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DEVELOPMENT OF INDUSTRIAL PRODUCTION OF ESSENTIAL OILS, AROMAS AND FLAVOURS

DP/VIE/84/010

THE SOCIALIST REPUBLIC OF VIET NAM

Terminal report*

Prepared for the Government
of the Socialist Republic of Viet Nam
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

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* This document has not been edited.

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TABLE OF CONTENTS

I. INTRODUCTION

During the early part of the century, the Vietnamese Essential oil industry was concentrated largely in the rural areas of the country and enjoyed a high international reputation. As a result of the events that followed, the production and even the quality of oils dropped leading to a loss of international markets. The raw material resource base too dwindled as a result of change of cultivation priorities in rural areas.

The government of Vietnam recognized the importance of re-developing the industry as a major step in its plans to improve and develop the economy of the rural areas. At the same time, if the quality of the oils produced could be improved to conform to international standards, the re-capture of markets abroad would bring in much needed foreign exchange revenue.

The old distillation stills which have been used over the years were in need of modernization. The yields and quality of oils had to be improved to regain the loss markets.

The Government therefore considered the development of the Essential Oils Industry as a priority area in its five year plan of 1986-90 within the "Assessment and Exploitation of Natural Resources". In April 1985, a request was made to UNDP/UNIDO for technical assistance for the strengthening of the industry through application of modern technology.

A pre-feasibility study was first carried out in April/May 1986 which resulted in the Project " VIE/84/010, Processing of Vietnamese Essential oils and related natural products". Although the project document was signed in October 1987, the implementation commenced in April 1988. The duration of the project was three years.

The National Centre for Scientific Research (NCSR) was identified as the national implementing agency with its Essential oils division as the project site. As a consequence of the changes in economic policies of the country , the essential oils division was transformed into an autonomous commercial Enterprise named ENTEROIL which undertook the responsibility of the implementation of the project. This was unusual to other projects in that an independent trading company within a prestigious R & D centre having complete freedom to directly trade in essential oils both nationally and internationally was for the first time given the responsibility of being the official counterpart to a project. Thus a change in emphasis of project activities was required in order to give greater importance to strengthening of marketing aspects .

II. DEVELOPMENT PROBLEMS

The immediate development problem was to increase the production of Vietnamese essential oils for export by upgrading technology and improving the quality to international standards. Development of marketing expertise and contacts with foreign markets was also envisaged as an important activity . The transfer of technology developed at Enteroil to provincial production centres as a means of future production was considered as the effective way by which the rural economy could be developed .

The technical solutions to the above were achieved by the provision of modern distillation and fractionation equipment for R & D and pilot scale production, an up-to-date analytical laboratory for quality assessment and improvement (Annex 1) supported by the transfer of technology through expert services and improvement of know-how and self-reliance of counterpart staff by training both locally and overseas .

Furthermore the local engineering capabilities were improved by transfer of know-how on designing and local fabrication of improved stills and fractionating columns. This overall approach was highly effective in improving the quality and quantity of essential oils produced at Enteroil. The initial transfer of technology for distillation has been made through installation and commissioning of field distillation units in rural areas which resulted in the farmers being convinced of the effectiveness of the improved stills for better yields and quality of oils. This built the confidence of the rural farmers to initiate systematic cultivation to produce the raw materials needed for processing, resulting in increased rural employment, biodiversity conservation and income generation. The control of the quality of oils produced was done at Enteroil through issue of quality certificates for exporters and private Enterprises.

Marketing contacts have been made through visits of counterpart staff to trading houses abroad and by attending international conferences and trade fairs .The market strategies and planning have been strengthened by use of international experts. The technical approach to achieving the outputs and thereby the objectives were appropriate and sound in achieving the infrastructure strengthening function of the project.

III. REALIZATION OF OUTPUTS

The original project document contained seven outputs. Several modifications were made at the first Tripartite Review Meeting held in December 1989 . Output 3(a) Multipurpose demonstration unit for distillation and solvent extraction was dropped due to very high cost of equipment which would have caused an over-run in the budget. Furthermore the running costs would have been very high due to non-availability of solvents in Vietnam.

