several factors such as waterlogging observed in the cultivated areas, insufficient use of pesticides and herbicides, plantation spacing too strait and insufficient weeding control.

The mission selected some medicinal plants which are native to the Cochabamba region and other ones which grow naturally in the Yungas of La Paz. The list of these medicinal plants is given with their geographical site as follows:

- 1 *Cephaelis ipecacuanha* -roots (ipeca) . Yungas of La Paz

- 2 *Passiflora incarnata* -aerial parts . (maracujá) Chapare
- 3 *Citrus aurantium* -peel (naranja) . Chapare
- 4 *Peumus boldus* -leaves (boldo) . Yungas of La Paz
- 5 *Matricaria chamomilla* -leaves and flowers (manzanilla) .Chapare
- 6 *Eucalyptus globulus* -leaves (eucalipto) .Cochabamba-Chapare
- 7 *Plantago ovata* -seeds (lanti-lanti) .Cochabamba-Valle Alto
- 8 *Cynara scolymus* -leaves (alcachofra) .Cochabamba-Valle Alto
- 9 *Taraxacum officinale* - whole plant (leche-leche; dente le leão). Chapare

The cultivation of these selected medicinal plants could be initiated on a small scale (1 to 2 ha) with the aim of obtaining sufficient quantities of grass for preliminaries trials (chemical composition, extraction process, pilot scale extraction . quality control, etc)

7 PRE-FEASIBILITY STUDY FOR AN INDUSTRIAL MEDICINAL HERBS PROCESSING PLANT

7.1 The nature of the task

The industrial processing of medicinal plants should be initiated with extreme caution, especially in countries where this activity is poorly developed. Generally, the industrial scale production of whatever product is conditioned by several parameters

- Market will command the quantity and quality of the processed products
- Technology will command quality, scale-economy and production costs
- Investments will command purchase of adapted equipments, maintenance, marketing and social expenses (salaries, taxes, etc)
- Benefits should be secured when the ratio Turn over/Investments is more than 1

The medicinal plant industrialization is a specific case where other parameters are also

concerned regular availability of the raw materials, continuous quality control operation, highly specialized human resources (pharmacist, chemist, physicians, agronomists, etc) health-care legislation

The nature of the end-product should guide the installation of an industrial medicinal plants processing unit. Several type of end-products could be considered

- a) Raw material (whole or part of plant) used in the natural form (tea-bag) or exported as natural raw materials (medicinal plants)
- b) Processed products the methodology of processing depends on the ultimate use of the medicinal plant and will vary from the simple process of pulverization of dried raw material to the more complex process of isolation of pure substances leading to involved chemical modifications

Processing of medicinal plants results in the production of hot aqueous medicinal extracts (infusions, decoctions), organic solvents extracts (total extracts, tinctures), purified extracts in dosage forms, and finally chemically pure active compounds. Each of these processed products can be manufactured as tea-bags, syrups, pills, capsules, suppositories, etc., generally named pharmaceutical forms

The processes used to obtain these end-products are briefly resumed as follows

- 1 Manual or mechanical harvesting for wild and/or cultivated flora
- 2 Transportation of the raw material to the processing unit. It is important that the gathered material is assembled in one or more areas where the post harvest preparation or treatment can be carried out under controlled conditions: sorting of extraneous matters, washing, drying, storage in good ambiantal conditions, packing in bales, cloth sacks, paper bags or in boxes
- 3 Obtention of medicinal extracts by hot or cold extraction or percolation of the plant raw material with either water, alcohol or organic solvents, followed by removal of the

extracting agent (stripping of the solvent)

- 4 Purification of the extracts by precipitation, crystallization or by use of separation techniques such as column chromatography, preparative HPLC, countercurrent extraction, etc
- 5 Standardization of the extract in terms of the content of active constituents, routine quality control of extracts by use of sophisticated analytical techniques (thin layer chromatography, gas and high performance liquid chromatography, spectroscopic methods, etc) Analyzes have to be conducted by a well accepted laboratory in order to be reliable and acceptable to the industry
- 6 Obtention of pure products and/or selected group of active constituents by modern separation techniques and sophisticated process purifications

The effective implantation of an industrial processing unit should take into account one or several of the parameters listed above, when specific conditions exist in a determined country. The most important parameter concerns the previous industrial cultivation of selected medicinal plants. In the case of Bolivia, we should note that the immediate installation of an industrial plant will be of anti-economical value for the following reasons:

- 1 There is no industrial or semi-commercial medicinal plant cultivation
- 2 The existing native medicinal flora had not been evaluated in an economical manner. There is no economical-mapping of the medicinal flora as it could be done by the qualitative and quantitative identification of the natural resources of a determined geographical area
- 3 The interest of the bolivian private sector is very recent and its participation in this activity would be very slow
- 4 The medicinal plants and phytopharmaceutical markets (local or international) needs more detailed studies. These studies should cover the public and private Health care systems, to evaluate their acceptance of these natural products, the quantities needed and the economic return of industrial productions
- 5 The total investments for such an industry could vary from 500,000.00 US\$ to

2,000,000 00 US\$ for a small medium size unit, excluding the investments needed for the manufacture of pharmaceutical forms

These limiting factors could be diminished by initiating pilot plant scale activities for a limited number of products

7.2 Industrial Plant Processing Unit (1^{ton}/day)

As mentioned in § 7.1, one could list several stages for medicinal plants processing:

- a) Collection of plant material.
- b) Drying.
- c) Crushing.
- d) Solvent extraction by percolation (battery of percolators)
- e) Storage of extracts
- f) Stripping of the extractive solvent under vacuum and re-use of the solvent.
- g) Filtration of the solid extract
- h) Drying of the solid extract.

A list of equipments needed for all these operations is given below. The capacity of the equipments are adapted to process one Ton per day of raw material. The estimated price of the unit is about 200,000US\$

MODEL UNIT FOR THE PREPARATION OF PLANT EXTRACTS

EQUIPMENTS	CAPACITY	NUMBER REQUIRE- D	ESTIMATED PRICES (excluding freight) US\$/unit
WEIGHING BALANCE	20-200 KG	01	6,000.00 (6,000.00)
HAMMER MILL, with sieving arrangements	100 kg	01	12,000.00 (12,000.00)
PERCOLATOR, stainless steel (AISI 304)	1,500 l	05	2,000.00 (10,000.00)
CIRCULATION PUMP, stainless steel proof explosion	500 l	08	3,500.00 (27,000.00)
STORAGE TANK, stainless steel	3,000 l	01	12,000.00 (12,000.00)
CONCENTRATOR, stainless steel jacketed with agitator	500 l	02	24,000.00 (48,000.00)
SHELL and TUBE heat exchanger stainless steel, area exchanger 2m ²	250 l	02	13,000.00 (26,000.00)
RECEIVER, stainless steel	100 l	01	4,000.00 (4,000.00)
FILTERS, DRYER		02	no available quotation
BOILER, 10 bar pressure	300 kg	01	36,000.00 (36,000.00)
VACUUM PUMP, water-ring type 0.06 bar	80 kg	02	6,000.00 (12,000.00)

CHILLED-WATER circulation unit	20 L	01	4,000.00 (4,000.00)
DIESEL GENERATOR.	75KVA	01	12,000.00 (12,000.00)

This model do not include laboratory analytical equipments. A well equipped analytical laboratory should be constituted containing the following equipments. (Prices in US \$)

- Spectrophotometer UV, Visible with monitor (20,000)
- High liquid performance chromatography (35,000)
- Thin layer chromatography equipment (15,000)
- pH meter (4,000)
- Centrifuge, laboratory model (2,000)
- Vacuum pump oil multistages (2,000)
- Microscope, trilocular (11,000)

The main activities of this laboratory concerns the quality assessment of the obtained extracts

7.3 Pilot Plant Unit for Medicinal Plant Processing

Several aromatic, spices, culinary herbs and medicinal bolivian plants had been selected during the course of the mission.

As a general rule, any industrial process should be preceded by pilot plant trials. The pilot plant capacity represents 10% of an industrial plant capacity (100^{kg}/_{hr} of raw material). Due to the diversity in component nature of the selected plants (essential oils for aromatic and spices herbs, medicinal extracts for medicinal plants), the pilot plant to be chosen, should present versatility in its functions.

A such multipurpose pilot plant unit could be constructed locally or purchased from specialized firms, at relatively low costs. Prices vary from 100,000 to 180,000 US\$

depending on size capacity (50 to 100 Kg raw material plant by charge) The operations that may be carried out with the plant either in successive steps or simultaneously are

- Steam distillation and separation of essential oils.
- Percolation in a solvent at ambient temperature.
- Hot solvent extraction by the Soxhlet method.
- Extraction by repeated leaching with hot or cold solvent
- Filtration of the micella.
- Vacuum concentration of the miscella.
- Rectified solvent distillation and recovery.

The loading capacity of the extraction vessel is 50 to 100Kg per charge, depending on the apparent density of the raw material to be processed. The plant may be scaled up or down by a factor between 0.5 and 2.0 by generally enlarging or reducing the vessels prorata. Some restrictions concerning the size-variation of the evaporators and condensers equipment, do not permits their upscaling. The complete description of distillation / extraction unit and construction requirements is fully detailed in a UNIX document published in 1991 under Ref IPCT 143 (Spec). This technical document could be used for the implantation of the pilot plant in Bolivia (see *Annex 10*, Extraction plant diagram).

7.4 Processing Equipments for Culinary Herbs

7.4 a) Technical Operations

- Cultivation of culinary herbs is very similar to truck farming. The first operation is the harvesting which is done by special equipments (harvesters). Harvesters are chosen with a cutting device and should be adapted to the morphology of the plants. Size of the field and quantity of the crop to harvest should guide in the choice of the harvester type.

- Leaves are the botanical part of culinary herbs which are generally commercialized. They are generally harvested with the stems. The stems are parts which are not desired.

excepted in few cases (sage), by the buyers. The separation of the stems from leaves is generally done before or after the drying operations by the use of air-blowing or mechanical threshing.

- The drying operation determines the quality of the final product in terms of visual aspect, colour, flavour and bacteriological content. Drying techniques should be chosen depending on the quality requested for the final product and its selling price.

- The last operation to be done is packing, in conformity with international regulations.

7.4b) List and prices of equipments

We present as follows the main equipments needed for the realization of these operations

Equipments	Capacity	Area cultivated	Prices (US\$)
Farm tools/Trucks			
Harvesters			
-Powered mowers	---	1Ha	2,000.00
-Powered bin-mowers	2.5m ³	2Ha to 20Ha	7,000.00/20,000.00
-Powered loaders Harv	10 to 40m ³	5Ha to 50Ha	8,000.00/40,000.00
Blow Dryers with hot air	20m ³ /10'Kcalh	-----	6,000.00
Cutters with conveyor belt, rollers /mechanized	---	---	2,000.00/8,000.00
Mechanical threshing/blowing	---	---	20,000.00
Cleaner (granulometry)	---	---	2,000.00/5,000.00

7.5 Total Investments

In this study, the consultant proposes a global amount of the necessary investments for a pilot plant multipurpose unit and for post-harvesting of culinary herbs. The costs referred to the agronomical trials are not included and should be established by the bolivian local staff

7.5a) Medicinal Herbs Processing Plant

This evaluation concerns only the purchasing of the main equipments.

- <u>Building</u> : 15x10x12m (Lxlxh) ± 150m ²	25,000.00US\$
- <u>Energy-power</u> supply: 75 to 150 KVA	12,000.00-18,000.00US\$
- <u>Water supply</u> 1m ³ /hr	not quoted
- <u>Pilot Plant Costs</u>	200,000.00US\$
- <u>Analytical Laboratory</u> :	
* Quality control of essential oils and medicinal extracts	175,000.00US\$
- <u>Bench Scale Pharmaceutical Formulations</u>	
* Erweka equipments	70,000.00US\$
(steam jacketed tank for syrups, capsules fillers, semi-automatic dual syringe filler, basic drive and table press unit EKO type, autoclaves)	
- <u>Human resources Costs</u>	not quoted
(Pharmacists 03, Chemist 01, Industrial Technologist 01, Technicians 10)	
- <u>Global Evaluation</u>	488,000.00US\$

7.5 b) Post-Harvest Costs for Culinary Herbs

This evaluation concerns only the purchasing of the main equipments

EQUIPMENTS	UNIT	LOWER ESTIMATION (1ha field) COST US\$	HIGHER ESTIMATION (20ha field) COST US\$
Harvesters	01	2,000.00	20,000.00
Driver	01	6,000.00	80,000.00
Cutter	01	2,000.00	6,000.00
Air-blower	01	20,000.00	20,000.00
Cleaner	01	2,000.00	5,000.00
Packaging	01	not quoted	not quoted
TOTAL		34,000.00	59,000.00

7.6 Market Perspectives

- The market prospects for the selected essential oils bearing plants, spices and culinary herbs are described in item 5 of this report
- The selected medicinal plants market evaluation is therefore less detailed due to the lack of official information. Two of them have a known regular market: the Ipecac (*Cephaelis ipecacuanha*) and Passion flower (*Passiflora incarnata*)

The consultant recommends therefore that it is possible to begin scientific studies and pilot plant trials for the others (listed in § 4.2). All of these plants furnish phytopharmaceuticals for the pharmaceutical industry and their uses are fully recognized by modern medicine worldwide.

In the following table are shown the modern therapeutic uses of these plants with the names of the main international laboratories producing of these remedies.

