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PROCESSING OF MEDICINAL PLANTS CULTIVATED AND COLLECTED IN NEPAL

DP/NEP/80/044
NEPAL

Terminal report*

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

Based on the Work of Mr. Baldev C. Gulati,
Adviser on processing of medicinal plants

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United Nations Industrial Development Organization
Vienna

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Abbreviations used

R & D	=	Research and Development
HMG	=	His Majesty's Government of Nepal
RDRL	=	Royal Drugs Research Laboratory
HPPCL	=	Herbs Production and Processing Company Limited.
UNIDO	=	United Nations Industrial Development Organization
UNDP	=	United Nations Development Programme

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Summary

The project DP/NEP/80/044 "Processing of Medicinal Plants Cultivated and Collected in Nepal" started functioning from 10 October 1984 and is scheduled to terminate by end January 1988.

Developmental and Immediate Objectives have been successfully achieved. With the establishment of a suitable processing facility, import of medicinal items such as liquid extracts of belladonna and vasaka is stopped. These are now regularly produced and supplied to RDL. Menthol and products from mint oil have been developed as an import substitution items.

Exports earnings have increased significantly from NCRs. 1,193,800 in 1984-85 to NCRs. 6,802,686 during 1986-87. Production and sales have been increasing by about 100 percent every year since 1984-85. Production and sales target for 1987-88 have been fixed at NCRs. 14 million.

A Central Processing facility comprising of purchase, installation and commissioning of equipment together with trained staff has been established. With the training of technical staff in various aspects of processing and quality control, it is now possible to produce standard quality products acceptable in foreign market.

A small well equipped laboratory and workshop has been set up. This has made HPPCL self sufficient in analysis and quality control and upkeep and proper functioning of project equipment. Few reference books were also purchased for day to day use.

Experts of the Project gave special attention to train personnel of HPPCL in purchase (procurement), processing, quality control, packing, accounts, planning and marketing. Eight persons received training abroad in various disciplines. Management system for HPPCL was developed.

Out of six outputs, all except the sixth (report on expanded activities of HPPCL) have been completed. The sixth output will also be completed before termination of the Project.

HPPCL broke even during 1985-86 and is expected to make a small profit during 1986-87 which has proved economic viability of such a venture in Nepal.

Recommendations

Now that a well equipped central processing facility has been well established with the help of the project, it is necessary to consolidate the benefits throurh out the nation. A few points are listed as recommendation:

1. Strengthen the organisation aspects of the company vis a vis Planning, Costing, Procurement of quality raw material, Processing Quality control of finished product and subsequent sale of the products.

2. In consideration of the above aspects, Marketing will play a key role. It has been possible to sell products in foreign markets where quality, price and timely supply are the main considerations. It will be necessary to have some publicity programme regarding conventional products such as Palmarosa, Citronella, Lemongrass, Japanese mint oils, Valerian resinoid and new introduced products like tree moss resinoid and absolute, Surandha kokila oil, Juniper leaf oils, Winterfreen, Abies spectabilis and Rhodondendron oils.

3. In the group of products from medicinal plants, Diosgenin and Belladonna Concentrated extract seem to have potential market. Side by side products from Chiraita, Rhubarb, Podophyllum (if correct raw material is located) should be market evaluated.

   Xanthotoxin production has to be considered if Heraculeum candicans availability is assured. Otherwise, cultivation of Ammi majus should be retried as its cultivation in India has not posed any problem with developed method of harvesting.

4. Production needs to be strengthened on two accounts:

   a) Increase production volume of existing saleable products.

   b) Broaden the range of products especially from aromatic plants; a few of them every year. Work on few items has already been done and efforts for new items and introducing in market should be continued as per the guidance given.

5. Farm area under HPPCL in increasing besides cultivation by small land holders under extension. A few items were suggested (vide Report of Baldev Gulati, 8 April 1985, p 24). Tagetes minuta will be another potential item for cultivation and processing. This

item should fit well under extension in Terai area; the crop being winter annual would leave the area free for paddy cultivation as a second crop.

6. During the last three years, sales of HPPCL are doubling every year. However, overheads have also increased which need be carefully checked so as to reap benefits out of increased production and sale.

7. HPPCL has ambitious though realistic programme of work which will need technical and some equipment support of UNDP which offered such support earlier. Two aspects are recommended:

   i) The consultant should visit the HPPCL at regular interval of about 4 months for a period of 2-3 weeks as the need be. This will help in ensuring removal of bottlenecks of technical nature and ensuring the implementation of technology transferred as also optimum utilisation of project equipment.

   ii) There is a need for a follow-up mission either by formulating a new project or extending the existing project with indication of needs for technical and equipment support.

In nutshell, expansion and development of the present programme is a continuous processes which have got two dimensions. The first dimension is to continue the programme intensively (increasing volume) and extensively (increasing number) as per guidance given during project period. The second dimension is to expand field activity and direct the development towards totally new aspect of the medicinal plants. To highlight these aspects, two components are mentioned as follows:

a) Production of pure phyto-chemicals from herbal resources.

b) Production of drugs and allied products from medicinal plant. The latter would cover two aspects as mentioned above. This would need either multilateral or bilateral international assistance

Introduction

Nepal by virtue of varied climatic conditions, ranging from alpine meadow in the North and Sub-tropical forests in the South within a span of 130-240 Km. has rich vegetable kingdom. Medicinal and aromatic plants are found growing in state of nature, their collection and export provide regular income to the inhabitants. It is estimated that about 80 species of these plants totalling over 1000 tonnes are exported annually contributing over 2 percent of the foreign exchange earnings of the kingdom.

His Majesty's Government of Nepal initiated R & D efforts on medicinal plants as far back as 1937 with experimental cultivation of exotics like Digitalis purpurea and indigenous plants like Aconitum ferox. These efforts were further enhanced in 1961 with the establishment of the Department of Medicinal Plants for the purpose of formulation and implementation of HMG policies on the cultivation, collection, processing and utilisation of both medicinal and aromatic plants. The Department has four R & D institutions.

1. Royal Drug Research Laboratory.
2. Royal Botanical Gardens.
3. Botanical Survey and Herbarium.
4. Herbal Farms.

As a result of work by RDRL, cultivation of Belladonna, Pyrethrum, Citronella, Palmarosa, Lemongrass, Japanese mint was shown to be successful crops for Nepal. Simultaneously, efforts were made to develop technologies for processing of medicinal and aromatic plants.

HMG Nepal established Royal Drugs Ltd. in 1972 to manufacture allopathic medicines. The Herbs Production and Processing Company Limited was established in 1982 with the main objectives as under:

a. to collect herbs from natural sources for export as such or after processing.

b. to cultivate and promote the sale of medicinal and aromatic plants (products) in domestic and foreign markets for use as therapeutic agents.

c. to encourage small farmers to cultivate medicinal and aromatic plants.

c. to make the country self sufficient in the field of drugs, especially drugs derived from plant sources.

d. to acquire and conserve foreign exchange earnings both by export and as import substitution respectively.

Having provided the technical and financial assistance, UNDP, during the third country programme, executed the following projects:

i. NEP/78/009 - Primary Health Services

This multi-bi-project aimed at organising the logistics of drugs distribution both ayurvedic and allopathic for better supply in rural areas at the same time training local health care personnel in the administration of drugs.

ii. NEP/80/003 - Strengthening the Royal Drug Research Laboratory

This project "Strengthening the Royal Drug Research Laboratory" was executed by UNIDO in association with WHO.

The Project which began in early 1982 was aimed at developing the R & D components on medicinal plants with a view to their industrial utilisation. A pilot plant has also been established for developing processes on industrial scale.

iii. DP/NEP/79/007 - Cultivation of Medicinal and Aromatic Plants executed by FAO.

The Project (1983-1986) aimed at cultivation of medicinal and aromatic plants on the herbal farm of HPPCL and to develop cultivation by farmers under extension programme. A programme of cultivation followed by distillation of aromatic plants is also done at site on the herbal farm of HPPCL.

iv. DP/NEP/80/044 - Processing of Medicinal Plants Cultivated and Collected in Nepal.

This project is executed by UNIDO.

The project, schedules to start on July 1, 1984 became operational only from 10 October 1984 with the arrival of the Production Technologist/ Chief Technical Adviser. The project had a budget provision of US$ 770,100. Later on the budget was increased to US$ 848,100 (first revision) primarily due to the following:

	US Dollars
1. Establishing a routine analytical laboratory.	30,000
2. Setting up a mechanical workshop.	20,000
3. Training programme.	28,000
Total	78,000

The project which was earlier sanctioned for 2 years was extended further by one more year. Budget, due to second revision, came to US$ 969,285 i.e. an increase of US$ 121,185 over the first revision.

The HMG Nepal's contribution in the project was estimated at NCRs. 5,830,000 (in kind). The HFPCL contributed by way of buildings, services, electricity, a few components of equipment etc.

The project has achieved its objectives, both the development and immediate, in ample measure.

Production in the factory covered the following aspects viz:

i. transfer of technology.

ii. training of staff in production as also laboratory analytical work at site as a continuous and on-going activity.

Training was further augmented by fellowships abroad of selected personnels.

Objectives and Logic of the Project

In the modern day pharmaceutical, flavour and fragrance industries, plant derived products find extensive use. In many cases natural products are still considered indispensible inspite of advent of synthetics. A large number of useful medicinal and aromatic plants occur in state of nature in Nepal. Due to diverse agroclimatic conditions, many plants of economic importance can be cultivated. In view of this, it was but natural that a venture of this type comprising of collection, cultivation and processing is started. This was accomplished by the setting up of the Herbs Production and Processing Company Limited in the year 1982. To help setting up a Central Processing Facility on technically sound basis a project was sanctioned by the UNDP, executed by UNIDO. This project DP/NEP/80/044 came into force on 10 October 1984 with the arrival of the Production Technologist/Chief Technical Adviser.

The project had following objectives:

A. Development Objectives

i. To reduce the import of medicines and hence the outflow of foreign currency by production and collection in Nepal of medicinal plants which can be cultivated and processed within the country and so substitute imported drugs.

ii. To increase the foreign currency earnings of Nepal by collecting, cultivating, processing and exporting of concentrates of both medicinal and aromatic plants.

B. Immediate Objectives

i. The establishment of a processing facility in Kathmandu and of simple field processing equipment, with an objective to start primary processing of medicinal herbs for the first time in Nepal.

ii. Developing the Herbs Production and Processing Company Limited into an economically viable enterprise.