One of the major requirements of setting up of an analytical laboratory for quality assessment for which budgetary provision has been made in the project was included as an output at this meeting.

Some additional outputs (see below) were agreed upon to re-allocate the funds earmarked for the solvent extraction equipment. Consolidation of some of the outputs was possible out of the savings resulting from the local fabrication of equipment at a fraction of the cost of imported items.

The status of the outputs produced and problems encountered are given below:

Output 1: Demonstration field distillation unit

A still of 1000L capacity of French design was installed. It is fully operational being used for demonstration of pilot production and R & D work on new oils. The oil separator was modified to make the still more versatile. Process parameters to obtain optimum yields of good quality oils have been developed and technical reports (in Vietnamese) containing these protocols have been produced (Annex 2).

Demonstrations of 200 kg batches have been conducted to train producers from the provinces. Star anise, Cassia, Ocimum gratissimum and Ocimum basilicum have been processed. This unit is also being used for re-distillation of contaminated and adulterated oils. Training of producers in distillation technology will be continued which will have a marked impact on the quality and yields of Essential oils produced in the provinces.

Output 2: 2000l capacity field distillation still using natural gas as fuel to generate steam externally.

A still of 2000L capacity of French design has been supplied and commissioned. The equipment supplied is fuel fired as natural gas is not available in Hanoi. A prototype could be fabricated locally for use of natural gas when transfering to areas where gas will be available. This plant is too large for operation at Enteroil as large quantities of raw material are required for economically viable production. It therefore has to be transfered to a province where raw material availability can be guaranteed.

Output 3(a): Deleted at TPR Meeting

Output 3(b): **Bench scale 40l capacity all glass fractional distillation column for preparing upgraded oils pure isolates and deterpenated and rectified oils**

Due to high cost, an all glass fractional distillation unit of 25L capacity has been supplied and commissioned. The unit is fully operational and is being used for bench scale operations for determining parameters for upgrading inferior oils, rectification and preparation of isolates. These parameters are used to upscale production on the 150L fractionating unit fabricated locally. Large number of oils have been fractionated for R & D work and for developing parameters for upscaling. Many people have been trained using this piece of equipment.

Output 4: **Training**

(a). 6-8 scientists and technologists trained with knowledge of up-to-date distillation and extraction technology in relation to the Essential oil industry

Trainirg was an essential part of the project and consisted of (i) study tours by senior staff, (ii) training fellowships for technical staff at advanced centres overseas, (iii) on the job training and workshop by experts (iv) participation at international conferences and workshops and (v) provision of latest books and journals.

(i) Five senior staff members including the NPD visited organizations in India, France and Germany connected with R & D and production of Essential oils and perfumes and cultivation of aromatic plants. Visits to some industrial enterprises and UNIDO Headquarters were also included in the 8-week study tour (Annex 3). The participants enriched their know-how and learnt the latest developments of the industry during the study tour. This know-howwas used in planning and development activities of ENTEROIL.

(ii) Training fellowships

Eight staff members were trained (27/mm) in India in distillation technology, design and fabrication of equipment, agro-technology and quality control (Annex 3). The knowledge and experience gained by them have been gainfully employed in upgrading the processing and quality of Essential oils. They also have in turn disseminated the know-how gained to other scientists in the provinces. The reports submitted by them will serve as guide material for future training (Annex 4). The NPD spent two weeks at the UNIDO project site in Eskisehr ir Turkey to update his knowledge in modern analytical techniques and the setting up of national data base.

(iii) Eight international experts were fielded during the project period. Some were directly involved with the outputs of the original document while some assisted in transfer of know-how on additional outputs (Annex 5). While Technology and know-how transfer was the main task of these experts, they also trained the counterpart staff in their special fields and conducted seminars and group training courses for technical personnel from the provinces.