SELECTED BOLIVIAN MEDICINAL PLANTS WITH RECOGNIZED THERAPEUTIC EFFECT				
BOTANICAL NAME	LOCAL NAME	THERAPEUTIC ACTIVITY	PHARMACEUTIC FORM	INTERNATIONAL LABORATORIES (PRODUCERS)
<i>Cephaelis ipecacuanha</i>	Ipeca	- antiamoeba - expectorant	- pills - syrup - injectable	- Merck-Boehringer Ingelheim (Ger) Rhône-Poulenc (Fr)
<i>Passiflora incarnata</i>	Maracuja	- sedative	- syrup	- Merck (Ger) - Sandoz (Switz) - Millet-Roux (Fr)
<i>Citrus aurantium</i>	Naranja	- venous disorders	- pills - syrup	- Knoll (Switz) - Roussel-Uclaf (Fr) - Servier (Fr)
<i>Peumus boldus</i>	Boldo	- hepatic disorders	- pills - syrup	- Abbott (UK)
<i>Matricaria chamomilla</i>	Manzanilla	- sedative - digestive	- pills - syrup	- several laboratories Ger, Fr, Switz
<i>Eucalyptus globulus</i>	Eucalpto	- respiratory disorders	- pills - inhalant	- Merck (Ger) - Pierre Fabre (Fr)

<i>Plantago ovata</i>	L'anti-lanti	- intestinal disorders	- mucilage	- Botton (Fr)
<i>Cynara scolymus</i>	Alcaachofia	- biliar dyskinesy	- pills - syrup	- Merck (Ger) - Pierre Fabre (Fr) - Millet-Roux (Fr)
<i>Taraxacum officinale</i>	Dente de leão	- antianemv	- syrup	- several laboratoires Fr. Ger

The existence of traditional botanical remedies in the bolivian Health Care System is not based on scientific and clinical trials. The introduction in the Health Care System of phytopharmaceuticals fully recognized by the modern medicine could open the local market for their use. Unfortunately several changes occurred at the Bolivian Ministry of Health during the course of this mission and it was not possible to meet the officer in charge to discuss this matter.

8. CONCLUSIONS AND RECOMMENDATIONS

The mission finds that the Industrialization of Bolivian medicinal and aromatic plants should be reached in several steps. The participation of skills available in several public and private institutions should be encouraged to reach the final objective. This could be done by the implementation of a suitable multidisciplinary project. Agrotechnology, Research and Development, Process Technology and Market development will be the main features of a such project.

Accordingly, the following recommendations are made.

- 8.1 Initiate systematic cultivation on a semi-commercial scale of the selected medicinal and aromatic plants including spices and culinary herbs. This work should be done by the farmers of the Chapare-region and strictly monitored by local agronomical institutions (IBTA at la Jota, CIAT in Santa Cruz and Agroquimico-programme in Cochabamba) and by international agencies such as FAO and UNIDO representations in Bolivia, through their existing projects.
- 8.2 Preliminary scientific work should be done by the Universities of La Paz and Cochabamba (respectively IIQ, IIFBQ and Agroquimico-Programme) with the aim of evaluating the active principles (medicinal extracts, essential oils) contained in the selected plants. Quality control techniques should be implemented in accordance with the international regulations.
- 8.3 Pilot plant processing is needed in order to develop technology for further scale up. The Agroquimico-Programme (University of Cochabamba) should be entrusted with the task of processing the selected plants; The UNIDO design of the multipurpose pilot plant could be made available for its fabrication. Purchasing from known international companies is also recommended.
- 8.4 Agronomical and pilot plant trials results should be proposed to the private sector for further industrial development. The Industrial Farmaceutical Laboratories of Bolivia (ALIFABOL), the Foundation Bolivia Exporta (F. B. E.), the Industrial and Commercial Chambers of Cochabamba and Santa Cruz could be very useful partners.
- 8.5 Commercial samples of the selected products obtained at a pilot scale, should be tested for their market possibilities. The active collaboration of Ministry of External Commerce (DICOMEX), International Trade Center (ITC - Geneva) and Foundation Bolivia Exporta (FBE) is requested.
- 8.6 The actual project UNDCP/UNIDO AD/BOL/93/818 could be the focal point for the implementation of the future project.

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

TECHNICAL ASSISTANCE MISSION TO BOLIVIA

- Post title: Industrial Technologist
- Duration: One month
- Date required: As soon as possible
- Duty station: La Paz, with internal travel to Chapare and Las Yungas
- Purpose of project: Consultancy assistance mission to prepare investment-oriented proposals for the systematic cultivation and processing of medicinal and aromatic plants in the Chapare of Bolivia.
- Duties: The expert will be specifically required to work with counterpart staff, UNIDO and UNDCP field staff, in carrying out the following duties:
1. Study previous reports of UNIDO experts and, in consultation with the counterparts, assess the potential of short-term projects on the utilization of medicinal and aromatic plants.
 2. Identify medicinal and aromatic herbs/plants which have the potential for intensive cultivation from the following sources:
 - a) Medicinal plants or herbs already identified in existing studies of the Bolivian flora. (More than 100.)
 - b) New herbs or plants which could be suitable, given the climatic conditions of the area.
 3. Investigate and estimate the possible environmental impact of intensive cultivation of the herbs/plants identified presently found in the area and of those herbs/plants from other regions which would be introduced in the area.
 4. Investigate and estimate the potential yield per hectare of the potential herbs/plants identified and, based on experience, advise on optimal cultivation methods.
 5. Elaborate a pre-feasibility study for an industrial medicinal herbs processing plant, taking into account

the following aspects: markets, technology, investment, etc.

6. Prepare a technical report containing the expert's recommendations.

Qualifications: Pharmacist/Chemical Technologist, with at least 10 years' experience in the industrial utilization of medicinal and aromatic plants and some experience in developing countries.

Languages: English, Spanish would be an asset.

MISSION PROGRAMME

- 15 March: - Commence UNIDO Consultancy Mission Analysis of previous reports on Bolivia Unido Projects available at HQ/Vienna
- 16 March: - Briefing - UNIDO HQ/Vienna
- 17 March: - Briefing concluded
- 18 March: - En route to Brazil
- 30 March: - En route to Bolivia - La Paz
- Settling in La Paz
- 31 March: am - Briefing with Mrs. Renata Ehmer, Acting Director UNIXP

- Briefing with Mr. Gonzales Roda UCD in Bolivia. Planning of activities and organization of mission programme.
- pm - Discussions with Oscar Freundenthal, UNIDO-CTA project AD/BOL/93/818. Orientation/Discussions.

- Meeting with Edgar Tapia, sub-Secretary Alternative Development-Section-Ministry of Social Affairs. Overview on the Chapare Region.

- Meeting with Felip Caceres, General secretary of Agricultor's Syndicate of the Cochabamba Region.
- 01 April: - Analysis of UNIXO project's reports available at La Paz: AD/BOL/93/818, BOL 84/405; AD/BOL/88/412.
- 02 April: - Business Plan 1995-2004 for Alternative Development in the Chapare-Region.

- 07 April all day - Continuation of visit to UNIDO project in Chapare (Chimore).
- Visit of Citral Distilleries in Senda D.
 - Visit of demonstration plots of *Eucalyptus globulus*, *E. citriodora*, *Vetiver zizanioides* and *Cymbopogon flexuosus*.
 - Discussion held with staff (D. Baker and technical Staff).
- 08 April am - Departure for Santa Cruz, by road.
- 10 April am - Meeting with Mr. Erwin Reck, Manager of the "Agropecuaria Chamber of Orient" - (CAO) in Santa Cruz.
- Meeting with Mr. René Salomão, CAO's Executive Secretary.
- 12^m - Return to La Paz
- pm - Meeting with Mr. Erick Ponce, Projects Coordinator of Bolivia Export Fundation
- 11 April am - Meeting with Dr. Sandro Calvani UNDCP. Representative in La Paz.
- Meeting with Mr. Alfredo Arana, Manager Camara Nacional de Industrias.
- pm - Discussions with Mr. Manuel de Lucca, Adviser in medicinal plants.
- Meeting with Dr. Luis Rivera Cortes, Executive Manager of the Industrial Pharmaceutical Laboratories of Bolivia (ALIFABOL).

- 12 April** **am** - Visit of the Pharmaceutical Center of the University Mayor de San Andres - La Paz.
- Meeting with Dr. Roger Carvajal Head, Control Laboratories for Tropical Diseases.
- Meeting with Dr. Gimenez Turba, Research Center Faculty of Pharmacy of La Paz.
- pm** - Meeting with Dr. Helmut Krieger, consultant GTZ-Protrade - Medicinal and Aromatic Plants Programme.
- Meeting with Dr. Roland Weihs, Adviser GTZ - programme support to the Bolivian Private Sector Confederation.
- Review meeting with Mr. Gonzales Roda, UCD in Bolivia. Presentation of the preliminary conclusions.
- 13 April:** **am** - Review meeting with Mrs. Renata Ehmer, UNDCP Acting - Director. Presentation of the preliminary conclusions.
- 16 April:** - Return to Brazil.
- 17-21 April:** - Report preparation.
- 09 May:** - Departure to Vienna.
- 09 May:** - Arrival to Vienna.
- 10-11 May:** - Debriefing and review of reports.

LIST OF PERSONALITIES MET AND INSTITUTIONS VISITED

01. Jorge Gonzales Roda
Unido Country Director, La Paz
02. Dr. Sandro Calvani
UNDCP - Contry Director, La Paz
03. Renata Ehmer
UNDCP - Adviser, La Paz
04. Jouko Kinnuen
UNDCP - Programme Officer, La Paz
05. Flavio Mirella
UNDCP - Associate Adviser, La Paz
06. Oscar Freudenthal
C.T.A. UNDCP/UNIDO Project AD/BOL/93/818, La Paz
07. Ton A. J. M. Oomen
FAO - Representative, La Paz
08. Simeon Moutaftchieff
FAO - Programme Officer, La Paz
09. Ing. Oscar Sanjinés Aguirre
Sistema de Ventanilla Unica de Exportacion
National Director
Landaeta #380, P.O. Box 5832, La Paz
10. Rosalia Zamorano Rodriguez
Instituto Nacional de Promocion de Exportaciones (INE)
Chief Documentation
p.o. Box 10871, La Paz
11. Dr. Alfredo Arana Ruck
Camara Nacional de Industrias - General Manager
Av. Mcal. Santa Cruz 1392, p.o. Box 611, La Paz
12. Lic Hugo Peña Rodriguez
Camara Departamental de Industria - President
Av. Ballivian 0782, p.o. Box 221, Cochabamba
13. Gonzalo Mercado F.
Camara Departamental de Industria

- Adviser on Quality/Productivity
Av. Ballivian 0782, p.o. Box 221, Cochabamba
14. Dr. Edwin Reck
Compagnia Agropecuaria del Oriente (CAO) - Manager
Santa Cruz Della Sierra
 15. Lic Rene Salomão
C.A.A. - Executive Secretary, Santa Cruz della Sierra
 16. Dr. Luiz Rivera Cortes
Manager of the Association de Laboratorios Industriales Farmaceuticos
de Bolivia (ALIFABOL)
Camara Boliviana del Medicamento
Av. Mcal. Santa Cruz , p.o. Box 8747, La Paz
 17. Erick Ponce
Fundation Bolivia Export - Project Coordinator
p.o. Box 473, La Paz
 18. Dr. Dieter Schilling K.
Pharmaceutical Laboratories INTI - Manager
p.o. Box 1421, La Paz
 19. Dr. Helmut Krieger
GTZ - Protrade - Consultant
Postfach 5180, D-65726 Eschborn, Germany
 20. Roland Weihs
GTZ - Confederacion de Empresarios Privados de Bolivia
German Technical Cooperation, p.o. Box 4239, La Paz
 21. Ing. Ramiro Iriarte
Instituto Boliviano de Tecnologia Agropecuario (IBTA)
Chief Tecnical, Centro Lajota (Chapare)
 22. Ing. Gustavo Pereira C.
Centro de Investigaciones Agricola Tropical (CIAT)
Executive Director
P.O.. Box 247, Santa Cruz
 23. Ing. E. Zembrana Montan
Programma Agroquimico - Director
Universidade Mayor de San Simon, p.o. Box 992, Cochabamba
 24. Carlos Aguirre B.
Academia Nacional de Ciencias de Bolivia - President
p.o. Box 5829, La Paz

25. Dr. Roger E. Carvajal
Instituto SELADIS - Director
p.o. Box 2270, La Paz
26. Dr. Alberto Gimenez Turba
Instituto de Investigaciones Farmaco-Bioquimicos - Researcher
Universidade Mayor San Andre, p.o. Box 10430, La Paz
27. Manuel de Lucca
Agronomist / Ethnobotanist
Av. Mscal Santa Cruz 1295, La Paz
28. Dr. Benoit Turcat
Fondo para el Desarrollo de los Pueblos Indigenas
de America Latina y El Caribe, La Paz
29. Felipe Caceres Garcia
Federacion Especial de Trabajadores Campesinos del Tropico de
Cochabamba - General Secretary, Tel: 042-24560
30. Dr. Edgar Tapia
Fondo del Desarrollo Alternativo (FONADAL) - 2nd Secretary
La Paz
31. Gilberto Villaroel
Centro para el Estudio de las Relaciones Internacionales y el
Desarrollo (CERID)- Adviser
p.o. Box 11228, La Paz

DE ONUDI

NO DE FAX 391504

03:01PM ABR 07 1995

P. 01

07-04-1995 14:33

PROGRAMA AGROQUIMICO

591 42 33648

P.01

CORPORACION REGIONAL DE DESARROLLO DE COCHABAMBA
UNIVERSIDAD MAYOR DE SAN SIMON**programa
agroquímico**

CORDECO - UMSS



ONUDI	
La Paz - Bolivia	
Acción	
P. R.	
D. R. R.	
U. C. D.	
P. O.	
Fecha:	07 ABR. 1995
Archive:	

Cochabamba, 7 de abril de 1995
PAGE 0107/95Señor
Jorge González
UNDCP
Fax 391504
La Paz

ATENCION: Dr. Henri Dandoun

Estimado Dr. Dandoun:

De acuerdo a lo convenido, adjunto a la presente hago llegar a usted alguna información sobre el Programa Agroquímico.