The Project was envisaged to generate six outputs:

Output No. 1.

A central facility in Kathmandu for processing of plant material for production of drugs, pharmaceuticals, and aromatic products on a pilot scale.

Output No. 1.

Installation of field processing equipment (post-harvest preparation: drying and pulverising) in order to facilitate transportation to Kathmandu.

Output No. 3.

A core of trained staff to operate and maintain the Central Processing facility and a national competence in the production of Pharmaceuticals and allied products from plants.

Output No. 4.

An experienced organisational capability within the Herbs Production and Processing Company Limited.

Output No. 5.

Feasibility studies on production of selected plant-derived from cultivation to marketing.

Output No. 6.

Preparation of a feasibility study on expanded activities for the Herbs Production and Processing Company Limited.

Progress in the Activities Carried Out and Outputs Produced

Progress achieved in generating the outputs of the project is as under:

Output No. 1.

A Central facility for processing of plant material, both collected from natural sources and cultivated, has been created in Kathmandu. Careful selection of various items of equipment has made it possible to process now a large number of plant material needing different technologies. Products produced so far have been readily accepted in the local as well as foreign markets.

Output No. 2.

It was envisaged earlier to instal drying and pulverising equipment to facilitate transportation of plant material to central processing facility at Kathmandu. It was observed right from the start of the project that installation of such equipments had no particular advantage. On the other hand it was felt that field distillation unit and pine resin processing unit at site of growing/collecting would be more advantageous.

A distillation unit for distillation of cultivated aromatic plants at Tamagadhi Farm was provided by the project NEP/79/007 (FAO executed). However, simpler and inexpensive field units are envisaged now for installation at various centres in Nepal where mostly wild growing aromatic plant (material) will be distilled. Similarly relatively simple field pine resin plants are contemplated to be installed at the collection site.

Output No. 3.

HFTCL has now well trained staff not only in the factory but also in the planning, accounts and sales sections. Training was imparted both *in situ* by the Chief Technical Adviser, Marketing Consultant, Engineer and Economist Cost Benefit Analyst as also in abroad under followships.

Output No. 4.

As one of the important outputs of the project, an experienced organisational capability has been achieved within the company and can be regarded as unique experience in the field throughout the country.

Output No. 5.

Feasibility studies on plant derived products from cultivated sources only have been made. Such studies on products from naturally occuring plant materials will be completed before expiry of the project.

Output No. 6.

A feasibility study on the expanded activities for the HPTCL will be made and submitted before the termination of the project.

It will be seen from the above that outputs envisaged in the project have been successfully generated and the organisation is running on economically sound basis.

Description of Activities Carried Out

Activities carried out for achieving the objectives and generating outputs are detailed hereunder:

1. Production Programme

At the onset of the project, a realistic production programme based on available raw materials and marketability of the products therefrom was chalked out in consultation with the National Project Director, Director-General, Department of Medicinal Plants and Scientists of the Royal Drugs Research Institute. The programme was annexed to the Project Document.

This revised production programme is given at Annexure I.

2. Equipment Specification and Procurement

The HPTCL had purchased a few items of equipment like, boiler, solvent extraction plant (Soxhlet type), pine resin unit, vacuum concentrator, a pulveriser, percolator and distillation unit. On working it was observed that

a few of these had developed some troubles but nevertheless were being put to use. A list of equipment appended with the project document was seen to be inadequate. Considering the type of work envisaged under the project, a fresh list of equipment with specifications was drawn. The final list with specifications was forwarded to UNIDO Vienna (Austria) on 19, December, 1984.

International bids were called by PAC, UNIDO, Vienna. Summary of bids was received by the project on 1, July, 1985 and final recommendations were made to UNIDO on 11, July, 1985. The orders were placed with supplier by the PAC, UNIDO as per UN purchase regulation.

With the help of Project Engineer equipment was installed as and when received and put to use.

List of equipment procured is given at Annexure II.

3. Quality Control and Routine Analytical Laboratory.

Help of RDRL was envisaged in quality control and analysis of products. It was, however, felt and observed that magnitude of analytical work on raw material and products involved (obtained daily from various trial batches) necessitated creating this facility at site in HPTCL. This matter was placed before the TPR held in March 1985 where it was unanimously agreed that HPTCL should have its own routine analytical laboratory if it were to produce sucessfully products meeting set standards. A provision of US$ 30,000 was agreed to for equipping a small laboratory. A well equipped laboratory has been set up with trained personnel.

List of items purchased is given at Annexure III.

4. Mechanical Workshop.

Equipment procured through the project needs to be maintained properly. It is also not practicable to arange for repairs, if any, from outside considering limited facilities available in Nepal. The matter was also considered by the TPR in March 1985 wherein a provision of US$ 20,000 was agreed to. With this provision, a mechanical workshop has been established with the help of the Project Engineer. HPTCL has built a separate accommodation for this workshop. The Project Engineer has trained the respective personnels in proper use of workshop equipment.

List of main items purchased is given at Annexure IV.

5. Training of Staff

This activity was given considerable attention. The technical personnel, both from laboratory as also from production side, were given training by the CTA and other Project Experts at site, while 8 personnels were sent abroad under project fellowship.

Training at site - After completing preliminary work of the project, laboratory and factory work was started from January 1985. Facilities available in the labor tory were evaluated. Analytical work started actively involving the techni personnels. For new essential oils, analytical procedures were standardised.

For developing and evaluating processing technology for various items, laboratory staff was involved who are now well versed in this aspect of production work.

Similarly in the factory, the projection staff was involved and trained in the distillation of new essential oils. Considerable work was done in setting parameters for producing oil of Supandha Kokila meeting buyers standards.

Details of technical work and progress is given separately in this report.

Selected personnels were sent for training abroad in the fields of quality control and production, planning and accounts and sale. Following personnels received training abroad.

1.	Senior Processing Officer	U.K. and India	4 months
2.	Analytical Chemist	U.K.	2 months
3.	Production Officer	Sri Lanka	2.5 months
4.	Production Officer	India	1 month
5.	Sales Officer	Europe	1 month
6.	Accounts Officer	Barbados	2.5 months
7.	Planning Officer	Ireland	2 months
8.	Cost Accounts Officer	Pakistan	1 month

Besides the above, the National Project Director went for a study tour in selected places in Europe.

Economist and Cost-Benefit Analyst imparted training to officers in Accounts, Planning and Sales. A suitable management system was also suggested by him for implementation in future. With his help, the company has developed a number of formats for use in internal administrative work.

6. Cost-Benefit Analysis of Products

This part of the activity was carried out by the Economist. Cost calculations were made on cultivated crops which gave clear idea on the profitability or otherwise of cultivation of medicinal and aromatic crops both in the farm of the HPTCL and at farmers level.

7. Developing, Marketing Strategy and Policy Guidelines in Export of Herbs and their Products.

Marketing consultant to advise HPTCL on the export of herbs and their products as also to suggest overall working strategy for the Kingdom in this field was arranged or 3 months under the project. The consultant submitted his report for follow up by HPTCL and HMG Nepal.

In order to enable the company to handle the supply system at an International level the various activities were carried out successfully and outputs produced as summarised under:

a) A Central processing facility for processing of plants materials - medicinal and aromatic-with analytical laboratory and a mechanical workshop has been established to cover wide range of material giving products of diverse nature.

b) Field processing equipment like drying and pulverising was not considered necessary. On the other hand, field processing equipment such as distillation units and pine processing units were considered necessary. Steps were taken to instal these in various parts of the kingdom.

c) A core of trained staff to operate and maintain processing facility and produce plant products to meet set standards has been created.

d) Adequate steps were taken for training in situ and abroad under fellowship to strengthen organisational capability of the company.

e) Feasibility studies on production of selected plant derived products were carried out.

f) Feasibility study on expanded activities for the company will be prepared.

Achievement of Immediate Objectives

The project had (1) development objectives and (2) immediate objectives. These objectives have been achieved; quantitatively and the economic impact, though, small, is likely to increase with time resulting in substantial economic growth in the future. Data in support of the above statement are summarised under:

Development Objectives

1. To reduce the import of medicines and hence the outflow of foreign currency by production and collection in Nepal of medicinal plants which can be cultivated and processed within the country and so substitute imported drugs.

A small beginning has been made by processing Adhatoda vasika (from natural sources) and Atropa belladonna (cultivated) for their extracts which are supplied now regularly to Royal Drugs Ltd. Total requirement for these two extracts is met but further production is limited to the extent of their demand. These items cannot be exported due to large volume - transportation becomes uneconomical.

A third item - menthol - has been developed in sufficiently large quantities to meet the entire demand of the country which is put at about 1000 kg. worth about Rs. 400,000 per annum.

It was observed that demand for extracts of medicinal plants was very limited as an exportable commodity.

Development of other products that can be utilised in Nepal is given under technical progress.

2. To increase the foreign currency earning of Nepal by collecting, cultivating, processing and exporting of concentrates of medicinal and aromatic plants.

The products made by the Company have been accepted in the foreign market. The production and sale are increasing as evidenced by the following data.

	Actual Sales - Value in NCRs.			
Product	1984-85	1985-86	1986-87	1987-88(Estimat
Total sales of which	2,031,309	4,144,630	8,041,000	14,000,000
Exported to India	901,495	1,610,603	5,268,463	-
Europe	292,305	1,023,724	1,534,223	-
Local market	837,509	1,510,303	1,238,314	-

Immediate objectives

1. The establishment of a processing facility in Kathmandu and of simple field processing equipment with an objective to start the primary processing of medicinal herbs for the first time in Nepal.

This objective has been fully achieved as per details given in the report.

2. Developing the Herbs Production and Processing Company Limited into an economically viable enterprise.

As per audited accounts of the working of HPPCL, the company broke even in the year 1986-87. Reasonable good profit is expected during the year 1986-1987. The company is now an economically viable unit.

Technical Report

As per job description, work was also to be undertaken on the development and production of products from medicinal and aromatic plants. The work scheduled for second phase of the CTA's mission, was, however, taken up during the first phase (6 months - October 1984 - April 1985) using available facilities in the HFTCL pending receipt of project equipment and establishment of laboratory.

Extensive discussions were held with the National Project Director, Director General, Department of Medicinal Plants and Senior Scientists of the Royal Drug Research Laboratory on the aspect of work to be taken up. Based on the data provided on the availability of raw materials and marketability of the products, a production programme was chalked out (Annexure I).