The maintenance of equipment and solution of trouble shooting were demonstrated in addition to training in good manufacturing practices and general safety.

(iv) Participation at international congresses and workshops

Some counterpart staff members attended international conferences and workshops (Annex 3) to enhance their know-how and to learn about the latest R & D work on Essential oils.

The participants made good contacts with foreign scientists and technologists which could be useful in initiating collaboration and cooperation programmes in related activities.

(v) Books and journals (Annex 6) were supplied during the project period. These will serve as reference materials and in future training activities.

(b). 6-8 operators of field distillation units trained on problems regarding factors such as siting of field stills and the necessity of adequate maintenance, the economies needed to be effected in materials particularly water and post harvest treatment of raw materials prior to distillation.

A large number of operators of field distillation units were trained on all aspects of technology improvement, siting of field stills, maintenance, trouble shooting, post harvest treatment , energy saving and economy of production. Some counterpart staff from Enteroil visited the provinces to advise on the above aspects and demonstrate proper use of stills and energy saving.

Output 5: Rehabilitated rural distillation units (minimum of two)

Rehabilitation of many rural distillation units have been achieved (Annex 7). Furthermore, counterpart staff members have visited these units to advise and guide them on optimising the operational parameters to obtain better yields and quality oils.

Output 6: Established link with international trade, through which the ministry of foreign trade or its designated agency will then be able to call upon likely buyers in foreign countries by establishing contacts with those utilizing essential oils as raw materials.

This output as indicated to involve the Ministry of Foreign Trade was no more relevant as government has allowed Enteroil to establish trade contacts directly. This is the most significant and quantifiable output as seen by the export figures (Annex 8) and trading contacts that have been made. This output was consolidated by sending the Director of Enteroil, the marketing manager and the NPD on a visit to UK to establish trade links. The Director of Enteroil and secretary of the project participated at the International Congress of Essential Oils and Flavours in Vienna where they were able to make some useful trade contacts.

An international marketing expert conducted lectures on theory and practices of marketing, market planning and techniques. His report described many market strategies and trading practices for export.

The real impact of the project activities is well demonstrated by this output. In addition to increase of export, product diversification has also taken place. One problem for export is non-availability of sufficient raw materials of certain essential oils due to lack of systematic cultivation. This problem has to be urgently addressed if a steady export market is to be maintained.

Output 7: Established investment policy to ensure continuing cultivation, processing activity and incentives for export and marketing, as well as institutional and practical links between production centres and marketing outlets.

The Government has decentralized the entire production, marketing and export of Essential oils. Hence encouragement of private enterprises may be useful by provision of credit facilities.

The activities of Enteroil specially training and demonstrations relevant to essential oils production have encouraged and assisted in building-up of confidence of the private sector to expand production capacities. Furthermore the analytical facility of Enteroil issues quality certificates to enable them to export the products and get the international market prices.

Output 8: An operational analytical laboratory

This output though not spelled out in the original project document was implied as seen by the list of equipment in the original project document. The following analytical instruments have been supplied and commissioned.

-GLC with automated integrator
-HPLC
-TLC equipment with densitometer
-IR spectrophotometer
-UV spectrophotometer
-Refractometer
-Moisture balance
-Analytical balance
-Melting point apparatus
-Polarimeter
-Some other physico-chemical instruments

These are fully operational and have contributed to the achievements of the outputs by providing the much needed back-up on quality control, process control and the development of analytical methods. The laboratory has analysed more than 12,000 samples from a large cross section of enterprises. The laboratory has been recognised by the government as the Quality Certification Laboratory for Essential oils. The establishment of quality assurance has contributed to recognition of the quality of Vietnamese Essential oils abroad.

NEW OTPUTS AGREED AT TPR MEETINGS:

1. **A pilot plant scale 150L capacity/batch all stainless steel fractionating column for preparing fragrance isolates and upgrading of quality of inferior oils.**

This column was fabricated locally with guidance from international experts. It is fully operational and in extensive use to upgrade oils and for R & D work. The initial experiments done at the bench scale (all glass) column can be upscaled using this column. This is a very good example of success in achieving self-reliance in local engineering capabilities. The designing was done with inputs from local staff and the fabrication was accomplished in quick time. The column has stood the wear and tear of extensive use.