Sin otro particular, saludo a usted atentamente,


 In. Eduardo Zambrana Montán
 DIRECTOR
rfj./
Adjunto: lo indicado (7 páginas)

37-04-1985 Universidad Mayor de San Simón, Facultad de Ciencias y Tecnología. Tel. (891 42) 3258. B2
 Fax (891 42) 3338. Telex 6363 UMSS - IV. Casillas de correo 992 y 722 Cochabamba - BOLIVIA

PROGRAMA AGROQUIMICO "CORDECO-UMSS"

ANTECEDENTES

El Programa Agroquímico (PAGQ.) es una unidad de investigación aplicada al servicio del desarrollo agroindustrial. Fue creado en diciembre de 1981 mediante un convenio suscrito entre dos de las principales instituciones de Cochabamba: la Universidad Mayor de San Simón y la Corporación Regional de Desarrollo.

OBJETIVOS

El objetivo central del PAGQ, es el de contribuir a dinamizar el desarrollo regional mediante la elaboración sistemática de proyectos para la industrialización de recursos y residuos agrícolas.

CAMPO DE ACCION

El Programa Agroquímico desarrolla actividades en el subsector de la agroindustria, en tres áreas específicamente definidas acorde con sus propósitos:

- Alimentos conservables; obtenidos por la aplicación de métodos específicos de conservación a los productos agrícolas.
- Productos naturales; que involucra procesos de extracción, separación y purificación de principios activos
- Productos químicos básicos; que comprenden transformaciones fisicoquímicas y fermentaciones industriales

ESTRUCTURA ORGANICA

En el marco de su estructura se han definido tres equipos básicos de trabajo: Ingeniería, Laboratorios y Plantas Piloto. Se han conformado, además, Equipos de Ejecución de Proyectos Específicos, encargados de realizar tareas de inversión en proyectos que han culminado etapas previas y/o de proyectos que cuentan con financiamiento externo bajo plazos y condiciones específicas.

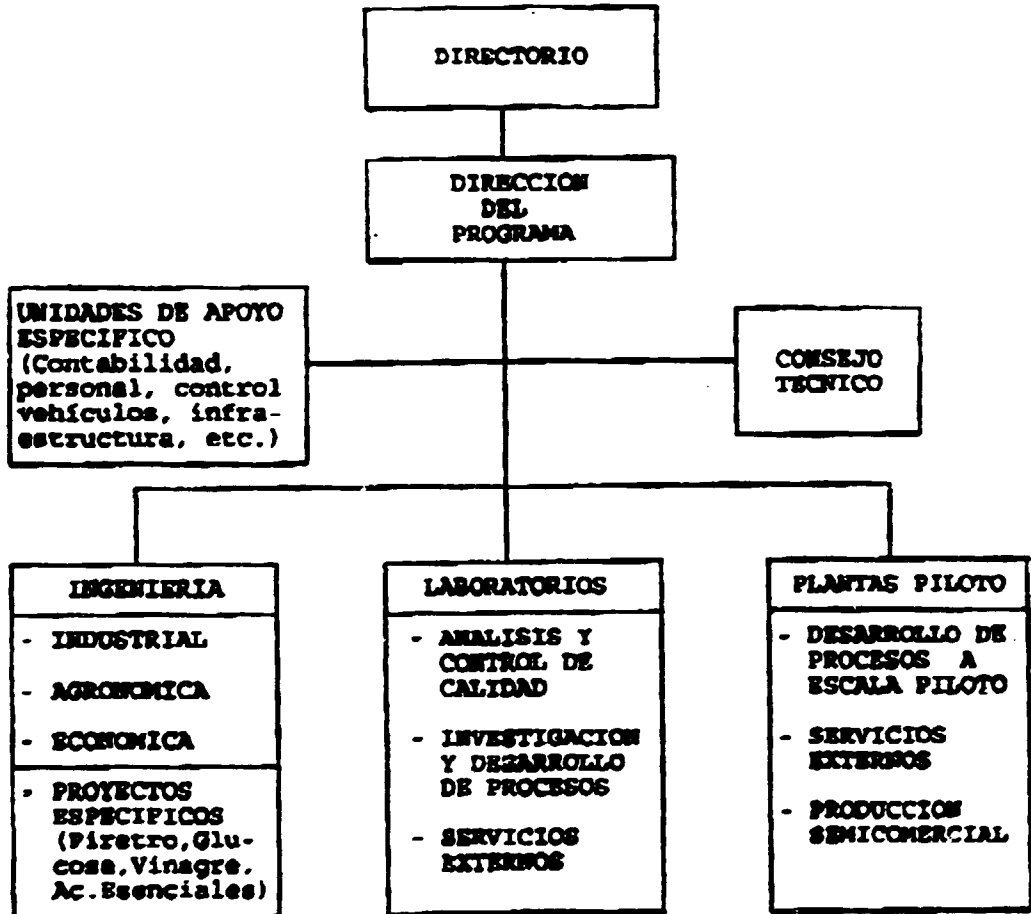
En la figura N° 1 se presenta esquemáticamente la estructura orgánica actualmente vigente.

07-04-1995 14:34

PROGRAMA AGROQUIMICO

591 42 33648

P.03

ESTRUCTURA ORGANICA

07-04-1995 14:35

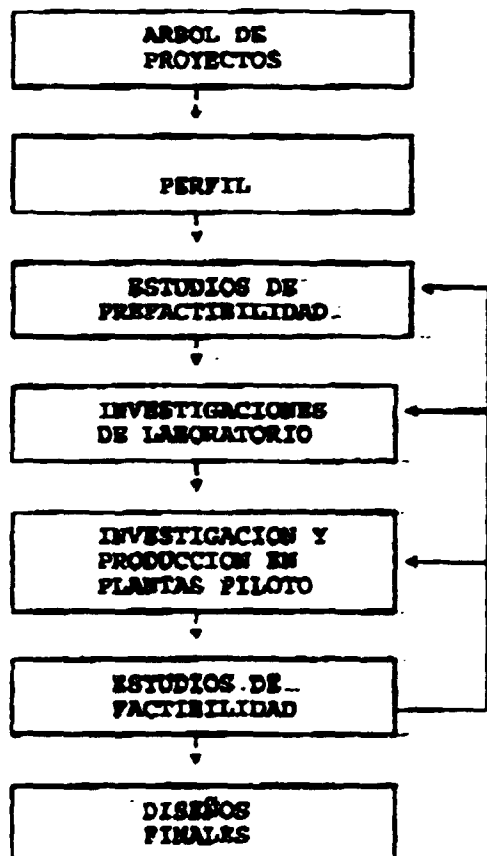
PROGRAMA AGROQUIMICO

591 42 33648

P.01

METODOLOGIA

Como metodología de acción se decidió en el PAGO evitar la elaboración convencional de proyectos por consultoría externa y la simple selección de paquetes tecnológicos; encarando, por el contrario, el reto de adaptar, desagregar y generar tecnologías adecuadas a la situación socio-económica de la región. De esta forma, la elaboración de proyectos incluye etapas de investigación en Laboratorios y de investigación y producción semi-comercial en Plantas Piloto; de las que surgen los antecedentes experimentales que permitan "certificar" los proyectos elaborados.

METODOLOGIA PARA LA ELABORACION DE PROYECTOS

INFRAESTRUCTURA Y EQUIPAMIENTO

A través de los años se ha verificado una dotación creciente de infraestructura y de equipamiento científico y logístico, particularmente destinado a las actividades de Ingeniería, Laboratorios y Plantas Piloto.

El Programa Agroquímico constituye actualmente una de las principales instituciones de su género en el país, tanto por la naturaleza de sus actividades como por la infraestructura y equipamiento con el que cuentan.

Los ambientes de trabajo y la superficie destinada a cada una de ellas se presentan en el siguiente cuadro.

INFRAESTRUCTURA.

Ambiente	Superficie
Laboratorios	501 m ²
- Analítico y de procesos	336 m ²
- Cultivo de Tejidos	165 m ²
Plantas Piloto	242 m ²
Invernadero	120 m ²
Oficinas	372 m ²
- Área de Ingeniería	252 m ²
- Administración	120 m ²
TOTAL.	1,235 m²

EQUIPAMIENTO

El Programa Agroquímico cuenta en sus tres unidades con importante equipamiento científico-tecnológico moderno, aunque aún incompleto para las crecientes necesidades de investigación.

El equipamiento básico que actualmente posee el Programa pueda apreciarse en los listados que se presentan por unidad.

EQUIPAMIENTO DE LABORATORIOS DE ANALISIS Y DE PROCESOS

- 1 Cromatógrafo de gases de doble columna, con detectores de conductividad térmica y de llama, Marca Variant, modelo 3700, con registrador marca Sargent.
- 1 Cromatógrafo de gases isotérmico, columna simple, marca Chromatron (Berlin).
- 1 Cromatógrafo radial marca "Chromatotron" con lámpara ultravioleta.
- 1 Espectrofotómetro U.V.-vis, Marca Perkin - Elmer, modelo "Lambda Z", de haz doble.
- 1 Espectrofotómetro I.R. marca Beckmann, modelo Acculab 1 de haz doble.

DE JNUDI

NO DE FAX 391504

03:04PM ABR 07 1995

P 07

27-04-1995 14:36

PROGRAMA AGROQUIMICO

591 42 33648

F.04

- 1 Espectrofotómetro visible, de haz simple, marca Sargent-Welch, modelo SM.
- 1 Espectrofotómetro visible, de haz simple, marca Carl-Zeiss Jena, modelo Spekol.
- 1 Balanza de precisión al 0,00001 g, cap. hasta 160 g. marca Sartorius, mod. R160 P.
- 1 Balanza de precisión al 0,0001 g. cap. hasta 160 g marca Carl Zeiss Jena.
- 1 Balanza de laboratorio marca TORBAL.
- 1 Balanza de laboratorio, de 3000 g, al 0.01 g marca Precisa.
- 1 Balanza de precisión digital Mettler, Cap. 3 kilogramos. Sensibilidad 0,01 gr.
- 1 Balanza analítica Sartorius R110 Cap. 120 gr. Sensibilidad 0,1 mg.
- 1 Refractómetro de Abbe, marca Carl Zeiss, Jena.
- 1 Microscopio binocular, marca Carl Zeiss Jena.
- 1 Microscopio estereoscópico marca Carl Zeiss Jena.
- 1 Microscopio monocular SWIPT, modelo M250.
- 1 Polarímetro Carl Zeiss, Jena.
- 1 pH metro digital Pracitronic MV 870.
- 1 pH metro digital Sargent mod. 9000.
- 2 pH metro digital Sargent mod. 3000.
- 1 Baño termostático MLW de laboratorio.
- 1 Estufa de secado "Mermert".
- 1 Evaporador rotativo.
- 1 Extendedor de placas para cromatografía en capa fina motorizado.
- 1 Horno de sufla marca Gerhardt
- 1 Lámpara ultravioleta de pie, marca VEB
- 1 Colector de fracciones para cromatografía en columna, para 200 tubos, marca LMIN, húngaro
- 2 Columnas de vidrio para rectificación una con bomba de vacío
- 1 Columna de vidrio para rectificación totalmente automatizada. Marca NORMSCHLIFF GERATERAU WERTHEIM industria alemana.
- 1 Centrifuga grande, para 4 tubos de hasta 1 litro cada uno marca MLW Janetzki, modelo S70D.
- 7 Registradores potenciométricos, marca SARGENT (5 de doble pluma).
- 1 Regulador de temperatura (digital) criostato
- 1 Sonificador de ultrasonido
- 1 Agitador Vortex Genie II
- 1 Cámara de Flujo Laminar marc Labconco
- 1 Esterilizador microbiológico eléctrico

EQUIPAMIENTO DE PLANTAS PILOTO

La mayor parte de los equipos de esta unidad han sido construidos con materiales localmente disponibles en base a diseños propios, adaptación y/o copia de equipos similares, de acuerdo a necesidades del medio. Características de dichos equipos se describen brevemente a continuación.