Work done in the factory as per progress in the fulfilment of production programme are discussed in this chapter of the report.

Essential Oils, Isolates, Concretes and Absolutes

Considering better market potential of this group of products, work was started on these from January 1984.

1. Essential Oils

1.1. Essential oil of Sugandha Kokila

Sugandha Kokila, fruits of Cinnamomum polyandrum (tentatively identified) Fam. Lauraceae is mostly found in Nepal in Dang district.Fruits, when ripe are collected, dried both naturally and artificially. These are sold regularly in Indian market where these are used a flavouring of tobacco. Estimated 100 tons of Sugandha Kokila Berries are traded annually.

Sample of oil (500 gm.) produced in 1984, evoked interest of a buyer abroad. The buyer also asked for oil having minimum ester value of 65. Large scale trials were started and it was observed:

i) that the commercial samples varied from batch to batch in respect of ester value.

ii) it was not possible to exhaust berries in single distillation.

This necessitated standardising conditions of production to produce oil of standard ester value and to extract as much oil as possible.

During 1985, about 10 tonnes of berries were distilled under varying conditions. The problem was all the more aggrevated for want of a distillation unit. Soxhlet equipment of 2000 litres capacity was used as a distillation unit. From various trials, it was observed that:

a) Water distillation gives oil with good ester value while steam distillation gives oil with comparatively low ester value.

b) Yield of oil is better with steam distillation as compared to water distillation which takes more time to distil comparable quantity.

(In HPPCL there was no arrangement for water distillation hence the oil was recovered using steam distillation only).

c) It is not possible to recover oil completely in first distillation. Partially exhausted berries after drying yield additional quantity of oil in economic yield of 0.7 - 1.0 percent. Here also, oil quality varied from batch to batch but oil was generally of standard quality.

d) Grinding of berries, gives better yield in lesser time but invariably oil of sub-standard quality.

e) Oil quality improved by rectification using water distillation to produce oil of standard quality.

f) Interrupted distillation of berries gave substandard oil.

g) Drying of air dried berries in the sun for about 3 days prior to distillation gives oil of better ester value than the berries without sun drying.

h) Under the existing conditions of equipment (Soxhelt unit) and distillation, a charge of 400 kg berries gave overall better yield of standard quality oil.

Increase in charge size gave low recovery of standard oil and mostly of sub-standard quality. This increased cost of distillation.

Keeping the above observations in view, production of standard quality oil was produced as under:

A charge of 400 kg berries was distilled for about 20 hours using steam distillation. About 1 percent oil produced during distillation was kept separately and analysed. If the ester value was about 40, the entire oil recovered was observed to be of standard quality. In case ester value was less than 40, the fraction was kept separately and later on rectified to upgrade to ester value of 65 and above. Distillation was stopped when about 3.5 percent was recovered. The partially exhausted berries were removed from the distillation unit, dried and redistilled. This gave an additional quantity oil; yield varied from 0.7 to 1.0 percent depending on oil recovery during first distillation.

Sub-standard oil was rectified. Extent of rectification was determined by analysis of sub-standard oil. Rectification by water distillation gave earlier low boiling portion having ester value of 5 to 10 only. Remaining oil, undistilled, was removed and analysed which always had ester value as per calculations.

It was possible to produce standard quality oil in an yield of over 3.5 percent and about 4 percent.

Later on with the installation of proper distillation unit and boiler of one ton/hour capacity, it was possible to improve distillation whereby an average recovery of 4.4 percent oil (mostly standard) was achieved. With further work we hope to achieve a recovery of about 5 percent standard oil.

Work on improvement of oil recovery was done in later 1987 as under:

Oil is concentrated mostly in the outer part i.e. pericarp. On decortication it was found that berries have about 55 percent of pericarp and about 45 percent cotyledon which is rich in fixed oil. Laboratory and pilot scale distillation indicated about 10 percent oil in outer part of the berries and about 0.8 percent in the inner part.

Separation of pericarp and cotyledon manually by beating the berries resulted in breaking of both husk and kernel in powder as under:

Out of 500 kg berries -

1. Pericarp 156 kg.
2. Cotyledon 108 kg.
3. Powder 236 kg. (Mixture of both).

All the three were distilled separately in laboratory. Data obtained are:

Material	Oil Content	Ester value
i. Pericarp	10.61 %	43.91 %
ii. Powder	4.25 %	76.45 %
iii. Cotyledon	0.51 %	51.23 %

Distillation on pilot scale gave following data:

Material	Oil Content	Ester value
i. Pericarp	8.87 %	56.78 %
ii. Kernel (Cotyledon)	0.34 %	84.3 %

Large scale distillation was done combining pericarp and powder. Oil was obtained in 5.97 percent yield, ester value 44. Average content of oil yield came to 4.75 percent calculated on 500 kg berries. Yield of standard oil recovery came to 3.2 percent. Yield is likely to improve if pure pericarp is distilled.

Partially distilled Sugandha Kokila berries were also separated into pericarp and cotyledon. Laboratory and pilot scale distillation gave data as follows:

Material	Yield	Ester value	Mode of distillation
Pericarp (Laboratory)	7.12 %	126.99	Water distillation
Pericarp (Pilot scale)	a) 1.80 %	84.92	Water distillation
	b) 2.00 %	82.9	Water distillation

It was observed earlier that pericorp comprised of about 55 percent, by weight, of berries. It is, therefore, considered advisable to separate this for distillation which will not only reduce cost of distillation by about 50 percent but will also improve recovery of oil. It is also visualised that it will be possible to complete distillation in one step as against distilling berries twice, as already mentioned. This will further reduce cost of production.

2. Processing of Japanese Mint

Oil of Japanese mint, now produced regularly in the farm of HPPCL, is processed further for menthol. Work done so far on this oil is as under:

Oil produced in the farm is of good quality, having 84 - 85 percent free menthol, 2.6 - 7.6 percent esters (calc. as menthyl acetate) and about 5 percent ketones (calc. as menthone).

During 1985 - 1986, about 45 kg menthol was produced by chilling in laboratory scale (5 kg oil batch size) and 130 kg during winter - taking advantage of cold weather. Menthol produced was further graded according to crystal size.

During 1986 - 1987, 230 kg of menthol was produced during winter. Partially dementholised oil will be further processed to produce additional quantities of menthol. A special cold room is being arranged for gradiant chilling of oil to produce good quality menthol.

Oil, being rich in menthol, does not yield good crystals of menthol if temperature is not controlled effectively. For this quality oil temperature control parameter had to be standardised afresh.

Menthol produced so far has compared well with the imported menthol. Import substitution should not pose much of a problem.

Other products from Japanese mint oil produced on small scale are:

a. Rectified dementholised peppermint oil (DMO) for flavouring of tooth pastes etc.

b. Liquid menthol from DMO by chemical means.

c. An extra fine quality of menthol from rectified mentha oil and DMO.

As mentioned earlier, products from Japanese mint oil are proposed to meet entire demand of Nepal as import substitution products.

DMO can find ready export market if produced in sufficiently large quantities and at competitive price for which it would be necessary to raise this crop for oil by small holding farmers.

3. Calamus Oil

Calamus rhizomes are available in Nepal in large quantity (500 tons) and are exported mostly to India as such. Oil content was observed to be 3.5 percent by water distillation and 10 percent of oleoresin by solvent extraction. Both the oil and oleoresin are nearly similar to each other and rich in asarone content.

Scientists of RDRL have claimed distillation time as 3½ hours only as against more than 24 hours normally required to win over the oil. The new method will help reduce cost of distillation to a great extent; while at the present the main expense in producing calamus oil is incurred due to long time for distillation.

It would be possible to export upto 500 kg oil annually.

4. Oil of Jatamansi

Nardostachys jatamansi from Nepal is normally of good quality and large quantities are exported mostly to India. Oil content in the roots of jatamansi varies between 0.4 to 1 percent and above. Quality of oil has been graded as very good. Upto 50 kg of oil can be exported to India. Production will be economical even at yield of 1 percent of oil.

5. Tagetes Minuta Oil

Tagetes minuta (Syn T. glandulifera) comes up very well in Nepal as cultivated crop. It also grows in limited quantities in state of nature in Kathmandu valley. Oil content was observed to be 0.47 - 0.59 percent (moisture content of plant material 49.7 percent). Quality of oil is good. Tagetes oil has export potential and is scheduled for regular cultivation as winter annual crop in Tamaphdhi Farm. Cultivation prospects in Kathmandu valley are being ascertained by experimentation for the last two years.

6. Timur Oil

Fruits of Xanthoxylum armatum are available in large quantities upto 500 tons annually and are a regular export item from Nepal. Oil content is 3.5 percent (average) having linalool and linalyl acetate content of 62.63 and 20.03 percent respectively.

As the prevailing price of timur and with 3.5 percent oil content, cost of production is higher than the sale potential price. Efforts are being made to locate Xanthoxylum area having oil content of about 5 percent. At this level of oil content it will be possible to export the product at relatively cheaper price.

7. Other Essential Oils

i. Artemisea vulgaris oil

Oil of Artemisea vulgaris is a regular item of commerce. However, it has not been possible to locate areas in Nepal rich in Artemisea vulgaris. Till the availability of this material is ascertained in commercial quantities, production cannot be undertaken. There are atleast six genotypes of Artemisea vulgaris plant available at different altitudes of Nepal. Oil content of the available material was about 0.2 percent.

ii. Alpinea malaccensis oil

Rhizomes of Alpines malaccensis gave an oil in 1.72 percent yield having 83.5 percent methyl chavicol. Such an oil has sale potential; methyl chavical being starting material for production of anethole regularly used in flavour industry.

Data are being collected about the availability of this material and price before planning production.

iii. Juniper oils

Oil of juniper was produced from -

a) Berries of J. communis and J. recurva.
b) Leaves and terminal twigs of J. communis and J. recurva.

Yield of oil from berries of J. recurva was 3.3 percent (moisture content 6.8%) while the same from berries of J. communis varied from 0.2 - 0.63% which is rather poor.

One of the reasons observed was the harvesting of green immature berries. Good quality and yield of oil is produced from ripe blue berries. Distillation of correct material will be done this year to evaluate quality and economics of production.