2. A crystal menthol plant to produce bold crystals of Menthol from Mint oil (Capacity 50 kg)

Two cold rooms were supplied and commissioned. The technology for production of Menthol crystals was transferred. It is fully operational and will enable the production of crystals form of Mint oils when the Mint oil market prices are low.

3. Introduction of high yielding varieties of aromatic plants

A high yielding variety of Mint from India was introduced and has been cultivated. The oil yield was double that produced by the indigenous varieties. More agronomical work has to be carried out to get disease resistant, hardy varieties. Development of propagation material has to be undertaken.

4. Trained manpower and expertise in sensory evaluation olfactory quality control, blending and formulation of perfumes.

A national workshop was held with international resource personnel. Several counterpart staff members were trained at Enteroil. Subsequently some of them were given an advanced training at a workshop held in Ho Chi Minh City organized by other project on Aroma chemicals. The staff members are now able to recognise and identify adulterated Essential oils by sensory evaluation. Training in perfume blending and olfactory quality control was accomplished during these workshops. Perfume blending activities are undertaken by the project at Ho Chi Minh City.

5. A field distillation unit, 1000 l capacity, using separate steam boiler

Savings were used to locally fabricate a field distillation unit and a boiler which were installed in the hill country in Yen bai province. This still is set up as a field demonstration unit to encourage farmers and small enterpreneurs to develop additional stills to process Cassia and Pemou oils. This is a good output where the impact of the project activities have been well demonstrated as extension work in the rural areas. This has encouraged more cultivation in the area.

6. Production type fractionating column, complete system

Engineering design drawings were prepared by Dr. D.X.Hao under guidance of the CTA and the fabrication was subcontracted to Hanoi Polytechnic University. All accessory items not available in Vietnam were supplied through Field Purchase Orders. The equipment is now ready to be installed and is awaiting the construction of high roof building. The bulding is expected to be completed next month. Once commissioned, this column will function as a

production unit for upgrading inferior oils and production of value added isolates.

7. **Capability for design engineering and fabrication of stills and high technology fractionating columns.**

Engineering designs for outputs have already been achieved by Enteroil engineers under the guidance of two international experts. Two institutes in Hanoi have fabricated these equipments (Annex 9).

8. **Computer and software.**

Personal computer with software has been procured for storage and retrieval of trade statistics and quality control specifications. This has greatly helped in routine office work and accounting. Training has been provided for counterpart staff. It is expected to build a data base on Essential oil specifications and marketing data for reference.

9. **Essential oil filtration system.**

A continuous high speed centrifuge for solid/liquid and liquid/liquid separation has been procured and commissioned for use in filtration of Essential oils and separation of solids enabling the improvement of the quality.

10. **Technical reports**

A number of technical reports were produced during the project period (Annex 10). These will serve as reference materials for future use. They contain very valuable technical information for future training needs.

Other inputs provided to facilitate the achievements of above outputs are:

(i) Chemicals and laboratory equipment (Annex 11)
(ii) Photocopier
(iii) Dehumifiers
(iv) Electric generator 10 KVA
(v) Vehicles (3)

There has been a very close working relationship with the Aroma Chemicals project (DP/VIE/86/033) at Ho Chi Minh city. This has been mutually beneficial and was an outcome of having a common CTA. Joint training programmes and workshops have been conducted.Some installation and commissioning work at Ho Chi Minh City project have been done by the trained staff members of this project.

The changes in the government policy with regard to export of Essential oils facilitated the achievements of outputs as the counterpart agency has a direct export interest of the Essential oils produced. The foreign contracts and inquiries were directly

made, so that certain degree of tailor made products was possible. The contact of the producers with the buyers has an advantages effect in establishing closer association and mutual confidence.