07-04-1995 14:37

PROGRAMA AGROQUIMICO

591 42 33648

P.05

- Columna de rectificación de aceites esenciales, de 6 mts. de altura, 6 pulgadas de diámetro equivalente a doce platos teóricos, rellena de anillos Rashing. Opera a presión reducida, la capacidad del calderín es de 150 lts.
- Columna de rectificación de aceites esenciales, de 3 mts. de altura rellena de anillos Rashing equivalente a 6 platos teóricos, de 3 pulgadas de diámetro. La capacidad del calderín es de 18 lts.
- Módulo de refrigeración para la cristalización de aceites esenciales, compuesto por cinco congeladores.
- Reactor catalítico de lecho fijo; equipado con dos columnas para almacenamiento temporal del reactante, rotámetro para medición de caudal de alimentación, reactor catalítico con sistema automático de calefacción (energía eléctrica), sensores y controladores de temperatura, indicador de presión; condensador, serpentín para enfriar el agua de condensación y un colector de condensados.
- Batería de columnas de extracción por solventes; consta de un tanque de 4,000 lts. para almacenamiento de solvente, bomba dosificadora para alimentación continua a la batería de cinco extractores o alternativamente un tanque elevado para alimentación por gravedad. Incluye un sistema para la recuperación de solventes mediante vapor, un condensador y un sub-enfriador.
- Sistema de concentración de extractos, compuesto por dos tanques alimentadores de extracto, un evaporador de película descendente, sistema de calefacción, sistema de vacío mediante eyector (con indicador de vacío) y sistema de bombeo de agua para condensación de solvente.
- Columna de decoloración de extractos, rellena con carbón activado granular y en polvo, y un tanque alimentador de extracto.
- Centrífuga de canasto, para la separación de sólidos en suspensión.
- Molino de martillos, para diámetros variables de molienda.
- Marmita con fuente de calor incluido de uso múltiple.
- Estufa para realizar secado de material húmedo.
- Columna de vidrio, equipada con manómetros de mercurio para realizar pruebas experimentales de caídas de presión y otras en columnas empacadas.
- Taller mecánico, equipada con soldadura arco y oxi-acetileno, y herramientas necesarias para realizar mantenimiento y reparaciones.

EQUIPAMIENTO DE INGENIERIA

- 8 Equipos de computación
- 4 Impresoras Epson
- 1 Impresora Laser
- 1 Equipo de Fax
- 1 Modem
- 1 Fotocopiadora Xerox
- 1 Escaner Logoitech

RECURSOS DISPONIBLES**RECURSOS HUMANOS**

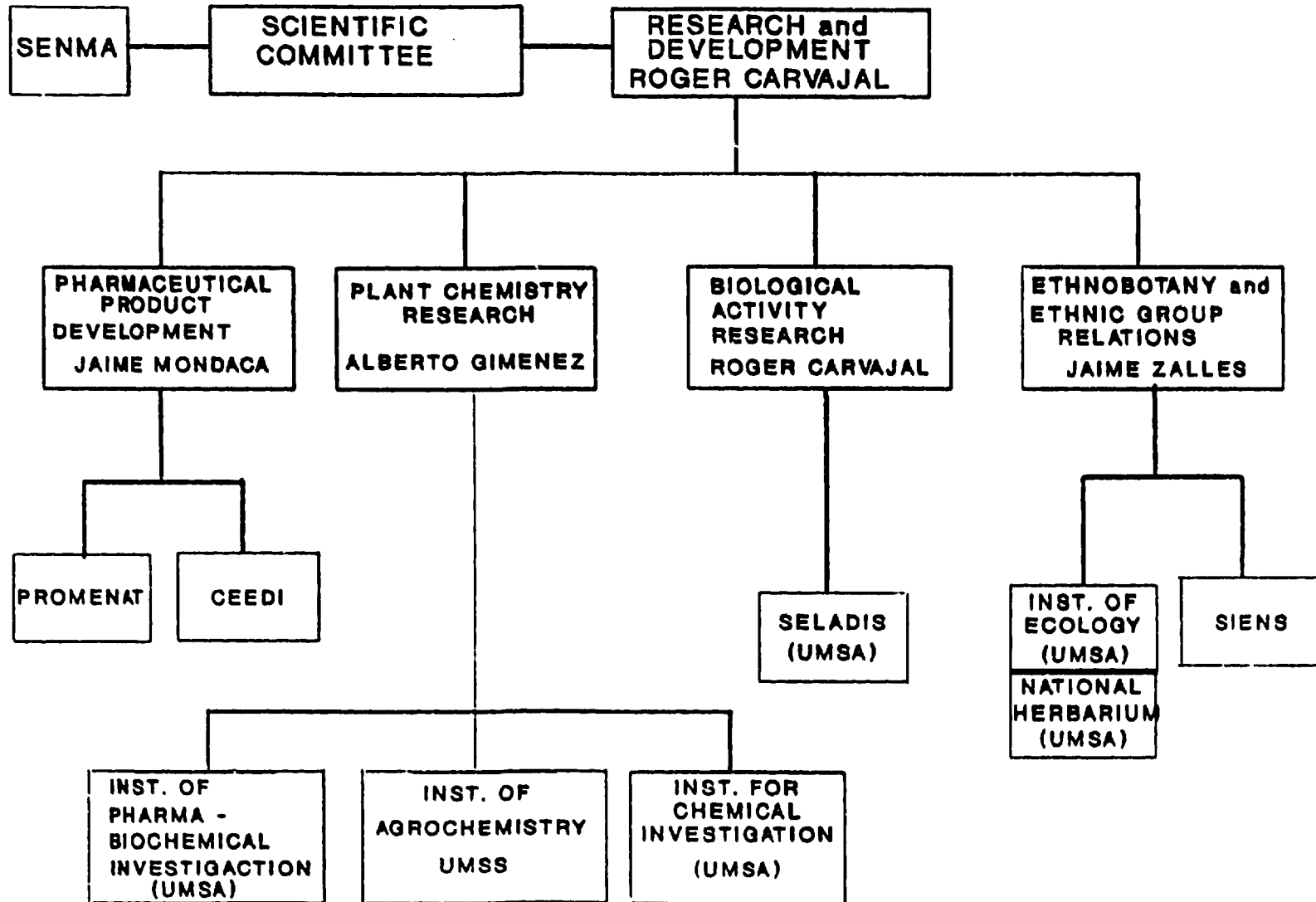
Para encarar eficientemente la realización de los diferentes proyectos, el PAGQ. cuenta con personal técnico multidisciplinario, muchos de ellos con formación de pre y post-grado en universidades y centros de investigación internacionales. Asimismo para las tareas de apoyo a la producción y administración cuenta con personal calificado y de experiencia en el campo.

PERSONAL DEL PAGQ.

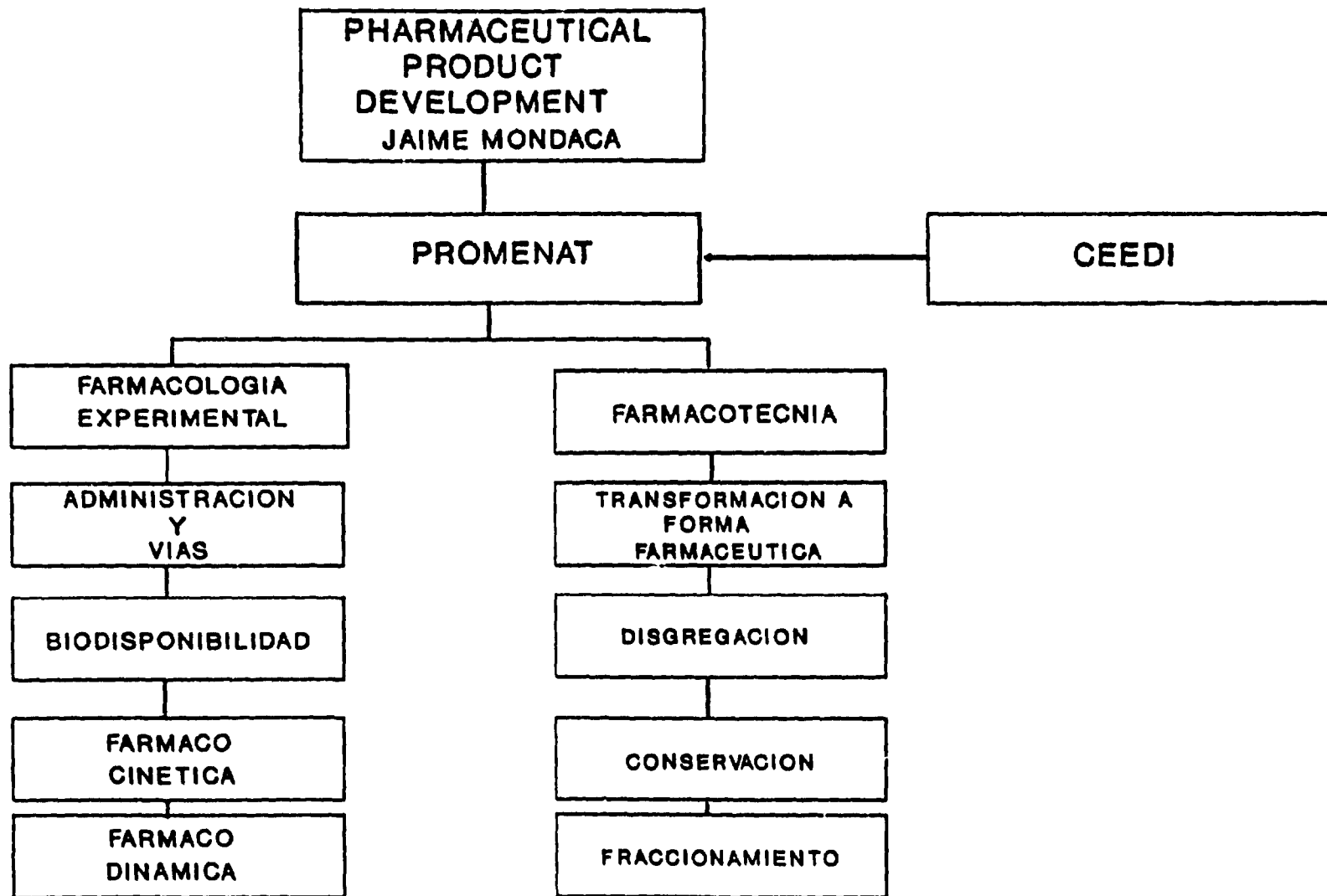
CALIFICACION	UNIDAD				TOTAL
	LAB.	ING.	P.P.	ADM.	
PERSONAL TECNICO					31
- Ing. Química		3	5		8
- Lic. Química	8				8
- Ing. Alimentos	1				1
- Ing. Industrial		3			3
- Lic. Economía		1			1
- Ing. Agronomía		6			6
- Téc. Química	2				2
- Téc. Agronomía		1			1
- Aux. Laboratorio	1				1
PERSONAL DE PRODUCCION					6
- Operarios Plantas Piloto			6		6
PERSONAL ADMINISTRATIVO Y DE APOYO					10
- Contador				1	1
- Aux. Contabilidad				1	1
- Aux. Administrativo				1	1
- Operador de computador		1			1
- Secretaria				2	2
- Chofer		1			1
- Portero-Mensajero				1	1
TOTAL PERSONAL	12	16	11	8	47
PERSONAL EVENTUAL		10			10
Trabajadores de campo		10			10
TESISTAS	3	1			6

LAB: Laboratorios; ING.: Ingeniería; P.P.: Plantas Piloto; ADM.: Administración

ETH. BIOS. SA



ETHNOBIOS, SA



RESUMEN DEL PROYECTO DE INVERSIÓN

1. Presentación:

Ethnobios S. A. es una empresa dedicada al descubrimiento y desarrollo de nuevos productos farmacéuticos derivados de plantas bolivianas con antecedentes de uso medicinal. Para esto se combinan, de manera rigurosa, disciplinas como la Etnobotánica (estudio de los usos de las plantas medicinales por las culturas nativas) con actualizadas tecnologías derivadas de la Química de productos naturales de plantas (Fitoquímica), Biología y Medicina Científica.

Con el propósito de identificar productos con potencial terapéutico de manera más rápida y menos costosa, se estudian plantas con antecedentes de uso en humanos lo que determina su efectividad y seguridad y, por tanto, su potencial económico para su incorporación en la industria farmacéutica.

Hasta hoy Ethnobios ha concentrado sus actividades en la prospección y análisis del mercado y las posibilidades de la ejecución de la investigación y obtención de componentes activos de origen natural para la exportación. Asimismo, ha iniciado y desarrollado conexiones, asociaciones y negociaciones con diversos organismos internacionales, universidades, empresas locales y extranjeras para asegurar una óptima futura ejecución de su plan de operaciones.

Para realizar lo anterior Ethnobios ha iniciado su actividad con un capital que está siendo registrado en \$us 20.000, el mismo que, dada la naturaleza de las tareas técnicas iniciales, ha sido consignado especialmente a gastos de funcionamiento entre los que se cuenta el proceso de formalización de la constitución de la empresa y los pasos legales para la obtención de la Personería Jurídica que se encuentra actualmente en trámite. El capital operacional se encuentra en proceso de financiamiento y negociación.

2. Antecedentes:

- El desarrollo económico y social de los países incluye necesariamente un proceso de crecimiento basado en las exportaciones sin afectar al ecosistema y el futuro de los recursos primarios o naturales (Desarrollo Sostenible).
- La exportación de productos derivados de los recursos naturales solo es posible si a estos se incorpora un alto valor agregado habitualmente basado en la aplicación tecnológica.
- Ante la disminución de los requerimientos mundiales para los productos de exportación tradicional (minerales y gas) y los no tradicionales de escaso valor agregado (productos agrícolas), se hace necesario generar productos exportables que adquieran competencia en el mercado mundial en base al aprovechamiento de ventajas comparativas y competitivas evidentes.
- En Bolivia son pocos los productos o rubros con estas características; tal vez los más relevantes sean los derivados de los camélidos andinos y las plantas económicas y, entre éstas, las de tipo medicamentoso, dado el conocimiento que se tiene sobre ellas (Etnomedicina) y la gran Mega-Biodiversidad (5 pisos ecológicos) con que se cuenta.
- En la actualidad existen amplios requerimientos de la industria farmacéutica mundial para generar nuevos medicamentos con mayor actividad terapéutica en antiguas y nuevas enfermedades.
- Existe una importante corriente, en las farmacéuticas y en los consumidores, que tiende a la

utilización de productos de origen natural. Un alto porcentaje de los fármacos de uso actual provienen de plantas

Existen fuertes evidencias que muestran que la conservación del ecosistema y la biodiversidad pueden ser rentables y un buen negocio para los países en desarrollo mediante la adecuada explotación-exportación de las plantas de valor económico en especial las medicamentosas

Bolivia sufre en la actualidad una fuerte presión social para la obtención de divisas por exportación que permita sustituir los ingresos por el cultivo de la coca

3. Oportunidades de Mercado

Recientes avances en técnicas de bioensayos farmacológicos y en procesos de elucidación de estructuras químicas han inducido a las compañías farmacéuticas a hacer otra vez un uso efectivo del material crudo proveniente de diferentes formas de vida natural

En la actualidad, alrededor de 200 firmas farmacéuticas e institutos científicos están empeñados en la investigación y desarrollo de productos naturales.