Yield of oil from leaves and terminal twigs of J. recurva was 0.83 - 1.12 percent (Moisture content of leaves 32.8%) while the same from leaves and twigs of J. communis was 0.57 - 0.87

Juniper oil of commerce is produced only from berries of J. communis. The oil can be produced in small quantities in Nepal. Large quantities of oil of Juniper can be produced from leaves and terminal twigs of J. recurva and J. communis. These oils will be at best a cheap substitute for true juniper oil. Even at lower price, it would be economical to produce this oil.

iv. Abies spectabilis oil

Considering availability of Abies spectabilis in Nepal (estimated potential 13.6 tons of oil by exploiting 20 percent of available material), a detailed survey work was done on this plant under NEP/80/003 project. Oil yield on distillation of needles and tender twigs was observed to be 0.4 percent, having ester value of 26. Conifer plant needle oils have good market and oil from Abies spectabilis seems to be a promising item.

A distillation unit has already been set up in area of habitat of this plant species.

v. Oil of wintergreen

Due to advent of synthetic methyl salicylate, oil of wintergreen lost commercial importance. However, recently some interest was shown in this oil by a buyer in France.

Gaultheria fragrantissima is available in Nepal to permit large scale production. It was observed that even dry leaves give good yield of oil. Oil yield was found to be 1.2 percent on air dry basis of leaves (moisture content 28.5%). Methyl salicylate, content was observed to be 94.94 percent and 93.88 percent in

2 samples distilled in HPPCL. Trial lot of 5 kg oil has been sold abroad.

vi. Rhododendron oil

It is reported that rhododendron oil is produced only in China. Oil from leaves of Rhodendron species was produced in an yield of 0.8 percent from air dry leaves (moisture content 11%). There is potential for large scale production. Oil samples have been sent abroad for evaluation.

Concretes, Resinoids and Absolutes

From the available materials in Nepal, few concretes, resinoides and absolutes were prepared. Out of various materials concrete of Surandha kokila and Resinoid and absolute of tree moss have market potential. Details of work done is mentioned as under:

1. Concrete of Sugandha Kokila

Concrete of sugandha kokila is a potential market item. Various trials have been done on its production; it was observed that cold extraction (room temperature) with normal hexane gave a product of acceptable quality and economic yield. Concrete was prepared from dry berries (undistilled) as well as from partially exhausted and fully exhausted berries. Some data are given as under:

Material Extracted	Mode of Extraction	Yield of Concrete (% by weight)
i) Dry berries (undistilled)	Soxhlet, hot extraction	27.60 (average of 4 trials
ii) Dry berries (undistilled)	Cold percolation	27.10 (average of 3 trials
iii) a) Marc (Once distilled berries)	Hot Extraction	33.80
b) Marc (Once distilled berries)	Cold Extraction	30.15
c) Fully exhausted berries (twice distilled)	Cold Extraction	26.00
d) Marc - wet (Moisture content 51%)	Hot Extraction	3.12
e) Marc - wet (Moisture content 51%)	Cold Extraction	2.54

As equipment for extraction in hot was not available (during earlier experimentation) the concrete was produced on pilot scale (78 kg. berries) using cold percolation with hexane. An average yield of 21.52 percent was achieved. Product was exported abroad and accepted by the buyer.

Concrete from marc (once distilled berries) of Sugandha Kokila was found to be equally good as also absolute from the concrete.

Absolute from concrete of Sugandha Kokila berries was also prepared using ethanol as extractive solvent. Yield of absolute varied from 17 to 24 percent on weight of concrete. Olfactory quality of absolute was observed to be good.

2. Concrete of Osmanthus

Osmanthus fragratissima grows in state of nature in Kathmandu Valley (near Pashupati temple). Its flowers are small and delightfully fragrant. Concrete of Osmanthus has potential. With this view, work was undertaken on this product. Extraction was done at room temperature.

It was observed that:

a. flowering season is of short duration of about 2 weeks (last two weeks of September).

b) flowers must be processed immediately after harvesting.

c) flowers can be extracted again after drying after first extraction to obtain additional quantity of concrete by about 13 percent of the first extraction if extracted in hot. Quality of product obtained in second extraction is inferior to that obtained by first extraction.

Yield of concrete was 0.23 percent in first extraction and 0.03 percent in second extraction. Quality of the concrete is good.

3. Musk absolute

Musk absolute was prepared from seeds of Abelmoschus moschtus which have fine musk odour. The plant is easy to cultivate.

Absolute of musk ambrette was prepared by two methods:

a. Direct extraction of seeds with ethanol of appropriate strength and treating the extract with mixture of solvents and further processing.

b. Preparation of concrete of ambrette seeds and treating the concrete with ethanol of appropriate strength and further processing.

Yield of absolute was on an average 0.3 percent. Selected seeds gave an yield of 0.6 percent of absolute. Yield of oil by distillation was 0.15 percent only. A large number of trials were made to train production staff and to ascertain the quality.

Complete process for processing musk absolute from musk seeds has been worked out and technical staff is well acquainted with it.

The item merits production although on small scale (a few kilograms only), there would be limited demand considering high cost of the product.

An expert has suggested cultivating ambrette seeds of Peru origin which according to him would give product of better quality.

4. Resinoid and absolute of tree moss

Work done on production of resinoid and absolute of tree moss has resulted in its commercial production. This work is described in some details as follows:

Large quantities of tree moss are produced from natural sources in Nepal. Estimated trade in tree moss from various species would of the order of 1500 tonnes.

Commercial samples of tree moss consist of:

Parmelia nepalensis	about 75 %
P. tinctorium	about 10 %
Usnea spp.	about 2-5 %

Extraneous matter such as tree bark, small twigs and dust comprised 10 -13 percent.

Work on the commercial sample as also on individual species of tree moss was done. However, production is done from mixture of lichen species as they are received from the trade. Samples were received, mostly from collection centres in Kathmandu, Gorkha, Tulsipur and Ramechhap. It was not considered possible to work on samples from different locations as also study on the effect of age on storage of samples for yield and quality.

Variation in yield of resinoid and absolute was observed in various trials using material from different sources and of different ages. About 40 trials were made in laboratory before initiating large scale commercial production.

Three methods of extraction, using 3 solvents were adopted:

a. Cold percolation
b. Extraction by refluxing solvent in material.
c. Soxhelt extraction - hot solvent.

Three solvents, benzene, normal hexane and rectified spirit (95%) were used. On the basis of odour evaluation and yield, alcohol was finally selected as solvent for extraction. Main draw back in using alcohol is the dark brown colour of the end product. The product, however, was acceptable in Indian market.

Summary of observation on yield of resinoid and absolute is as under:

Effect on yield due to solvent

Solvent used	Yield of resinoid (%)	Colour	Remark
Benzene	2.51	Green solid waxy	Average of 4 trials
n-Hexane	2.00	Yellowish Green Powdery Material	Average of 2 trials
Acetone	10.12	Powder	-
Alcohol	8.49 - 18.28	Dark brown (Average 12.71)	20 trials

Yield of concrete was same (2.5%) with benzene whether extraction was done in cold or hot.

Yield of resinoid from different lichen species by extractions in hot by ethanol is as under:

Material Extracted	Yield of Resinoid
1. Parmelia nepalensis	12.75 % (average)
2. Parmelia tinctorum (i)	23.62 % (average)
(ii)	19.00* %
3. Usnea species	8.33 %

* Extracted dry lichen

Production of Absolute of Lichens

It was observed that the resinoid after removing alcohol is not soluble in alcohol. This is not considered desireable. Work was, therefore, further undertaken to produce asbolute which is alcohol soluble. Absolute has much better and finer odour than that of resinoid.

One step process was developed to produce absolute as extraction is done by alcohol, which is also a solvent used for making absolute. The process in brief is as under:

For the preparation of resinoid, alcohol is not recovered completely. Quantity of alcohol unrecovered was standardised whereafter the solution is left to cool down to room temperature (cold room at 10°C would give better separation). The solid separated is filtered and alcohol is completely recovered under vacuum. The resultant absolute is drained while hot; left unexposed for some time and packed in an air tight container.

Yield of absolute varies from 6 - 10 percent from Parmelia nepalensis and upto 20 percent in case of P. tinctorium.

Improvement in colour of Absolute of Lichens

It is desireable to have green coloured moss resinoid or absolute. This is achieved if lichen is extracted with benzene or hexane. However, yield

is low i.e. 2.5 percent with benzene and 2.0 percent with hexane while alcohol gives much better yield and acceptable quality. Quality evaluation by consumers also indicated alcohol extracted resinoid to have better quality as against benzene or hexane extracted product.

It was observed that the chemicals or constituents imparting dark brown colour were soluble in both hot water and ethanol. However, the resinoid on treating with hot water did not improve in colour. On the other hand, extraction of the absolute with n-hexane gave a dark green product with good odour. In consistency, it resembled the tree moss concrete produced in Europe and widely used in the industry. The yield of this green coloured concrete was only 1.75 percent calculated on the basis of lichen extracted.

Using another method of first removing colour and extracting the resinoid has given a product with greenish colour. This line of work seems promising and worth persuing further. Economics of production will be studied and quality of product evaluated in comparision to normal product before adopting this new method. This work will be undertaken if time permits prior to termination of the project.

Analytical Laboratory - Analysis of raw materials and products

As mentioned earlier, work for setting up of a small analytical laboratory was taken up in January 1985. List of chemicals, apparatus and equipment was prepared. Simultaneously, work was started with the available facilities. At the present, complete analysis of essential oils and content of active principles of medicinal plants can be performed in the laboratory.

Since start of work, total number of essential oil samples analysed are as under:

	Samples analysed (January - December)		
Oil of	1985	1986	1987 (January - 20 August)
Sugandha kokila	477	800	477
Japanese mint	9	52	10
Citronella	-	7	5
Palmarosa	1	7	4
Abies spectabilis	-	3	-
Lemongrass	-	10	2

Oil of	1985	1986	1987 (January - 20 August)
Tagetes minuta	-	-	2
Juniper	-	2	
Vetiver	-	3	
Xanthoxylum	1	2	
Gaultheria fragratissima	-	2	2
Jatamanshi	1	-	
Sugandha kokila concrete	5	-	
Sugandha kokila absolute	2	-	2
Sugandha kokila fat	-	-	2
Tree moss resinoid & absolute	1	20	6
Calamus	1	-	2
Total	486	894	518

Beside analysis of essential oils following samples of medicinal products were also analysed during 1985-1987 (20 August 1987)

i)	Belladonna Soft Extract	55 samples
ii)	Belladonna total alkaloids	11 samples
iii)	Belladonna leaves	28 samples
iv)	Vasaka extract	51 samples
v)	Berberis bark	10 samples
vi)	Miscellaneous analysis	289 samples

It will be seen from the above that HPMCL is now well equipped and personnel trained adequately in analytical work.