Otro factor que se destaca es el hecho de que últimamente la industria farmacéutica encara presiones de los gobiernos para regular el precio de las drogas de prescripción desalentando, a la vez, el desarrollo de fármacos que no tengan nuevos beneficios terapéuticos. En años recientes, alrededor del 58% de los medicamentos nuevos fueron drogas "Me too" basadas en estructuras químicas ya conocidas sin efectos terapéuticos novedosos.

Entre los elementos de regulación gubernamental, se incluye la creación de incentivos para invertir cada vez más en investigación y desarrollo (I - D). Este gasto a nivel global es en la actualidad de 20 billones de dólares anuales con importante tendencia al crecimiento.

Por otra parte, ya en 1985 se estimaba que el valor de los fármacos en el mercadomundial era de 90 billones de dólares de los cuales 43 billones provenían de las plantas medicinales, generando una fuerte dependencia, por parte del norte, de la producción-exportación del Tercer Mundo (UNCTAD-GATT).

Ethnobios está en una perfecta posición para aprovechar este mercado de I - D en fármacos de continua expansión. Es importante hacer notar que Ethnobios no pretende competir con la industria farmacéutica, sino por el contrario proveer a las compañías sus insumos esenciales: los servicios en investigación y los compuestos activos de plantas medicinales provenientes de nuestra biodiversidad. Estimamos que nuestras ventajas comparativas y otras de tipo competitivo, dadas por el acceso al conocimiento y a la materia prima (de colección o cultivo), las facilidades en investigación y los novedosos procedimientos para selección, permiten constituirnos en una fuente de oportunidades de descubrimientos de compuestos activos aislados bien dirigidos y confiables.

4. Ethnobios y sus procesos de descubrimiento:

A fin de orientar rigurosamente sus hallazgos, Ethnobios empieza sus procesos con materiales vegetales probados. Los datos sobre el uso de plantas medicamentosas generados por las culturas nativas, son recogidos a través de una red de etnobotánicos y prospectores en biodiversidad. Después de la inventariación e identificación de las plantas medicinales realizadas por expertos taxonomistas, Ethnobios aplica un sofisticado sistema de análisis. Las plantas, objeto del estudio, son confrontadas con una base de datos sobre plantas medicamentosas del resto del mundo y cuando encuentra un producto natural que es usado para similares propósitos medicinales en hasta tres culturas diferentes, inicia una extensa búsqueda de literatura en procura de medir mejor el potencial del mismo como un factor de desarrollo. Si la planta concuerda con los criterios de Ethnobios --esto es: si su objetivo terapéutico ha reportado una reversión visible de los síntomas, si los modelos preclínicos son aprovechables, y si el mercado potencial está insuficientemente atendido por los tratamientos disponibles-- Ethnobios somete la planta a su Comité Científico. Un grupo

interdisciplinario de expertos nacionales e internacionales que trabajan con la compañía, inician el trabajo priorizando las plantas y diseñando la ruta crítica de investigación de laboratorio, ampliando el estudio. Este grupo de científicos consiste de 5 consultores externos, encabezado por botánicos-economistas y biólogos y siete miembros bolivianos, entre los que se cuentan antropólogos, sociólogos, fitoquímicos, biólogos y médicos.

5. Selección de la Actividad Medicinal.

- a La ejecución de Pruebas Clínicas Preliminares (PCP) es una estrategia únicamente desarrollada por Ethnobios y se basa en la utilización previa de los productos en humanos por parte de la Medicina Tradicional Nativa durante siglos, de manera aceptada y sin efectos indeseables. En este proceso las plantas de gran prioridad son probadas en humanos en protocolos clínicos rigurosos aplicados por Médicos Científicos y Tradicionales durante un corto periodo de investigación para definir la existencia de componentes farmacológicamente activos. Este programa genera invaluable datos, los cuales pueden ser usados para dirigir amplias investigaciones en plantas promisorias.
- b El Departamento de Productos Químicos Naturales de Ethnobios es responsable de: la aplicación de tecnología avanzada para para fraccionar el material vegetal, la producción de los extractos y el aislamiento de los componentes responsables de la actividad medicamentosa.
- c El Departamento de Biología define los mecanismos de la actividad biológica, selecciona los componentes y confirma su mecanismo de acción contra el agente específico de la enfermedad.
- d Los principios activos detectados y aislados son utilizados en pruebas preliminares para confirmar su eficacia en animales experimentales (Departamento de Farmacología).
- e Los componentes aislados son sometidos a pruebas clínicas finales previa conversión del producto a forma farmacéutica.

6. Desarrollo de los Productos y su Estrategia de Mercado

Ethnobios no se encuentra en competencia con las compañías farmacéuticas, sino que provee a éstas de servicios esenciales, desarrollando tres principales direcciones de colaboración con la industria farmacéutica internacional:

1 Ejecución y Venta de Servicios:

Ethnobios ofrecerá sus investigaciones, su experiencia y sus potenciales capacidades de descubrimiento de nuevas estructuras químicas basadas en material vegetal al mercado farmacéutico internacional de Investigación y Desarrollo (I + D).

Las compañías farmacéuticas ahorrarán considerables montos de dinero y tiempo comprando estos servicios de Ethnobios antes que conduciendo sus propias investigaciones. Además, todos estos servicios pueden ser realizados según los protocolos específicos de cualquier compañía farmacéutica. Ethnobios ofrecerá estos servicios a cambio de una apropiada remuneración, pago adelantado, intercambio de conocimientos y futuras regalías garantizadas.

2 Investigación Propia

Gracias a su red de investigadores de campo y a su equipo de consultores internacionales, Ethnobios posee un valioso inventario de plantas medicinales de gran potencial para ser desarrolladas a través de un innovador método de selección.

El producto final, los componentes activos aislados con definidos mecanismos de actividad, podrán ser patentados y luego ofrecidos a compañías farmacéuticas internacionales para su venta o para suscribir acuerdos de riesgo compartido. Un "acierto" puede significar muchos millones de dólares.

3. Alianzas Estratégicas:

Mediante un análisis de mercadeo, Ethnobios identificará a las corporaciones farmacéuticas que se encuentran desarrollando productos para ciertas enfermedades que se hallan consideradas dentro de los objetivos de investigación de Ethnobios. A esas firmas se puede ofrecer la primera oportunidad de negociación, lo que significará que una vez que Ethnobios se encuentre trabajando en un área que sea del interés de estas compañías y se halle dentro de su campo de investigación, a ellas se ofrecerá la primera oportunidad de negociar un acuerdo con Ethnobios a cambio de un pago adelantado a Ethnobios por tal alianza estratégica.

4. Estrategia de "nada se pierde":

Las plantas con probada actividad terapéutica pero en las cuales no se logró este efecto con los compuestos aislados, serán sometidas a extracción total para desarrollar productos farmacéuticos herbolarios. Estos productos pueden ser ofrecidos como material crudo para la industria o desarrollados para un mercado independiente. Para esta propuesta, Ethnobios se ha asociado con PROMENAT y ALEPH empresas dedicadas a este rubro.

7. Ethnobios y el Desarrollo Sostenible:

Ethnobios está fuertemente comprometido con la conservación de los recursos botánicos de Bolivia y con el conocimiento tradicional de su pueblo. Puesto que Ethnobios trabaja sobre la base del conocimiento de las etnias indígenas, es que se consideran a estos grupos como verdaderos asociados, más allá de simples "fuentes de información". Más aún, Ethnobios reconoce que cualquier proyecto de investigación y desarrollo basado en los recursos del bosque trópico deberá ser conducido en una manera ética y ecológicamente sostenible ya sea a su modalidad de colecta simple o de cultivo. Ethnobios está convencido de que la mejor manera de conservar la riqueza de la diversidad biológica y cultural de Bolivia no es aislándola, sino haciéndola económicamente viable y, por tanto, elevando su capacidad para defenderse por sí misma de la destrucción.

8. Beneficios para Bolivia:

- a) Exportación de valiosos y renovables productos sin agotamiento de los recursos naturales
- b) Creación de empleo en diferentes rubros: científicos, técnicos, productores agrícolas, colectores, pueblos indígenas, etc.
- c) Incremento del ingreso de productores y colectores del material vegetal crudo, en una primera fase, y posteriormente a través de la transferencia tecnológica a los mismos para la elaboración de materiales con agregación tecnológica (producción de liofilizados, extractos simples, etc.).
- d) Desarrollo de la capacidad y estructura científica en el campo de la investigación de productos naturales así como de la capacitación de recursos humanos para la colecta y taxonomía etnobotánica.
- e) Activación de la industria farmacéutica nacional hacia el campo de los productos herbolarios.

9. Inversión:

La inversión buscada por Ethnobios es de 42 millones de dólares, que servirán para la construcción de una moderna estructura de investigación-producción y cuatro años de Presupuesto Operacional. Para esto, Ethnobios esta en proceso de negociación con algunos grupos de inversionistas en el rubro, a nivel institucional. Los gastos de inversión y de operaciones se muestran en un flujo de caja que acompaña anexo a este documento.

10. Riesgo:

No obstante que la industria farmacéutica es un negocio de "alto riesgo-alto retorno", la estrategia de Ethnobios consiste en procurar el máximo retorno minimizando riesgos. Esto se llevará a cabo apuntando hacia el descubrimiento de prospectos farmacéuticos y no de productos farmacéuticos. Estos últimos requieren inversiones del orden de los 200 millones de dólares en varios años aprobaciones en organismos internacionales, etc. Apuntando a la venta de: material crudo, extractos vegetales, servicios de investigación y compuestos activos, a la industria farmacéutica o desarrollando el mercado de productos herbolarios y alianzas estratégicas es definitivamente factible que lo anterior represente una oportunidad de negocios sumamente lucrativos.

**BOLIVIAN IMPORTS OF ESSENTIAL OILS,
SPICES, MEDICINAL PLANTS AND RELATED PRODUCTS**

NABANDINA CODE	PRODUCT	QUANTITY (KG.)					VALUE (US\$) FOB					
		1989	1990	1991	1992	1993	1989	1990	1991	1992	1993	1994
9.04.01.00.00	PIMIENTA (Pepper)	14,757	38,187	84,454	35,880	36,596	41,662	38,635	68,366	10,200	49,674	n.a.
9.04.02.00.00	CAPSICUM (Chillies)	93,686	62,755	861	675	1,564	26,614	19,255	2,123	1,893	6,726	n.a.
9.06.00.00.00	CANELA (Cinnamon)	149,799	117,147	285,939	-11,080	52,580	371,873	143,037	152,050	87,538	87,439	n.a.
9.09.03.00.00	COMINO (Cumin)	156,076	35,578	115,053	326,458*	313,669*	120,221	31,377	122,196	247,368	285,689	n.a.
9.10.02.00.00	LOURO (Laurel)	30,008	65	-	-	-	11,780	67	-	-	-	n.a.
33.01.01.02.00	ANIS (Ess.Oil)	-	87	5,105	-	-	24	1,616	6,818	-	-	n.a.
33.01.01.04.00	CEDRON (E.O.Lemongrass)	58	-	-	-	-	674	-	-	-	-	n.a.
33.01.01.06.00	EUCALYPTO (E.O.Eucalyptus)	-	-	501	26	-	3	-	806	793	-	n.a.
33.01.01.07.00	BERGAMOTA (E.O.Bergamot)	49	-	-	60	-	1,853	-	-	1,290	-	n.a.
33.01.01.08.00	LIMON (E.O.Lemon)	4,327	3,199	4,757	6,665	3,302	43,607	36,005	38,392	52,446	42,274	n.a.
33.01.01.99.00	OUTROS (E.O. others)	21,184	42,262	59,629	26,499	90,812	153,725	337,718	269,507	216,614	381,279	n.a.
33.01.89.00.00	OUTROS (E.O. others)	23,577	398	206,263	-	-	47,250	145,229	517,100	-	-	n.a.
33.04.00.00.00	PERFUMERY/MIXED E.O.	76,762	56,456	92,896	242,821	186,961	306,114	409,080	546,984	739,467	1,203,335	n.a.
33.06.02.00.00	MEDICINAL E.O.	9,663	-	5,047	-	-	23,964	-	21,876	-	-	n.a.
9.10.04.00.00	GINGER	-	780	-	228	26	-	681	-	677	97	n.a.
9.10.05.00.00	CURCUMA	-	306	-	-	-	-	138	-	-	-	n.a.
33.01.01.03.00	CITRUS OILS	-	-	421	432	1,381	-	-	4,469	4,784	6,122	n.a.
33.01.90.00.00	DETERPENED ESS.OILS	-	-	-	31,038	16,300	-	-	-	40,655	44,831	n.a.
GREAT TOTAL		579,946	369,220	860,926	711,867	703,191	1,149,364	1,162,838	1,750,687	1,403,725	2,107,466	-

* Seeds imports

Sources: Dirección Comercio Exterior - Instituto Nacional de Estadística (INE - La Paz)

BOLIVIAN PHARMACEUTICAL LABORATORIES
(Medicinal plants - Essential oils)

- 1 **Laboratorios INTI**
Calle Socabaya No. 242, P.O. Box 1421, La Paz
Tel. (591-2) 366171 - Fax (591-2) 391005
Manager: Dieter Schilling
Production under license of several essential drugs, essential oils

- 2 **Laboratorios ALFA**
Plaza Uyuni No. 115, P.O. Box 1588, La Paz
Tel. (591-2) 354207
Manager: Juan José Ferrer
Bag-teas with medicinal herbs

- 3 **Proyecto de Medicina Nativa (PROMENAT)**
Calle 3 No. 116, Bologna, P.O. Box 14251, La Paz
Manager: Rolando Mondaca de L.B.
Dosage-form of several remedies (traditional pharmacopeia)
Nasal solutions, aromatic and medicinal infusions, expectorant syrups, antirheumatic balsams

- 4 **Fábrica GLOBO Ltda**
Calle Mercado No. 945, P.O. Box 2231, La Paz
Tel. (591-2) 369949
Manager: Miguel Tobía
Soaps and shampoo - Essential oils-based

- 5 **Laboratorios FARCOS/IFC**
Calle Tumasla No. S-291, P.O. Box 3458, Cochabamba
Tel. (591-42) 49209 - Fax: (591-42) 49209
Manager: Orlando Prudencio Velasco
Respiratory-inhalants/eucalyptol and citral based remedies

- 6 **Laboratorios VALENCIA**
P.O. Box 3171, Quillacollo, Cochabamba
Tel. (591-42) 60265
Manager: Alejandro Valencia
Phytopharmaceutical products

- 7 **Química Industrial Santa Cruz**
Calle René Moreno No. 384, P.O. Box 3003, Santa Cruz
Manager: Freddy Fiorilo Guevara
Disinfectants, Hygiene products - Essential oils-based



ALIFABOL

ASOCIACION DE LABORATORIOS INDUSTRIALES FARMACEUTICOS DE BOLIVIA

La Paz, 12 de abril de 1.995

"ALIFABOL"

006/95

Al señor Dr.
Dn. Henri A. Dadoun
PRINCIPAL CONSULTOR TECNICO
INDUSTRIALIZACION DE PLANTAS MEDICINALES
Y AROMATICAS
ORGANIZACION DE NACIONES UNIDAS PARA EL
DESARROLO INDUSTRIAL
Presente

Distinguido doctor Dadoun:

Luego de la gentil visita que realizó usted el día de ayer a las oficinas de la Asociación de Laboratorios Industriales Farmacéuticos de Bolivia "ALIFABOL" en la que tuvimos la oportunidad de efectuar un amplio y fructífero intercambio de ideas sobre la posibilidad de iniciar un estudio que nos permita determinar el tipo de plantas medicinales y aromáticas cuyo cultivo sería de gran beneficio para la población boliviana en general y muy particularmente para la Industria Farmacéutica de nuestro país, me permito reiterar a usted mediante la presente nota, tenga la amabilidad de transmitir a la Organización de las Naciones Unidas para el Desarrollo Industrial nuestro mayor interés en que ese Organismo Mundial pueda en un futuro muy próximo encomendarle esta tarea para establecer un perfil que nos permita contar con datos sobre posible producción, mercado interno y externo de las plantas más indicadas para su cultivo y aprovechamiento técnico y científico en las distintas áreas geográficas y climatológicas de nuestra amplia geografía.



ALIFABOL

ASOCIACION DE LABORATORIOS INDUSTRIALES FARMACEUTICOS DE BOLIVIA

Consideramos que esta contribución que pudiera brindarnos, constituiría un gran paso para el desarrollo de nuestra industria y un aporte significativo para el bienestar del pueblo boliviano en general.

A la espera de sus gratas noticias y con la certeza de que nuestra solicitud será atendida favorablemente, aprovecho la oportunidad para reiterarle los sentimientos de mi consideración más distinguida.

Atentamente,

Dr. Luis Rivera Cortés
GERENTE EJECUTIVO

mjv.

c.c. Sr. Jorge Gonzalez Roda
Director en Bolivia
Organización de Naciones Unidas para
el Desarrollo Industrial

OPTIMAL CULTIVATION METHODS FOR THE SELECTED PLANTS

The detailed agronomic techniques, post harvesting practices and technological information concerning the following plants are given in this annex:

01. BLACK PEPPER
02. GINGER
03. CHILLIES/PAPRIKA
04. TURMERIC
05. MINT (Herb)
06. OREGANO (Herb)
07. SAGE (Herb)
08. BASIL(Herb)
09. CHAMOMILE
10. PATCHOULI
11. CITRONELLA
12. LEMONGRASS
13. JAPAN MINT
14. VETIVER

01. PEPPER*Piper nigrum* (Piperaceae)

(part used: fruits)

1) Soil and Climate.

Soil: well drained; good fertility; high organic matter content; pH 6-7; soils with acidic pH should be corrected

Climate: Temperature: 25° to 40°C

Altitude: less than 500m.

Humidity: over 80%. Rainfall: over 2,500 mm/year well distributed during 8 to 10 months.

The crop is supported high temperatures and heavy rainfalls

Waterlogging must be avoided

2) Cultivation

- The crop is grown up on supports (Bamboos; Trees such as Glyricidia or Erythrina.) which provide also a partial shade. Pruning is often necessary.
 - Eradication of weeds.
 - Correct drainage to avoid fungal infection by *Fusarium* sp.
- Selection of good crop: Balamcotta, Lampong which could secure good yields and resistance to soil born diseases. Essential oil and piperine contents should be monitored during growing.
- Plants should be hermaphrodite.
- Pepper is planted as rooted cuttings. Cuttings are only taken from the vertical climbing shoots (7 node terminal shoot) from plants less than two years old.
 - Plant spacing :- 2 x 2.5 m/rows each way
 - 2,000 plants/ha
- When drainage is poor, pepper should be grown on mounds spaced 2.5 x 2.5m.
- Planting at the beginning of the rainy season.
- To establish large and strong plants, plants should not be allowed to fruit in the first two years.
- Weeding: - Before planting and after crop establishment.
- Manually or by systemic-non residual herbicide (Gramoxone, Glyphosate).

3) Fertilizers.

- Organic manures and artificial fertilizers.
- When necessary apply per year, during three years.

N225 Kg/haMgO20Kg/ha

P₂O₅ 30Kg/haCaO60-100Kg/ha

K₂O200Kg/ha

Timing of applications depends on crop and rainfall patterns.

4) Harvesting.

- Two years after planting.
- Berries could be harvested 6-8 months after flowering.
- One or two harvests per year.
- Time of harvesting different for black and white pepper.
 - * Black pepper is obtained by harvesting mature green berries.
 - * White pepper is obtained by harvesting fully mature red berries.

5) Yields/Ha /year

First year: 2,000-4,000 ^{kg}/_{ha} (for a three years old plantation). High yield variety crops offer 10,000-12,000 ^{kg}/_{ha}. If plant management and nutrition is poor, yields decrease to 2,000-1,000 ^{kg}/_{ha}.

6) Pests and Diseases

"*Phytophthora palmivora*", "*Fusarium sp*" and "*Sclerotium rolfsii*". causes fungal diseases (roots rot and wilts).

Use of copper fungicides, bordeaux mixture;

Ridomil - 1,5g/l. is efficient against these diseases.

02. GINGER

Zingiber officinale (Zingiberaceae)
(part used: rhizome)

1) Soils and Climate.

- Fertile and well drained soils: pH 6-6.5; acidic pH <6, should be corrected.
- Weeding and mulching before planting (Glyphosate).
- Waterlogging should be avoided.
- Temperature - range: 25 - 32°C.
- Altitude up to 1,500 m.
- Rainfall: 1,000 to 2,000 mm. during the growing season.

2) Cultivation.

- Selection of correct cultivar. Oil content should be monitored before developing commercial plantings.
- Propagation by portions of rhizomes (setts) of 2.5 cm long.
- Select only rhizomes without any sign of fungal contamination. Contaminated rhizomes could be used after dipping for 30 minutes in a solution of 0.1% Macozeb. Drying before storage. After germination, shoots will start to appear above ground after 10-15 days and continue to appear over a 4-8 week period.
- Planting: close spacing. Setts are planted in rows 25 x 25 cm apart with spacing in the rows at 15-30 cm. Plant population: 130,000-150,000/ha.

3) Fertilizers.

- Organic mulches, manures (20-50^T/_{ha}) before planting.
- Sugar canes wastes: 120^T/_{ha}. Leaf analysis can be used to monitor crop nutrition and determine fertilizer requirements. Generally, in soils with normal fertility it should be used a mixture of
 - superfosphate: 375 ^{kg}/_{ha};

- ammonium sulphate: 300^{kg/ha};
- muriate of potash: 250^{kg/ha}.
- Another fertilizer, named "ginger mixture" can be used.
- Nitrogen complement (50^{kg/ha}) would improve the yields.
- Mulching with dried green leaves (20^{T/ha}), during planting increases the yields.

4) Weed Control.

Perennial grass weeds can affect considerably the yields. A thick surface mulch (10cm) will minimize weed problems. Weed control by:

- Mulching;
- Herbicides = Linuron (1.5^{kg/ha}); Diuron (4.5^{kg/ha}).

Weed control after crop germination: Monolinuron (1-2^{kg/ha}); Pentamethalin (1-1.5^{kg/ha}).

5) Pests and Diseases.

- *Pythium sp.*; *Fusarium sp.*; *Sclerotium rolfsii* causes roots-rot.
- Bacterial wilts and nematodes can result in significant crop losses.

6) Harvesting.

- First harvest 8-9 months after planting, at full maturity.
- Time of harvesting depends on the type of product required and should be determined by local experimentation (determinations of fiber content, essential oil content ...).

7) Yields/Ha

- The average yield of fresh green rhizomes varies between 7 and 10^{T/ha}.
- The exotic type "Rio de Janeiro" gives 36^{T/ha} of green matter (5.8^{T/ha} of dry ginger).
- The China-type yield 2.7^{T/ha} of dry ginger.

8) Processing

- Fresh ginger: harvested rhizomes are washed and then air-dried in the shade for 1-2 days, at 13-15°C and a humidity content of 65%.
- Dry ginger: fresh rhizomes are sun-dried to 6-10% residual moisture content. Rhizomes are prepared for drying as partially or clean peeled, or unpeeled. Peeling is not recommended when dry ginger is marketed for essential oil or oleoresin exportation.
- Ginger oil; oleoresin. High-added value products. Essential oil yields: 2-2.5% to 1.5-3% depending on origin and distillation process. Ginger oleoresin is obtained by organic solvent extraction.

9) Minimum Scale Operation

- For oleoresin extraction: one ton of fresh ginger per batch. 200Tons could be processed per year, to produce 15-20 tons of oleoresin.
- For essential oil production: 250 kg per batch. Distillation time 8 hours at low pressure, 5 kg of oil would be obtained per distillation.

03. CAPSICUMS/CHILLIES/PAPRIKA

Capsicum annum; C. chinense; C. frutescens (Solanaceae)

(part used: fruits)

1) Soils and Climate.

- Loam type soils are preferred with good draining. Water logging should be avoided.
- pH 6-6.5.
- Temperature range 15^o-32^oC. Temperatures over 35^oC reduce the fruit size.
- Rainfall 600-1,250 mm per year. Heavy rainfall reduces or stop fruit set.
- Altitude: up to 2,000 m in the tropics.

2) Cultivation.

- The site should be ploughed deeply and cultivated. The crop will respond to the application of organic manure which improve soil drainage. If drainage is poor, the crop

should be grown on low ridges. For large scale cultivation, rotation with cereals will prevent pest build-up and offer excellent potential for effective chemical weed control.

- Propagation by seed in nursery 1kg of seeds, sown in 100-150m² of nursery beds should provide sufficient transplant for 1ha. For crops direct drilled in the field, seed at 3-5^{kg}/ha and thin to final stand after germination. Seeds should be dressed with a fungicide prior to sowing.
- Planting: 7,000-150,000^{plants}/ha. Spacing 50-150cm between rows and 20-100cm between plants within the row.

3) Fertilizers

- Large application of manure should be made where possible.
- Application of NK fertilizers.

4) Harvesting

First harvest 3.5 and 4 months after sowing. Some cultivars take a little longer to reach maturity. The fruits are harvested when ripe and fully coloured.

5) Yields/Ha

- Yields of chillies vary considerably according to the cultivar grown, soil, climate and the inputs. Under rainfed conditions (1,000mm) a good average yield of fresh fruit is about 2.5^{Ton}/ha (0.6-0.8^{ton}/ha of dried fruit).
- Paprika cultivars are raised in an identical manner to chillies, but final plant spacings are usually greater. Yields of about 8.5^{Ton}/ha of fresh paprika (2.8^{Ton}/ha of dried paprika) are obtainable.

6) Processing

- Dried chillies: must contain less than 10% humidity after drying; drying in the sun during 3 to 15 days. Between 25-35 Kg of dried chillie is obtained from 100Kg fresh fruit. After drying, the chillies should be sorted and any discoloured and split fruits discarded. Storing in the shade, preferably in air-tight containers.