Besides the above, analysis of Dioscorea for Diosgenin, Podophyllum for resin is done regularly. Also samples of raw material as purchased in bulk are routinely analysed.

Analytical properties of some important essential oils produced in HPMCL are given in Annexure V.

Essential oil content of aromatic plants, yield of concretes, resinoids and absolutes and data on active principle content of medicinal plants are summarised in Annexure VI.

Products ex. Medicinal Plants: Work was done on trial production of following products with a view to start commercial production:

1. Total Alkaloids of Belladonna: Total alkaloids of belladonna comprising of l.hyoscyamine (major component), l-hyoscine and atropine were prepared using soft extract of belladonna.

   Belladonna extract being dark sticky liquid, extraction of alkaloids has to be done carefully. Repeated trials were made to train the staff in this process.

   It is necessary to use freshly prepared extract; old extract not only gives lower yield of total alkaloids but a product of sticky nature and not crystalline.

   Belladonna alkaloids extract showed an assay about 90 percent as hyoscyamine. Extraction of old samples of extract gives alkaloids assaying as 83 percent only.

2. Berberine hydrochloride: Extraction of Berberis stem bark is best done using ethyl alcohol. Product obtained by this method is very good. Yield of crude product comes to 2.35 percent while that of recrystallised comes to 1.25 percent. Work was not carried out further due to low yield of product and limited availability of the raw material.

   Perhaps, if roots are used as raw material, yield will improve. However, digging of roots poses problem of soil erosion.

   Production of berberine hydrochloride is, therefore, not scheduled for production.

3. Xanthotoxin ex. Ammi majus: Xanthotoxin (8-methoxy psoralene, methoxalene) is produced from seeds of Ammi majus (Cultivated) or roots of Heracleum candican (wild). As H. candican availability was not certain, cultivation of Ammi majus was taken up in Tamapadhi Farm of the HPPCL.

   Total extract of Ammi majus seeds came to 10 percent, out of which solid coumarins came to 2.7 percent (on weight of seeds).

4. Podophyllum resin: Podophyllum is available in reasonably large quantities in Nepal. HPPCL is engaged in procurement and sale of podophyllum root and rhizomes. With a view to process podophyllum, few trials were made.

It was observed that yield of resin from rhizomes, rootlets come to 1.12, 1.7 percent respectively (resin yield being more from rootlets). In some trials it was also observed that the yield of resin from whole material rhizome + rootlets comes to about 1 percent of a gummy product. The material as available in Nepal is not suitable for processing in commercial scale due to the lower yield.

Normal yield of podyphyllum resin ranges between 6 to 10 percent from material of Indian origin.

5. Extracts of Vasaka: Vasaka extract is a regular item of processing for use in the Royal Drugs Ltd.

Production is limited as export is not possible due to high price as compared to Indian product and bulk of the extract.

6. Belladonna liquid extract: Belladonna liquid extract assaying 0.7 percent of total alkaloids is produced regularly for supply to Royal Drugs Ltd. Export of extract is not economical due to the bulky alcoholic extract.

Trials were made to prepare concentrated soft extract. However, the soft extract suffers from lack of solubility in alcohol. Royal Drugs Research Laboratory has claimed a process for preparing soft extract soluble in alcohol. A sample produced by HDRL has been sent abroad for evaluation but the content did not come up to the stated standard.

Acknowledgement

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It was a matter of great pleasure and satisfaction to work with Dr. A. Sheak, General Manager of HFTCL and National Project Director who gave me his unreserved cooperation which has contributed to the success achieved in the work of the project. I was fortunate to have Mr. U.R. Poudyal, Mrs. H. Chapagain, Mrs. N. Yonzon, Mr. Jaya Pradhan, Mr. U.M. Shakya and other staff members as colleagues who due to their deep interest, devotion to duty and craving for new ideas and knowledge made my assignment a rewarding one. But for their's and Dr. Sheak's cooperation, it would not have been possible to make the project a success.

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Last but not the least, I express my thanks to Dr. A. Tcheknavorian and Dr. R.O.B. Wijesekera whose continous advise in the technical work made my job easier and fruitful.

Annexure I.

Production Programme

List of Medicinal Plants Products to be Produced from the Third year of the Project:

Medicinal Plants Products	(Value - RC Rs. '00' Thousands)			
	R.M. (tons)	Value	F.P. (Kg)	Value
1. Diosgenin ex. *Dioscorea deltoidea*	200	14.00	5,000	37.50
2. L - Dopa ex. *Mucuna spp.*	10	0.80	200	1.60
3. Belladonna:				
i. Extract (1%)	1	0.21	500	0.63
ii. Total alkaloids	7	1.47	20	2.40
4. Pyrethrum extract	5	1.20	400	2.60
5. Xanthotoxin ex. *Ammi majus*	7	0.84	35	3.50
Total	230	18.52	6,155	48.23

R.M = Raw material; F.P. = Finished product.

Rates as applicable during end 1984 to, both, raw material and finished products.

Production yields have been calculated based on available data.

List of Essential Oils to be Produced from the Third year of the Project:

Essential Oils	(Value - NC Rs. 100' Thousands)			
	R.M. (tons)	Value	F.P. (kg)	Value
A: Immediate (From wild sources)				
1. Artemisea vulgaris	50	0.50	250	1.25
2. Calamus	30	2.40	900	4.50
3. Juniper berry	5	0.25	200	1.60
4. Sugandha Kokila	30	3.00	1,000	6.00
	115	6.15	2,350	13.35
B: In near future (From wild sources)				
1. Cinnamomum tamala (Tejpat)	25	0.62	500	1.50
2. Zanthoxylum Sp. (Timur)	20	2.40	600	3.30
3. Valerian	10	2.50	40	3.60
	55	5.52	1,140	8.40
C: From cultivated sources				
1. Citronella	200	1.30	2,000	1.80
2. Lemongrass	650	0.40	2,500	4.00
3. Palmarosa	1,400	9.10	5,000	14.00
4. Mentha arvensis	1,200	7.80	7,000	19.60
	3,450	18.60	16,500	39.40
Total A+B+C	3,620	30.27	19,990	61.15

List of Extracts and Resinoids

Extracts / Resinoids				
1. Artemisea vulgaris	10	0.05	600	0.60
2. Rhubarb	40	4.80	5,000	8.00
3. Valerian	10	2.50	400	3.60
4. Vasaka	5	0.20	5,000	2.80
Total	65	7.55	11,000	15.00
Pine Resin				
Rosin and Turpentine Oil ex. Pine resin	250	17.50	2,25,000	33.75
Total	250	17.50	2,25,000	33.75
Total of Medicinal Products, Essential Oils, Extracts and Resinoids and Pine Resin	4,165	73.84	2,62,145	148.13

R.M = Raw material; F.P. = Finished product.

Rates as applicable during end 1984 to, both, raw material and finished products.

Production yields have been calculated based on available data.

Annexure II.

List of Equipment

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Dioscorea Hydrolyzing Unit.	Uttam Kastha Udyog. Kathmandu	One	268	01.12.198	01.01.1985	Being used
Laboratory Distillation Unit.	Balaju Yantra-Shala - Kathmandu.	One	368	01.11.198	01.02.1985	Being used
Oven Dryer (7 K. Watt)	M.E. Traders and Link. Kathmandu	One	2011	01.03.1985	01.03.1985	Being used
Herc Press	Balaju Yantra-Shala - Kathmandu.	One	900	01.02.1985	01.05.1985	Installed
Chain Pulley	Balaju Yantra-shala - Kathmandu.	2 set	463	24.04.1986	24.04.1986	Being used
Water Distillation Plant.	Sethi Engineers Works - Delhi - India	One	5833	05.09.1985	01.04.1986	Installed and Commissioned.
Tank S/S, Vertical, Cap. 400 Litres.	Rohatgi J.S. Fabricator - Kanpur - India.	One	2200	06.09.1985	01.05.1986	Installed and Commissioned.
Tank S/S, Vertical, Cap. 100 Litres.	Rohatgi J.S. Fabricator Kanpur - India.	One	1010	06.09.1985	01.05.1986	Being used.
Storage Tanks, S/S., Cap., 50 L.	,,	Six	1680	06.09.1985	06.05.1986	Being used.
Cap., 100 L.	,,	Six	2310	06.09.1985	06.05.1986	Being used.
Cap., 200 L.	,,	Four	2000	06.09.1985	06.05.1986	Being used.
Cap., 500 L.	,,	Four	4400	06.09.1985	06.05.1986	Being used.
Cap., 1000 L.	,,	Four	5600	06.09.1985	06.05.1986	Being used.

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Liquid Liquid Extractor, Cap., 100 L, ..., S/S, Complete.	Tournaire - France.	One	38707	17.09.1985	01.04.1986	Installed
Hoist, Capacity 1 Ton, Hand Operated	,,	One	1279	17.09.1985	01.04.1986	Being used.
Hoist, Capacity 2 Ton, Electrically Operated, W/Motor.	,,	One	6109	17.09.1985	01.04.1986	-
Rectification Column 10 Cm Diameter x 1.8 M Length, Complete.	Silicaware Bombay - India.	One	3337	26.09.1985	26.05.1986	Installed
Glass Reaction Assembly, Complete	Silicaware Bombay - India.	One	2948	26.09.1985	05.1986	Installed.
Nestler Horizontal 3 Pass Smoke Tube pakced Boiler Model DBO/40.	Nestler Boiler - Bombay - India.	One	25712	06.09.1985	01.04.1986	Installed and Commissioned.
Electric Feed Pump Complete with Motor and Starter Suitable for the above Boiler.	,,	Two	Incl.	06.09.1985	01.04.1986	Installed and Commissioned.
Fully Automatic Pressure Jet Burner Model MV-Way CL5.	,,	One	Incl.	06.09.1985	01.04.1986	Installed and Commissioned.
AFC Control Panel.	,,	One	Incl.	06.09.1985	01.04.1986	Installed and Commissioned.
Hobray Dual Control Device	,,	One	Incl.	06.09.1985	01.04.1986	Installed and Commissioned.
Base Exchange Type Water Softening Plant.	,,	One	1417	06.09.1985	01.04.1986	Installed and Commissioned.
Chimney: Suitable for 1 No. DBO/40 Nestler Boiler.	,,	One	1500	06.09.1985	01.04.1986	Installed and Commissioned.