- Ground chillies: humidity should not exceed 6-7%. Overheating during grinding should be avoided. Store in air-tight containers.
- Preparation of paprika: paprika is evaluated for quality on its appearance and colour strength. The better appearance is obtained by grinding the pericarps alone, added with about 10% of dried seeds. The ground product is rehydrated to 12% moisture content prior to storage.
- Capsicums Oleoresins : obtained by percolation of dried fruits (less than 6% humidity) with an organic solvent (acetone, dichloroethylene). After stripping of the solvent the oleoresin is obtained as a dark coloured viscous oil (0.7% capsaicin content). Many variants in processing of capsicum are used to obtain several kinds of pungency and colour.

04. TURMERIC

Curcuma longa (Zingiberaceae)

(part used: rhizome)

1) Soils and Climate.

- Turmeric thrives in a hot, moist climate. A rich, well-drained loam is better. Water logging should be avoided.
- Gravelly or sandy soils unpreferred.
- Rainfall 1,000-2,000mm per year.
- Altitude: up to 1,200m.

2) Cultivation.

The choice of the cultivar to be grown is of considerable importance as this will influence yields and intrinsic quality characteristics. Four main types of turmeric are recognized in international trade:

- Madras turmeric (from India), curcumin content: 3.5%.
- Allepey turmeric (India), curcumin content: 6.5%.
- West Indian turmeric (Haiti, Peru, Jamaica), yellow-brown color.
- Chinese turmeric (China), curcumin content less than: 3%.
- Propagation: by planting the lateral rhizomes (fingers) after storing during 3 months.

- Harvesting: 9 months after planting.
- Yield/ha: - 6,700-9,000^{kg}/ha for rainfed crops.
- 1-8^{ton}/ha of dried turmeric.

3) Processing of the spice.

- Curing of rhizome by boiling in fresh water.
- Drying of the cured rhizome after cooling and draining. The dried rhizome would not contain more than 12% humidity.

05 -08. AROMATIC AND CULINARY HERBS

Mentha piperiteae (mint)

Oreganum vulgare (oregano)

Salvia officinalis (sage)

Ocimum basilicum (basil)

MINT: (*Mentha piperiteae* ; *M. spicata*)

These mints are mainly produced for their dry leaves as well as for their fresh leaves.

1) Cultivation.

Mint can be reproduced by rhizomes or by young rooted sprouts.

- The rhizomes of an old plantation are re-planted in 5cm deep furrows. The re-planting of 1ha of new culture could be done with 1.1-1.5 tons of rhizomes.
- The young rooted sprouts (10cm long) are re-planted with a density of about 92,000 plants per hectare.

2) Fertilizers.

- It is generally used composition KPN : 1/1.5/0.7 (K₂O 150 + P₂O₅ 100 + N 70).
- Irrigation should be monitored taking into account the rainfall conditions of the country.

3) Pests and Diseases.

- *Puccinia menthae* and *verticilliosis* causes brown rust.
- Several nematodes attacks the rhizomes. When the attack is large, eradication of the cultures is recommended.

4) Weeding

- Several herbicides are used before and after planting: Terbacile (800g/ha) is generally used.

5) Harvesting and Yields

- Harvesting of the herb before flowering, 4 to 8 months after planting.
- Yields of 8 T^m/ha of fresh leaves (2T^m/ha of dried leaves) is common in several producing regions (Egypt, China, Morocco, France).
- The culture can be maintained for 2 to 4 years.

OREGANO: (*Oreganum vulgare* L.)

1) Soil and Climate.

- A light and well drained soil in a sunny position is preferred for cultivation. The plant could be cultivated in warm regions and supports calcareous soils.

2) Cultivation.

- The plant is propagated by seeds. The preparation of a nursery with 30g seeds for 60m² is preferred. This provides a field density of about 80,000 plants per hectare.
- The culture can be maintained for 3 to 4 years before replacement.

3) Fertilizers.

- Ground manure followed by fertilizer NPK (150/100/100) in several applications.

4) Weeding

- After plantation: 2,900^g/ha of Tebutame.
- Before spearing (2nd year culture): 800^g/ha Terbacile.

5) Diseases and Pests

- Very resistant.

6) Harvesting and yields

- At flowering stage. 4 to 8 months after planting.
- Two cuttings per year.
- Average of 2-3^{ton}/ha of dried leaves.
- The culture can be maintained for 3 to 5 years.

SAGE: (*Salvia officinalis*)

Tree species have a commercial importance: *S. officinalis* ssp. *major* (Dalmatian sage); *S. officinalis* ssp. *lavandulifolia* (Spanish sage) and *S. officinalis* ssp. *lirilsba* (Greek sage).

1) Soil and Climate.

- *Soil:* pH from 5.0 to 7.5. Well drained soils.
- *Climate:* dry to rainy. Low sensitivity to warm climate.

2) Cultivation.

- By sowing in a nursery (900g/100m²) or directly in the field (5^{kg}/ha). This density provides an average of 50,000 plants per hectare.

3) Fertilizers.

- Mixture of NPK (100/100/100) with organic manure rich in potassium and phosphorus, before sowing.

4) Weeding

- Before spearing: 2,000^g/ha of Chloridazone.
- After spearing: 2,600^g/ha of Chloridazone.

5) Pests and Diseases.

- Resistant.
- Some diseases such as: Brown rust (*Puccinia salviae*) and Oidium (*Oidium reysiphoides*) are signalled.
- Specific pests: *Phylloides attenuata* and *Arima marginata*.

6) Harvesting and Yields

- The leaves are used as culinary herb.
- Harvesting before flowering.
- Yields of 2^T/_m of dried leaves (without stems).
- Culture can be continued for five years and the first harvest could be done 12 to 14 months after planing.

BASIL: (*Ocimum basilicum*)

1) Soil and Climate.

- Humus-rich soils; well drained loam or sandy-loam soils.
- Water logging should be avoided.
- Temperate to warm and tropical climate.

2) Cultivation.

- Annual cultures from seed. In nursery or by direct sowing in the field (4-5^{kg}/_m of seeds). Seedling are thinned or transplanted when they reach 15cm high.
- Spacing 15 x 80cm each way. Several cuttings per year.

3) Fertilizers.

- Before ploughing: P₂O₅/K₂O (100/100).
- At sowing: N (100)N
- Growing period: N (60)
- After cutting: N (60)
- High water requirements.

4) Weeding

- Before spearing: 2,900^{kg}/_{ha} Tebutame.
- After spearing: 2,900^{kg}/_{ha} Tebutame.

5) Harvesting and Yields

- First harvest before flowering: 2 months after planting.
- Two to three cuttings at 6-8 weeks intervals.
- Yields 1.5-2.0^t/_{ha} of dried leaves including stems. These yields vary with the humidity content of the fresh herb.

09. CHAMOMILE

Matricaria chamomilla (Asteraceae)

(part used: leaves and flowers)

1) Soils and Climate.

- Chamomile can grow in any type of soils.
- pH near 7; can support alkaline pH.
- Encountered as native in the Cochabamba region (Valle Alto).

2) Cultivation.

- Propagation through seeds in nursery bed. About 1kg seeds provide sufficient seedling to cover one hectare.
- Transplanting of the seedling after 6 weeks. Spacing 30 x 30cm.
- Weeding and hoeing 3-4 times a year.
- The flowers appear 6 months after sowing. The flowers are harvested at the full bloom stage. Yield of 3,500-4,000^{kg}/_{ha} of fresh flowers is reached in India, which correspond approximately at 1,000-1,500kg dried flowers per hectare.

3) Fertilizers.

- Application of farmyard manure (20-25^{tr}/ha) before plantation.
- Fertilizer NPK (80-40-20)/ha is optimum for good yields.

4) Pests and Diseases

- Very few pests and disease of this crop have been observed. In case of attack by insects. spraying of flowers by Lindane 20%.

5) Processing.

- Drying in the shade between 20-24°C.
- Storing in moist-free conditions
- The flowers are processed for use as tea bags or for essential oil extraction. Steam distillation under pressure (7^{mm}/cm²) is used. Distillation time: 4h.
- Yield of oil vary from 0.3-1.3% and is influenced by the geographical location, strain and by soil conditions.

6) Uses

- Infusion used as a mild sedative and digestive.
- Flavouring agent in pastry and beverages.
- Therapeutic uses : antispasmodic, expectorant, carminative, anthelmintic, antibacterial and fungicide activities.

10. PATCHOULI OIL

Pogostemon patchouli var. *suavis* Hook.
(used for commercial)

Obs: *Pogostemon heyneanus* is not relevant for commercial uses

1) Soils and Climate

- Wide range of soils and climatic conditions.
- Well drained soils Fertiles soils with good rainfalls.

- Temperature: 22°-28°C and humidity: 75%.
- Plants should be partially shaded.

2) Propagation.

- *Vegetatively in nursery or mist chamber.* By cutting. The cuttings constitute of developed branches with 2-3 leaves containing 4-5 nodes in length. Application of growth hormone: Seradix B₂ to the basal end of the cutting promotes early rooting. The cuttings take about 30-35 days for rooting in nursery. Aeration, partial shade and regular watering are essential for early rooting.

The nursery is attacked by nematodes. Nematicides used: Carbofuran (20^{kg/ha} at 3% active); Fensulfothion (150^{kg/ha} at 5% active).

- *Transplanting in the prepared land treated by nematicide.* The beds are irrigated before transplanting. Transplanting in the shade obtained by interculture with coconut or glyciridia. Spacing 60 x 60cm. Irrigation every day for 3-4 days. After this, alternate day irrigation each 10-15 days. When the plant begin the erection, irrigation once in every 3 days is sufficient.
- *Manures and fertilizers.* Rich soil is necessary. Low fertility compensated by N (25^{kg/ha}), P (50^{kg/ha}) and K (50^{kg/ha}) in form of urea, superphosphates and potash muriate.

3) Harvesting.

- *First:* 5 months after transplanting (foliage becomes pale green to light brownish, and characteristic odor).
- *Second:* 3 months after the 1st harvest. Good yields and quality oil are obtained during the second harvest.
- *Third:* 3 months after the 2nd harvest.
- Plantation could be maintained for 3 years.

4) Drying

- The harvested material is spread out under shade during 3-6 days.
- Avoid fermentations. Good drying develop characteristic patchouli odor note.

- The quality of the drying influences the odor note and yield of essential oil.

5) Pests and Diseases

- Root-knot and leaf blight are the two main diseases encountered in the cultivation of patchouli.
- *Meloidogyne incognita* is a nematode found in tropical regions. It causes knot formation. Knot formation is controlled by nematicide or by crop rotation with lemongrass or citronella. Nursery should be pre-treated by Carbofuran (20^{kg}/ha, 3% active ingredient) or Fensufothion (150^{kg}/ha, 5% active ingredient).
- *Cercospora sp.* is a fungus which causes leaf blight. The attack appears one year after planting; controlled by "Zineb", spraying once a month during two months.

6) Distillation - Oil content

- Steam distillation is conducted under pressure (1.4 to 3.5^{kg}/cm²).
- Distillation duration 6-8 hours. Prolonged distillation affects the odor of the oil. Yield of oil 2.5 to 3.5%. Yield of 2.5% is more common.

7) Minimum scale operation

- 500kg still charge capacity.
- Provides 15kg of oil by charge - 900kg per year.
- Dried leaf/ha = 2,000kg
- Planting requirements: 15ha.

11. CITRONELLA

Cymbopogon winterianus (Java type, better quality)

Cymbopogon nartus (Ceylon type)

1) Soils and Climate

- The plant grows under varying soil conditions, but the sandy loam soil with abundant organic matter is the most suitable.
Soils pH between 5-8. pH around 6 is better.

- It requires abundant moisture and sunshine for a good growth. Rainfall at about 200-250cm, well spread over the year is ideal. Avoid water logging soils.

2) Propagation.

- By root division at the beginning of the rainy season.
- Spacing from 0.5 to 1m each way.
- Periodic weeding is necessary during cultivation.

3) Fertilizers

- The plant is soil exhaustive.
- Application of fertilizers depends upon the fertility status of the soils.
N: 80-120Kg/ha/year - applied every 3 months (poor soil)
K(K₂O): 40Kg/ha/year - applied every 3 months
P(P₂O₅): 40Kg/ha/year - applied every 3 months

4) Harvesting

-
- Only the leaves.
- 4 harvests/year: 1st, 6 months after planting
2nd, 9 months after planting
3rd, 12 months after planting
4th, 15 months after planting
- The plantation remains productive during 4 years. Better yields in plant and oil during the 2nd and 3rd year.
- Uprooting after 3½ years.
- Rotate the cultures with legumes crops.

5) Diseases and pest

- *Curvularia andropogonis* (Zimm) is a frequent pest which causes leaf blight. The essential oil content and leaf production decreases. The disease can be controlled by spraying Mancozeb and Zinab (Dithiocarbamates) at an interval of 10-15 days during the

growing period.

- *Coliectotrichum graminicola* is a fungus which affects the crop. Control by spraying Dithiocarbamates.

6) Strains of Citronella

- RRL JOR-3-1970 (Lucknow Institute)
- 73-1 (Lucknow Institute)
- These strains upgrade the yields and quality of the oil (citronellal yield up to 66%).

7) Yields of oil

- 0.5 to 1.0% with natural strains.
- 1.3% with strain 73-1.

8) Yields/ha/year

- 50 tones of fresh leaves.
- 240kg of oil/ha (good condition).
- 100kg/oil 1st year
- 150 kg/oil, 2nd - 3rd year (normal condition).