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Deep Freezers 450 lits., Horizontal Kelvinator Brand.	Binod Sound Sitamarhi Bihar-India.	Two	3000	06.09.1985	02.12.1985	Installed and Commissioned.
Rohatgi Percolator Capacity 1000 Lits.	Rohatgi J.S. Fabricator - Kanpur. India.	One	18500	13.11.1985	01.06.1986	Installed and Commissioned.
'JERIVAK' High Vacuum Pump Model V-15.	J.B. Sawant Engg. Pvt. Ltd. - Bombay - India.	Two	2857	05.02.1986	01.07.1986	Installed and Commissioned.
Counter Current Extractor, 3 Solvent Feeding Tanks in S/S.	Servotech Engg. Bombay - India.	One	14830	03.09.1985	01.09.1986	Installed and Commissioned.
Pulveriser, Capacity 100 kg/hr with 30HP, Flame Proof Motor -	,,	One	8049	03.09.1985	01.09.1986	Installed and Commissioned.
Generator, Capacity 100 KVA Complete with Accessories.	,,	One	21213	03.09.1985	01.09.1986	Installed and Commissioned.
Solar Dryer with Four Shleves and One Small Chimney.	Kathmandu Metal Work - Kathmandu	One	125	20.04.1987	20.04.1987	Installed and Commissioned.
Vacuum Concentrator, Capacity 800 Litres S/S 304 Construction Complete - India.	Servotech Engg. Bombay - India.	One	35924	03.09.1985	01.09.1986	Installed and Commissioned.
Vacuum Concentrator Cap. 300 Litres. S/S. 304 Construction Complete.	,,	One	Incl.	03.09.1985	01.09.1986	Installed and Commissioned.
Air Condition/	,,	One	1720	03.09.1985	01.09.1986	Installed and Commissioned.
Steam Distillation Plant 2000 litres Capacity Hocitril Tilting Type Still	Hocitril Engg. - Assam - India.	One	6186	16.10.1985	01.08.1986	Installed and Commissioned.

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Storage Tank for HCL, Cap. 10,000 Ltr.	Servotech Engg. Pvt. Ltd. Bombay - India.	One	4233	03.09.1985	01.12.1986	Under Installation.
Centrifuge 3-points pendulum suspended heavy duty vertical centrifuge machine	Servotech	One	6329	03.09.1985	01.12.1986	Installed and Commissioned.
Wheeled Tubs	,,	One	355	03.09.1985	01.12.1986	Being used.
Weighing Balance: a) Accuweigh protable platform scale steel yard type 200 kg.	,,	One	2136	03.09.1985	01.12.1986	Being used.
b) Accuweigh semi-self indicating scale heavy duty type 25 kgs.	,,	One	Incl.	03.09.1985	01.12.1986	Needs repair/ replacement
Centrifuge Pumps with motor, cap. 3m³ hour with base plate and coupling	,,	One	6369	03.09.1985	04.12.1986	Installed and Commissioned.
Jasmine Oil Extractor Unit	Sura Fabricator - Coimbatore India.	One	1450	02.07.1985	12.03.1987	Installed and Commissioned.
FRP Tank (Cylindrical) 2000 litres with Jacket.	Servotech Engg. Bombay		5086	03.09.1985	17.06.1987	Being Installe
FRP Tank (Cylindrical) 2000 litres with tilting arrangements	,,		6137	03.09.1985	17.06.1987	Being Installed.
Fine Resin	,,	One				To be Installed by Supplier

List of Project Vehicle

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Toyota Corona, Sedan 1600 CC, Chassis No.: AT 151-0058316, Engine No.: 1A3021926, Reg. No.: Ba Cha 7845.	Toyota Co. Japan	One	5800	24.05.1985	01.12.1985	
Avon Bicycle	Shyam Bahadur and Sons Asan - Kathmandu	One	62	30.04.1985	01.05.1985	

List of Office Equipment and Furniture

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Steel Filing Cabinet	Griha Laxmi Centee - Kathmandu.	One	361	01.11.1984	01.11.1984	
Steel Bookcase Cabinet.	Griha Laxmi Centre - Kathmandu.	one	Encl.	01.11.1984	01.11.1984	
Wooden Table	New Laxmi Kastha Udyog - Kathmandu.	Two	439	02.11.1984	02.11.1984	
Wooden Chairs	New Laxmi Kastha Udyog - Kathmandu	Six	Encl.	06.11.1984	06.11.1984	
Steel Cabinet	Valley Furnisher Corner - Kathmandu.	One	219	01.09.1985	01.01.1985	
Wooden Table	Valley Furnisher Corner - Kathmandu	One	205	01.10.1985	01.10.1985	
Wooden Chairs	Valley Furnisher Corner - Kathmandu.	Two	Encl.	01.10.1985	01.10.1985	
Olympia Typewriter 13-5503163	Mercantile Traders - Kathmandu.	One	764	16.11.1985	01.01.1986	
Steel Plain Almirah	Valley Furnisher Corner - Kathmandu.	One	129	01.07.1986	01.07.1986	
Wooden Office Table	Valley Furnisher Corner - Kathmandu.	One	314	01.09.1986	01.09.1986	
Wooden Dunlop Chairs	Valley Furnisher Corner - Kathmandu.	Five	Encl.	05.09.1986	05.09.1986	
Steel Plain Office Cabinet.	Valley Furnisher Corner - Kathmandu.	Two	304	22.05.1987	25.05.1987	

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Modern Flow Fine Heater.	Supreme Electric - Kathmandu.	Three	147	03.12.1985	03.12.1985	
Voltage Stablizer For Plain Paper Copier (Sen and Pandit).	Pacific Circle - Kathmandu.	One	189	01.05.1986	01.06.1986	
IBM MR. Model 570 Plain Paper Copier Complete. No. 78-9236-310R-5.	IBM Singa-Pore.	One	3250	06.01.1986	01.04.1986	

List of Laboratory Apparatus, Equipments, Chemicals and Solvents.

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Glassware Apparatus	Valley En Enterprises Kathmandu.	Various items	1545	08.04.85	08.04.1985	
Laboratory Apparatus and Equipments.	Valley Enterprises Kathmandu	Various items	847	11.10.1985	30.10.1985	
Chemicals and Solvents.	Chemical and Instrument Corporation - Calcutta - India.	Various items	740	19.01.1986	18.06.1986	
Chemicals and Solvents.	E. Merck Limited - Calcutta - India.	various items	1092	21.01.1986	07.09.1986	
Glassware Apparatus	Jindal Scientific Delhi - India.	Various items.	792	19.01.1986	28.09.1986	
Glassware Apparatus and Oven	Griffin and George U.K.	Various items.	2620	26.01.1986	07.08.1986	
Glassware Apparatus	Griffin and George U.K.	Various items.	2279	26.01.1986	15.08.1986	
Chemicals and Solvents	E. Merck Limited - Calcutta - India.	Various items.	946	21.01.1986	08.12.1986	
Laboratory Equipment. (Centrifuge, Stirrer, Oven (Vacuum), and other items.)	Nirmal International - Delhi India.	Various items.	3253	19.01.1986	31.01.1987	
One set thin Layers Chromatography Kit.	Valley Enterprises - Kathmandu	Various items.	333	19.01.1986	01.07.1986	
Dial Thermometer +15° to -40°C.	Valley Enterprises - Kathmandu.	Various items.	129	07.07.1986	07.07.1986	
Glassware Apparatus	Valley Enterprises - Kathmandu.	Various items.	847	11.10.1985	10.1985	

Description	Company	Unit	Value (US$)	Date of Order Date of Purchase	Date Received	Remarks
Glassware Apparatus	Valley Enterprises - Kathmandu.	Various items.	1537	08.04.1985	04.198?	
Heating Elements	Supreme Electric - Kathmandu/	one	29	29.01.1986	29.01.109?	

Annexure IV.

List of Workshop Items

Description	Company	Unit	Value (NRS)	Date of Order Date of Purchase	Date of Received	Remarks
Welding set 450 Amps. DC Type, Advani Make and Accessories.	Rani Machinery Kathmandu.	1 Set.	1943	10.11.1986	29.05.1987	Being used.
Lathe Machine complete size 6½ ft.	Rani Machinery Kathmandu	1 set.	2397	04.11.1986	26.01.1987	Being used.
Milling Machine No. '0' with Dividing Head, Boring attachment stanley attachment, Motor & Pump.	Rani Machinery Kathmandu	1 set.	2778	04.11.1986	07.11.1986	Being used.
Air Compressor Double cylinder with 3 HP, 440 V, motor pressure switch (Automatic)	Rani Machinery Kathmandu	1 set.	753	04.11.1986	31.12.1986	Being used.
Hacksaw Machine Complete with 1 HP, 440 V, Motor and Blade.	Rani Machinery Kathmandu	1 set	395	07.10.1986	07.10.1986	Being used.
Steel Cabinet for Workshop.	Valley Furnisher Corner - Kathmandu.	Two	299	05.11.1986	05.11.1986	Being used.
Wooden Workshop Table.	Dan Kastha Udyog - Kathmandu.	One	142	19.09.1986	24.09.1986	Being used.
Engineering Tools	National Trading Co. Ltd. Kathmandu	Various Items.	59	08.09.1986	08.09.1986	Being used.
Engineering Tools	National Trading Co. Ltd. Kathmandu	Various Items.	72	08.09.1986	08.09.1986	Being used.

Physico-Chemical Properties of some important Essential Oils produced in HFFCL.

1. Oil of Juniper leaves

Oil content 0.83 to 1.12 percent
Specific gravity 0.858 (29°C)
Optical rotation + 47°
Acid value 0.17
Ester value 12.78
E.V. after acetylation 60.35

2. Oil of Abies Spectabilis Needles

Oil content 0.43 percent
Specific gravity 0.8781
Acid value 0.25
Ester value 26.84
Ester content 9.39 percent
(Calc. as bornyl acetate)
Ester value after acetylation 66.43

3. Oil of wintergreen

Oil content 1.2 percent
Specific gravity 1.1727 (20°)
Optical rotation -0.30°
Ester content (Calc as methyl salicylate) 94.34 percent
Solubility in 70% alcohol 1:1.3 (20°C)

4. Oil of Rhodendron leaves

Oil content 0.8 percent
Specific gravity 0.8819 (15°C)
Optical rotation -26° 30'
Acid value 2.42
Ester value 12.72
Ester value after acetylation 75.11
Carbonyl value 11.56
Solubility Insoluble in 95% alcohol up to 10 volumes.