9) Minimum scale of operation

- Smallest: 500kg single batch of leaves.
- Common: 1T to 1 $\frac{1}{2}$ ton. Distillation during 4h.
- *Scheme for small unit:* 500kg capacity:
- 2-3 distillations per day: 400 to 600 distill/year.
- Annual raw material requirements: 200-300ton of leaves.
- Average yield: 35% of leaves (content 0.7% oil estimated).
- Planting area 6 to 8.6 ha.
- Annual output of oil: 1.4 to 2.1 $\frac{1}{100}$.

LEMONGRASS

Cymbopogon citratus, *C. flexuosus*
(West India, Brazil, Guatemala, China, Madagascar)

1) Soils and Climate.

- The soil requirements in terms of fertility are not so drastic. The crop flourishes on a wide variety of soils from rich loam to poor laterite. Well drained soils are preferred; water logging must be avoided. These soil conditions influence the yield of oil and its citral content
- Lemongrass requires a warm (23^o-27^oC) and humid climate (> 60%) with good exposure to the sun.
- The crop needs 200-250cm of rainfalls, but a higher precipitation causes a decrease in the oil content and in its citral percentage. Rainfalls should be well distributed in the year.
- It grows well at altitude between 100-120m.

2) Propagation.

- *From seeds:* the seeds obtained from unharvested plants are sown in a nursery at the beginning of the rainy season and covered with a thin layer of soil. On an average one plant gives 100-200g of seeds. 10kg of seeds are sufficient to plant one hectare. After 60 days old, the seeds are transplanted in rows 45-60cm/60-70cm apart. It is better to plant on ridges in areas receiving high rainfall.
- *By root divisions:* the leaves are cut off within 15cm of the root. The latter is divided in segments and the lower brown sheath is removed to expose young roots. One or two segments are placed into each hole no deeper than 15cm. The transplanting should be done at the beginning of the rainy season.
- *Spacing:* 60cm/90cm apart. Trial with varying spacement should be done to evaluate both the grass yield and the citral content of the oil.

3) Fertilizers

- Spent lemongrass as a compost with wood ashes in the ratio 10-12 tons per hectare (provides N and K).

- P₂O₅ (30Kg) + K₂O (30Kg) + N (30Kg) per hectare.

4) Pests and Diseases

- *Chilotea* spp. is a white caterpillar which bore into the stems and remains there. It is usually found at the bottom of the stem. It acts provoking a drying up of the central leaf. Application of pesticide "oxydemon-methyl" is efficient to destroy the pest.
- *Helminthosporium cymbopogi* is another pest frequent in Guatemala. It affects the leaves (browning and curling). This appears when the grass has an insufficient water content; this is frequent during the dry season.
- *Tyloporium christenseni*, *Ustilago andropogonis finitimi* causes smuts of lemongrass.

5) Weeding

- 2-3 times a year.
- Control by application of oxyfluorfen (0.5kg), diuron (1.5kg), simazine (2kg) ratios per hectare.
- Waste obtained after distillation of the leaves is applied: 3-5^t/ha. Good effectiveness in suppressing weeds.

6) Harvesting.

- The time of harvesting affects the yield and the quality of the oil.
- 1st harvest: - 3 months after transplanting (*C. flexuosus*)
- 6 months after transplanting (*C. citratus*)
- 2nd - 3rd harvest: - 7.5-7.6 months after transplanting

7) Production.

- Yield of essential oil: 0.2-0.4%
- Grass/ha: 17 Tons. Yields of 24 - 30 Tons are obtained with Guatemala-cultivar.
- Oil/ha: 40kg (1st year), 52kg (2nd, 3rd year). Yields of oil are higher with Guatemala-cultivar (73 - 86 tons)

8) Minimum scale operation

- Smallest and economical viable: 500kg. charge capacity.
- Distillation time : 2 to 4 hours.
- Operation timing:- 3 hrs for a batch
 - 4 distillations per day
 - 1,000 distillations per year (4x250)
- Yield in essential oil: 0.3%.
- Yield/year: 500tons of grass yield .75kg/ha of essential oil.

13. MINTS OILS

Mentha arvensis (japanese mint)

Mentha piperita (peppermint)

Mentha spicata (spearmint)

Mentha citrata (bergamot)

1) Soils and Climate.

- *Japanese*: deep soil rich in humus. Avoid waterlogging. pH 6-7.5. Avoid pH >8.
Climate tropical and sub-tropical.
- *Peppermint* and *Spearmint*: the same. soil conditions ; temperate climate (18-22°C)
- *Bergamot*: temperate and tropical conditions. Better in temperate conditions.

2) Cultivation.

- *Propagation*: by stolons (underground vegetative parts). Stolons are obtained from the plantation of the previous year.
- *Plantation*: on ridges is better than in flat land (to avoid waterlogging). Irrigation is important during the dry season.
 - To plant 1ha of land 400kg of stolons are required.
 - Spacing row to row 45-60cm.
 - Irrigation immediately after planting.
 - After 3-4 weeks the stolons sprout.

3) Fertilizers.

- N: 90-120^{kg}/_{ha} obtained from organic manure.
- In deficient soils, and at the time of planting apply: N (20kg); P₂O₅ (50kg); K₂O (40kg) per ha. Application in 3 doses: 1st dose: 6-8 weeks after planting- 2nd dose: 4 weeks after the first application - 3rd: 4 weeks after the first harvest.

4) Weeding.

- Very important. Manual or by herbicides: Terbacil and Prometrin for Peppermint, 3 weedings per year before the 1st harvest.

5) Harvesting.

- 1st harvest after 110 days of planting when the lower leaves start turning yellow.
- 2nd harvest after 80 days beginning from the end of the 1st harvest.
- 3rd harvest after 80 days beginning from the end of the 2nd harvest.
- The leaves should be distilled 24h after cutting (wither).

Japanese mint should be replanted each year.

6) Crop rotation

- To avoid diseases , pests and excessive weeds , rotate with :
 - mint-maize-potato (3years)
 - mint-early paddy-potato
 - mint-late paddy-potato

7) Pests and Diseases

- *Puccinia menthae* Pers.: very frequent in temperate zones and in Japanese mints plantations. Causes mint rust. The leaves turn yellowish-lemon-colored blisters on the upper surface of the leaves (powdering substance.); Severe case when the colored blisters turn on black. Not frequent in tropical zones.

- *Erysiphe cichoracearum* D.C.: causes severe loss by defoliation and decrease in the oil content up to 50%. This fungus provokes appearance of white patches on the two sides of the leaves and stem. (Powdery mildew). Control by spraying sulfur formulation or organic fungicide like Dinocap or Quinomethionate.
- *Macrophomina phaseoli* Hob. Ashy.: causes stolon rot. Appears during the growing period. Controlled by crop rotation (3 years). Affected stolons can be treated by Benomyl (0.1% Benlate).
- Insects ,Pest/Control:
 - Mint leaf Roller treated by BHC;
 - Hairy Caterpillar eliminated by Malathion application.

8) Distillation - Yields

- Time distillation: 2 hrs (steam water distillation)
- %oil: 0.4-0.6% (fresh).
- Agronomy yields: - 48ton of fresh herb/ha. for a good crop. In three cuttings, average of 25^T/ha.
- Yields-oil: 100kg ^{oil}/ha or 50-75kg ^{oil}/ha.

9) Composition of the oils

- *Japan mint*: Menthol 65-80%
- *Peppermint*: Menthol 35-50% (white) or 48-66% (black mint oil)
- *Bergamot*: Linalool / Linalyl acetate (60-80%)

10) Selected crops of mints

- The propagation materials are obtained from Brazil and China.
- India: CIMAP/Hyb. 77 (1988).

14. VETIVER OIL

Vetiveria zizanioides (native or cultivated)

1) Soils and Climate.

- all type of soil. The best is well drained sandy loam;
- Rainfall: 1 to 2 meters/year.
- Temperature: 20° to 43°C.
- Humidity: 60-70%.
- Good sun exposure. Shady areas should be avoided.

2) Cultivation.

- By propagation of small roots fragments (slips).
- Planting stock of small roots obtained from older plants.
- Planting at the beginning of the rainy season. In holes 5 to 8 cm deep. Spacing 60/90cm apart each way.
- Weeding: 3-4 the first year.
- Cleaning before harvest.

3) Fertilizers.

- When necessary apply: P₂O₅ (30kg/ha)
K₂O (30kg/ha)
N (60kg/ha) x 2 the first year.

4) Harvesting

- After 18 to 24 months (growth period).
- The physical state of the roots (thin or thick influence the quality of the oil. Thicker roots are better.
- Uprooting and shaking. In various cases, washing and drying in the shade 1-2 days of the roots is necessary to improve the olfactory quality of the oil.

5) Pests and Diseases

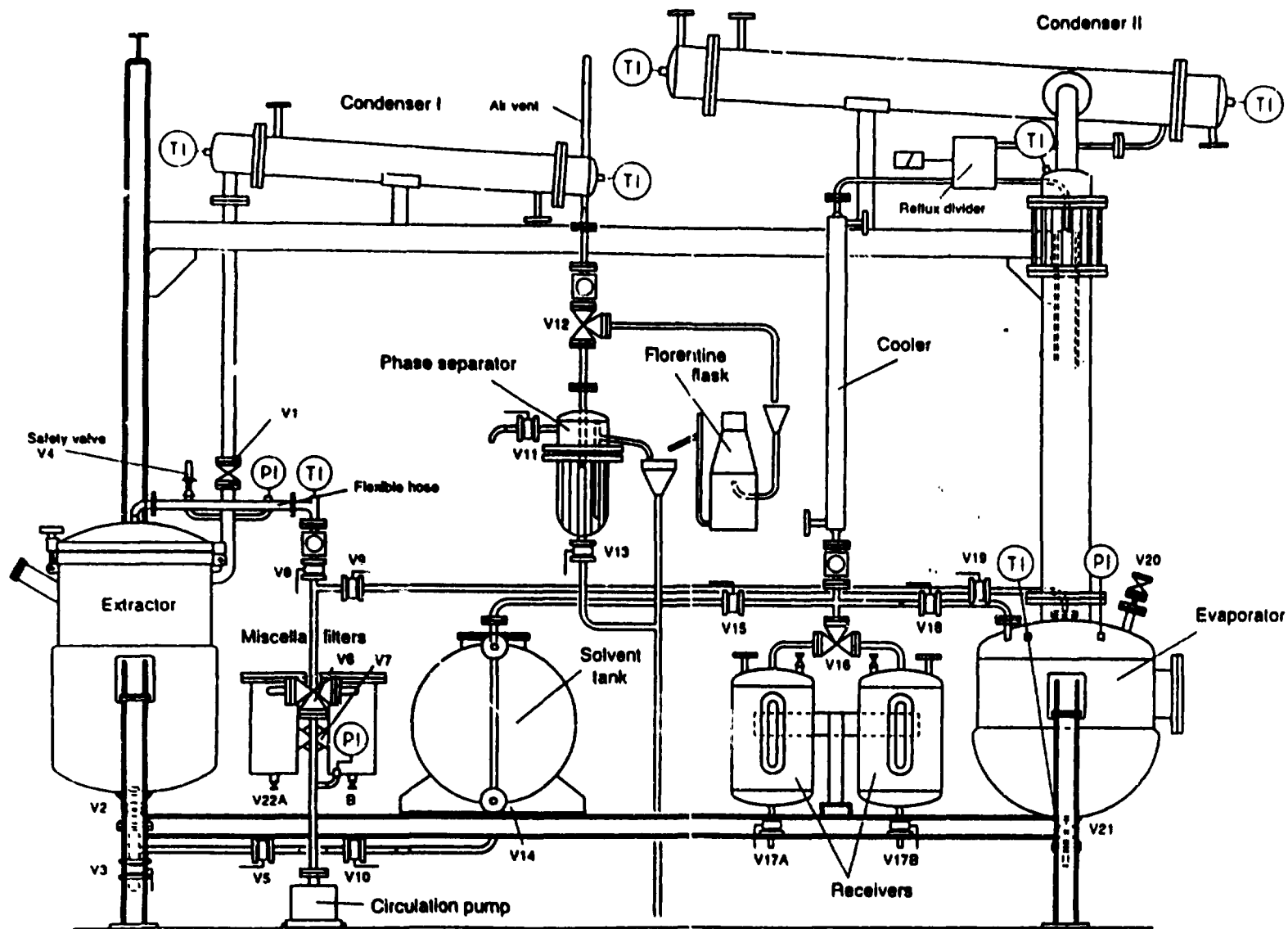
- *Curvularia trifoli* (Kanf) causes leaf blight.
- Spray copper fungicide (0.3%) containing 50% Cu^o.

6) Oil content - Oil yield

- Average 1.5 to 2.0%.
- Distillation of roots six months aged improves the quality of the oil.

7) Minimum scale operation

- Minimum charge capacity :500kg .More common:1.5tons
- Distillation time:- at normal pressure = 18 to 36 hours.
 - under pressure 10-12 Atm = 12 to 16 hours.
- Area of cultures:- 50ha for a small unit (500kg).
 - 100ha to avoid disrupting in the oil production.
- Operation timing: harvesting spread over 6 months (season).
- Yield of roots/ha: - 4.0-7.5 tons (India)
 - 1.0-1.5 tons (Brazil)
- Yield of oil/ha = 1 ton for 75-100 distill. per season.
- 50ha of land necessary to feed a 500kg unit.



Drawing No. 9004-01		United Nations Industrial Development Organization	
Scale	Distillation/Extraction Plant (pilot scale)		Arrangement & Instrumentation