5. **Oil of Tagetes minuta**

Oil content 0.5 percent
Ester value 21.48
Ester value after acetylation 79.36
Carbonyl content (Calc. as tagetone) 37.65 percent

6. **Oil of Citronella (Java type)**

Specific gravity 0.8866 (30°C)
Acid value 0.15
Ester value 45.70
Ester value after acetylation 257.16
Free alcohols (Calc as geraniol) 69.85 percent
Total alcohols (Calc as geraniol) 85.65 percent
Carbonyl content (Calc as citronellal) 28.57 percent

7. **Oil of Palmarosa**

Specific gravity 0.8832 (20°C)
Acid value 0.19
Ester value 47.09
Ester value after acetylation 277.53
Total alcohols (Calc as geraniol) 92.77 percent

8. **Oil of Sugandh kokila**

a) **Oil from air dried berries: Standard oil**

Specific gravity 0.9368 - (20°C)
Optical rotation - 4.43°
Refractive index 1.4891 (20°C)
Acid value 2.97
Ester Value 72.69
Ester value after acetylation 110.37
Carbonyl content (Calc as $C_{10}H_{16}O$) 8.85 percent

b) Oil from once distilled berries (dried marc).

Specific gravity	0.9511 - 0.9597 (20°C)
Optical rotation	-39.03° to -40.97°
Acid value	40.35 - 65.42
Ester value	95.85 - 107.79
Ester value after acetylation	142.39 - 158.88
Carbonyl content (Calc. as $C_{10}H_{16}O$)	4.3 - 6.56 percent

c) Rectified oil

Specific gravity	0.9496 (20°C)
Optical rotation	- 5.05°
Acid value	7.76
Ester value	85.14
Ester value after acetylation	158.88
Carbonyl content (Calc. as $C_{10}H_{16}O$)	6.73 percent

d) Oil of lots of 100 kg - 550 kg despatched abroad

Specific gravity	0.9263 - 0.9434 (20°C)
Optical rotation	- 5.05° to - 20.0°
Acid value	1.89 - 13.12
Ester value	68.13 - 78.68
Ester value after acetylation	115.51 - 130.07
Carbonyl content (Calc. as $C_{10}H_{16}O$)	5.66 - 8.37 percent

e) Fore-runs obtained during rectification

Specific gravity	0.8792 (20°C)
Optical rotation	-24.5°
Acid value	1.01
Ester value	10.18
Ester value after acetylation	32.15
Carbonyl content (Calc as $C_{10}H_{16}O$)	1.79 percent

Annexure VI.

Content of Essential Oil in Aromatic Plants

	Percent (By Weight)
1. Abies spectabilis (leaves and twigs)	0.19 - 0.56
2. Angelica archangelic	
i) Roots	0.24
ii) Seeds (old material)	0.10
3. Artemisea spp. (whole plant)	0.23 - 0.33
4. Acorous calamus (rhizomes)	3.32 - 3.5
5. Basil (Ocimum basilicum)	0.[illegible]
6. Chamomilla (Matricaria Chamomila dry flowers)	0.4
7. Cistus ladanifera (seeds)	traces
8. Coriander (local)	0.2 - 0.25
9. Davana (Artemisea pallens) (Whole plant - dry)	0.2 - 0.25
10. Jatamansi - (rhizomes)	0.68 - 1.2
11. Jethimadhu (Alpinea malaccensis)	1.73
12. Juniper communis	
i) Berries	0.4 - 0.8
ii) Leaves and twigs	0.57 - 0.87
13. Juniper recurva	
i) Berries	3.3
ii) Leaves and twigs	1.12
14. Origanum marjorana (whole plant)	1.62
15. Pine cones	1.18
16. Sugandha kokila	
i) Dry berries	4.0 - 5.0
ii) Once distilled berries dried (Marc)	0.5 - 1.0
iii) Oil from expressed fat from completely exhausted berries (dry)	3.03 - 3.20
17. Tagetes minuta (whole flowering plant - air dried)	0.5
18. Tejpat (Cinnamomum tamala) (dry leaves)	0.65
19. Timur (xanthoxulum armatum)	
i) Fruit whole	3.5
ii) Husk	5.59

		Percent (By Weight)
20.	Thuja occidentalis	
	i) Seeds whole	0.6
	ii) Seeds - powdered	1.15
21.	Vetiver (North Indian)	0.3
22.	Wintergreen (Gaultheria procumbens - dry leaves)	1.2 - 1.28
23.	Rhododendron (dry leaves)	0.43

Content of Concretes, Resinoids and Absolutes

01.	Artemisea concrete (n-Hexane as solvent)	2.0
02.	Calamus Oleo-resin (n-hexane as solvent)	7.14 - 19.0
03.	Cistus ladanifera	
	i) Pet. ether extract	0.41
	ii) Benzene extract	2.59
04.	Jatamansi concrete	
	i) Alcohol as solvent	6.30
	ii) n-Hexane as solvent	2.90
05.	Sugandha kokila concrete (n-Hexane as solvent)	
	i) From dry berries	28
	ii) From dry - once distilled berries	30
	iii) From husk	3.5 - 4.42
	iv) Seed kernel	30.0
06.	Valerian (V. wallichii rhizomes)	
	i) Alcohol as solvent	14.5 - 18.0
	ii) n-Hexane as solvent	2.0
17.	Osmanthus (using n-hexane as solvent)	
	i) First extraction	0.23
	ii) Second extraction by soxhelt	0.03
	iii) Soxhelt extraction of fresh flowers	0.60
18.	Sugandha kokila absolute	
	i) From n-hexane extractive	24.0
	ii) From fat from marc	1.55

19. Tree moss (Resinoid - Alcohol extracts)

i)	Parmelia tinctorum	23.0
ii)	P. nepalensis	11.82
iii)	Usnea species	11.66
iv)	Commercial lot containing above three	8.0 - 20.0

20. Tree moss absolute

i)	Parmelia tinctorum	20.62
ii)	P. nepalensis	7.63
iii)	Usnea species	6.30
iv)	Commercial lot containing above three	6.20 - 9.28

21. Tree moss - benzene extract 1.7 - 2.0

22. Ammi majus absolute 18.55

23. Musk absolute 0.3 - 0.6

Content of active principles of Medicinal Plants

01. Berberis species (bark) 1.25

02. Belladonna (leaves) 0.3 - 0.5

03. Dioscorea deltoidea

i)	From tubers	1.35 - 1.84
ii)	From hydrolysed material	5.88 - 7.59

04. Podophyllum resin from

i)	Rhizomes	1.12
ii)	Rootlets	1.70

Miscellaneous

01. Sugandha kokila fixed oil

i)	By solvent extraction	30.0
ii)	By expression	16.0

02. Xanthoxylum seed

i)	By solvent extraction	16.0 - 17.0

List of International Staff

Baldev Gulati	Production Technologist/ Chief Technical Adviser	10 October 1984 - 9 April 1985; May 1985 - January 1988
Walter J. De Boeck	Cost-Benefit Analyst	19 January 1985 - 18 April 1986 May 1985 - June 1986
V. Sitaram	Marketing Consultant	2 April 1985 - 9 June 1985.
Shahid Ahmed	Engineer	11 August 1986 - 10 November 1986 18 May 1986 - 10 August 1987.
Klaus Anthoni Duerbeck	Associate Expert	16 January 1987 - early 1988.

Recommendation of the experts are given in the following pages.

International Staff

The Project besides CTA had provision for experts in the following fields:

1. Economist-Cost Benefit Analyst
2. Marketing Expert.
3. Engineer.
4. Short-term Consultants

Details of their assignments are given in Annexure VII.

Summary of findings and recoomendations by the experts are given hereunder:

1. Economist-Cost Benefit Analyst - Economist was earlier scheduled to work for 12m/m. It was, however, felt that 6m/m were sufficient to complete his work. The assignment was completed in 2 split missions of approximately 4m/m and 2m/m respectively. During the first mission, study was completed on cost calculations of cultivated crops and a tript abroad to find possibilities of sale of HPPCL products. His main findings are:

1. In order to be profitable, HPPCL needs to exapnd Tamagadhi Farm to at least 100 ha without increasing overhead expenses and to reduce direct production costs.

2. Of all the crops, palmarosa is the most profitable one. Production of its oil can be increased to 5 tons. Mentha would be more economical if grown by farmers. From the farmers point of view, the crop is an attractive proposition.

   Lemongrass is not economical production although it has some margin of profit.

3. Belladonna, as a crude herb, cannot compete in the international market. There is some scope of its marketability in India.

   Main potential for belladonna lies in producing and marketing its extract, in local, regional and international markets.

4. In respect of crude herbs, HPPCL has a relative price disadvantage due to higher overhead expenses. The potential lies in developing a reputation for quality and reliability towards overseas customers to effect slight price disadvantage.

The Expert recommends:

a. Production programme should concentrate on items with proven profitability and market acceptance.

b. HPPCL should interact to the maximum possible extent with the private sector for technology transfer and market intelligence as private enterprise is likely to more cost efficient.

c. Tamagadhi Farm should be made a profit centre within HPPCL with more powers to work and take decisions.
Main emphasis should be given to palmarosa in the cropping pattern. Mentha should be given to farmers for cultivation Cultivation of citronella and lemongrass should be emphasised.
Mentha products should be developed as import substitution.

d. Possibility of exporting some form of belladonna extract to the consumers direct should be explored besides exploring regional market.

e. For improving efficiency of the HPPCL, management information system should be introduced (as per system given in the report by the Expert).

Regarding sale of products and herbs in Europe, the Expert recommended:

1. Sale of extracts is not feasible unless programme to produce high quality extracts as a joint venture with users in Europe is made which could have a chance of success.

2. There is more chance in developing a product line based on Himalayan herbs, there also only high quality products will have any chance. This venture be taken up with some well established European firm who is willing to take responsibility for product choice, packaging and marketing.

3. For products like diosgenin, xanthotoxin, rauwolfia roots, there is a possibility if dealt through some European company trading in these. Appointing a sales representative is recommended.

4. Regional markets may offer greater scope for selling plant extracts, as drugs from botanical origin are still used here. Such extracts are imported mostly from the west.

In general, European Companies contacted by the Expert were more open towards purchasing essential oils from developing countries than purchasing herbal extracts.

2. Marketing Expert - Main recommendation of the Expert are:

1. The Trade Promotion Centre and the HPPCL should make joint efforts for promoting exports keepkng in view quality, quantity and timely supplies at competetive rates and as per requirement of international market. Trade Promotion Centre should concentrate on marketing strategy, market intelligence and publicity of Nepalese products overseas, sponsorning and inviting delegations.

2. To build international contacts more meaningful and on long term basis, efforts to be made by constant dialogue with overseas buyers/ brokers/perfumers for buy back arrangement of manufacturered. goods.

3. Necessary regulatory steps to be taken by H.M.G. Nepal for improved exports.

4. Planning cultivation and producing products keeping in view international demand.

5. Assistance and active co-operation of H.M.G.'s Commercial representatives in Embassys abroad for publicity and assistance in locating long term buyers of Nepalese products.

6. Overseas market study should be carried out by the HPTCL, Trade Promotion Centre and Private Exporters with Government Assistance for contacts, pricing, new product development etc.

3. Plant Engineer - The plant engineer's mission was completed in two split periods of 3 months each due to staggered arrival of equipment, need to complete civil work for housing boiler, workshop equipment and generator. The job was completed during August 86 - October 1986 and May 1987 - August 1987. Two repotts were submitted.

Recommeddations made in the first report were accepted and taken care of to a large extent. Main recommendation pertained to

i. Completion of civil work
ii) To make provision for improved electric load
iii) Rewire the factory in accordance with set standards for safety.

In the terminal report following recommendation were made:

i) Order for remaining equipment to be expedited.
ii) Water supply system to be completed.
iii) Lagging of steam pipes and jackets for heat consumers to be completed.
iv) Replace undersize steam pipes.
v) Condensate return system to be installed.
vi) Training of maintenance personnel on general workshop practices.

As a long term measure the Engineer has recommended consideration of expansion of the plant to match the rate of growth.

The HPPCL has appointed a well qualified engineer who is attending to various recommendations. For long term recommendation, the matter is likely to be considered at the next TPR, if necessary.

List of Documents Produced

I. International Staff

1.	Baldev Gulati Production Technologist/ Chief Technical Adviser	Technical Report, 8 April 1985 (covering period 10 October 1984 - 8 April 1985)
2.	i) Walter J. De Boeck Cost Benefit Analyst	Technical Report, 25 April 1986 (covering period January 1986 - April 1986)
	ii) - do -	Technical Report, 17 July 1986 (covering period May-June 1986)
3.	V. Sitaram Marketing Consultant	Technical Report: Promotion and Marketing of Nepalese Medicinal Plants and Essential Oils, No. DP/ID/Ser A/731 20 August 1986. (Covering period 2 April 1986 - 9 June 1986).
4.	Shahid Ahmed Engineer	First Terminal Report: 12 November 1986 (covering period 11 August 1986 to 10 November, 1986). Terminal Report, 10 August 1987 (Covering period 18 May 1987 to 10 August 1987).

II. National Staff

A. Study Tours

1. Asfaq Sheak National Project Director	Report on Tour-sale Promotion of the Herbal Products and Finalisation of Equipment List with UNIDO (3 September 1985 - 4 October 1985).
2. Paras Man Tuladhar Sales Officer	Report on Market Study Tour and Export Market Selection and Development Market (Organised by ITC/UNCTAD/GATT) (30 April 1986 - 23 May 1986)

B. Training Programmes

1. Uddhab Raj Poudyal Senior Processing Officer	Report on Training at Chelsea Department of Pharmacy, London, and Regional Research Laboratory Jammu and Srinagar - India (7 February 1986 to 12 April 1986 14 July 1986 to 16 September 1986).
2. Mrs. Hima Chapagain Production Officer (Quality Control)	Report on Training at TDRI, London and Portsmouth Polytechnic School of Pharmacy, Portsmouth, U.K. (1 September 1986 - 24 October 1986).
3. Mrs. Minoka Yonzon Processing Officer	Report on Training at Ceylon Institute of Scientific and Industrial Research Colombo - Srilanka (2 December 1986 - 14 February 1987)
4. Jaya Pradhan Processing Officer	Report on Training in Extraction of Vegetable Tanning at Central Leather Research Institute, Madras - India (5 January 1987 to 4 February 1987).

Annexure 14.

List of Books Purchased

		£
01.	Beal (Ed.): Natural Products as Medicinal Agents (Hippokrates), Beal & Reinhard	29.60
02.	Koedam. A.: Aromatic Plants (Basic and Applied Aspects), 1982 (Nijhoff)	29.75
03.	Morton, J.E.: Major Medicinal Plants (Botany, Culture and Uses) (C.C. Thomas)	51.45
04.	Purseglove, J.W.: Spices (Tropical Agricultural Series) (Longman) Volumes 1 and 2.	50.00
05.	Guenther, E.: The Essential Oils (6 Volume set) (Krieger)	205.60
06.	British Pharmacopoeia (H.M.S.O) (2 Volume set) Addendums 1982 and 1983	70.00
07.	Martindale: Extra Pharmacopoea (pbk) (Pharmaceutical)	69.00
08.	The Pharmaceutical Codex (Pharmaceutical) (This is the reOtitled edition of British Pharmacopoeia Codex)	27.00
09.	Modern Methods of Plant Analysis (Springer Verlag) Volumes I, III, IV, V, VI and VII.	381.90
10.	Morbrey (Ed.): Proceeding: Conference on Spices (Tropical Products Institute, April 1972) (Tropical Development and Research Institute)	2.60
11.	Flavour and Fragrance Materials, 1981	68.90
12.	Lawrence, B.M.: Essential Oils, 1976-1978	33.00
13.	Lawrence, B.M.: Essential Oils, 1978-1980	33.00
14.	You and Your Health Volume I, II, III.	IC Rs.750.00
15.	1 Deutsche Arzneibuch DAB 6	Brf. 2.850
16.	1 addendum to DAB 6	2.750
17.	1 Deutsche Arzneibuch DAB 8 Ausgabe 1978	2.850
18.	2 DAB 8 addendum	1.700

Annexure X.

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO

PROJECT IN THE KINGDOM OF NEPAL

JOB DESCRIPTION

DP/NEP/80/044/11-01/32.1.D.

Post title	Production Technologist/Chief Technical Adviser
Duration	24 months (6 m/18m)
Date required	October 1984
Duty station	Kathmandu
Purpose of project	To enable His Majesty's Government (through the Herbs Production and Processing Company) to acquire processing technology for the production of plant-derived pharmaceuticals.
Duties	The expert will assist the Herbs Production and Processing Company to initiate semi-commercial, scale processing of selected medicinal and aromatic plants, to produce pharmaceuticals and essential oils for local use and for export purpose. The expert will be required, with the assistance of local counterparts and fellow experts (one plant engineer - six months; one economist/cost benefit analyst - 12 months) to plan and organize all activities of the Herbs Production and Processing Company connected with the procurement of plant, raw materials, storage, processing and quality ensurement, and distribution of finished products.

During the first phase of the split mission, the expert will specifically be required to:

1. Prepare (in collaboration with local counterparts) a realistic time-framed work plan for the project's defined activities.

2. Assess the equipment already available, prepare a list of equipment within the budgetary allocation of the project, and take the necessary steps for its procurement by the usual UNIDO procedures.

3. Evaluate existing facilities in the analytical laboratory of H.P.P.C., prepare list of requirements for routine work of plant analysis and quality assessment of the raw material and finished products and take steps to equip the laboratory.

4. Initiate analytical and quality assessment work in the laboratory and semi-commercial trial production of plant derived products with available facilities.

During the second phase of the mission, the expert will specifically be required to:

1. Continue semi-commercial production of plant derived products using available facilities.

2. Install, operate and maintain machinery with the assistance of Plant Engineer.

3. Equip the routine analytical laboratory; start regular chemical analysis of plant products and quality assessment work.

4. Undertake process development for the extraction of herbs and essential oil distillation as per the items mentioned in the project.

5. Purify the isolated active principles of medicinal plants on a commercial scale.

6. Stabilize the product and develop suitable packing methods.

7. Standardize and develop analysis methodology for products.

8. Modify and redesign the machinery as required, and redeploy all the existing units if deemed necessary.

9. Train the company processing staff in all aspects of processing aromatic and medicinal plant raw materials.

The expert will be required to prepare a final report, setting out the findings of the mission and recommendations to the Government on further action which might be taken.

List of Officials and Experts in Contact during the Project

Officials and Scientists of HMG of Nepal

01.	Mr. J.L. Maskey	Secretary - Ministry of Forests and Soil Conservation (1984 - 1986).
02.	Mr. B.N. Khujeli	Secretary @ Ministry of Forests and Soil Conservation ((1987)
03.	Dr. S.B. Malla	Director General -Department of Medicinal Plants.
04.	Dr. S.B. Rajbhandary	Deputy Director General - Department of Medicinal Plants.
05.	Dr. P.M. Adhikari	Senior Scientific Officer - Royal Drugs Research Laboratory.
06.	Dr. S.R. Adhikari	Senior Scientific Officer - Royal Drugs Research Laboratory,
07.	Mr. A.D. Shrestha	Senior Scientific Officer - Royal Drugs Research Laboratory.
08.	Dr. K.R. Amatya	Scientific Officer - Royal Drugs Research Laboratory.
09.	Dr. A.B. Shrestha	Member - Royal Nepal Academy for Science and Technology.

UNDP Officials

01.	Mr. T. Niwa	Resident Representative - United Nations Development Programme.
02.	Mr. A. Genir	Deputy Resident Representative - United Nations Development Programme.
03.	Dr. R.S. Mahat	Senior Programme Officer - United Nations Development Programme.
04.	Mr. A.N. Joshi	Programme Officer - United Nations Development Programme.
05.	Mr. B.K.L. Joshi	Senior Programme Officer - UNDP.
06.	Mr. D. Plas	Junior Professional Officer - United Nations Development Programme.
07.	Mrs. Inger Lassen	Junior Professional Officer - United Nations Development Programme.
08.	Mr. S.M. Poudyal	Administrative and Finance Officer - United Nations Development Programme.
09.	Mr. N.C. Chowhan	Assistant Finance Officer - United Nations Development Progeamme.
10.	Mr. G.P. Dhital	Personnel Officer - United Nations Development Programme.

UNDP Experts

01.	Mr. V. Dupont	Chief Technical Adviser (1984 - 1986)
02.	Dr. O. Bojor	Expert DP/NEP/80/003

National Counterpart

01.	Dr. A. Sheak	General Manager (National Project Director), Herbs Production and Processing Co. Ltd. Kathmandu.