The project was well conceived and was executed and implemented in a cost effective and an efficient manner. The close supervision and directing of activities through the services of the Chief Technical Adviser largely contributed to the success of the project. The CTA, Dr.C.K.Atal managed the financial inputs so well that many new outputs could be achieved. The enhancement of engineering design capability and the decision to locally fabricate equipment resulted in a lot of savings which were used to consolidate the outputs to have a better impact on the beneficiaries. The CTA has to be commended for his technical inputs and management of the project activities. Without much assistance from the project, the trade contracts were mainly negotiated by the initiative of the director of Enteroil. The continuous cooperation the Chief Technical Adviser received from counterpart staff was a major factor contributing to the success of the project.

ENTEROIL was always prepared to make the best use of experts' advice and took full advantage of all the inputs provided by UNDP/ UNIDO . The staff members demonstrated their abilities to absorb the technology transfered by producing oils of internationally accepted standards. Above all the strong export performance capability shown by them can be seen by the increase in exports during the project duration.

An In-depth Evaluation of the project was carried out by Dr.Nitya Anand, Dr.N.B.Bisset and Mr. D.T.Dinh in August 1990. The report of the Evaluation Mission was very favourable on the success of the project and the achievement of the major outputs and objectives (see Annex 12 for summary). The work during the 7 months after the Evaluation has contributed more towards the attainment of objectives and consolidated some of the outputs.

IV. ACHIEVEMENTS OF OBJECTIVES

The project was included in the Third Country Programme of Vietnam under "Assessment and Exploitation of natural resources". It had three immediate objectives.

1. **The first immediate objective was to increase the production of Vietnamese essential oils of inter-nationally acceptable quality. This was to be achieved by the use of improved processing techniques derived by means of the tranfer of technology and the application of appropriate parameters for improvement of both yields and quality.**

As seen from the outputs produced, the first immediate objective has been fully achieved by the introduction of modern processing techniques and development of parameters to improve

the yields and quality of oils. Modern analytical instruments supplied has made it possible to analyse the samples by internationally acceptable methods. This in turn has given the exporters the opportunity to sell oils at international market prices thereby avoiding the middle man who used to quote low prices for the products on the grounds of poor quality. A significant contribution has therefore been made by the project by extending the Certification of quality to other exporters as well. Changes in international standards organization specifications can be followed up to keep abreast of new methods and techniques.

2. The second immediate objective sought to forge an effective link between the CNRS and the Ministry of Foreign Trade so as to enable the latter to service requests from external markets particularly in regard to :

- **Information on essential oils produced**
- **The ability to provide the required quantities and quality of products and**
- **Forwarding of standard samples**

Enhancement of the research and technological competence of CNRS, as well as the field distillation units will serve to accomplish this objective.

The second immediate objective which was modified to accomodate changes in government policy has been fully achieved. Enteroil is now in a position to provide the quality of products required to meet the export orders but as for quantities, there seems to be limitations for some essential oils due to the non-availability of sufficient raw materials. Information on Essential oils produced is available for advertising the products and standard samples have been prepared. There should be more vigorous export promotion for value added products developed such as 99.5 % Safrole containing Sassafras oil and isolates like Geraniol, Citronellol,etc. The enhancement of R & D capability and technology improvement particularly efficient fractionation to either fortify or reduce some constituents have served to accomplish this objective.

3. The third objective was the development of an investment policy which will indicate the manner in which future production will be realised and how the transfer of technology from CNRS to the provincial production centres will be effected. This policy will include provisions to ensure that the production units have access to sufficient resources for re-investment.

The transfer of technology from Enteroil to provincial production centres has been demonstrated by the installation of a locally fabricated distillation unit in Yen bai province. This model can be duplicated to other areas with government investment support or through credit facilities to private enterpreneurs. The modifications if any, required for different types of oils and adaptation of improved technology will be done by the

competent staff of Enteroil. There is an effective interaction between Enteroil and other essential oil producers in the provinces.

The world demand situation can be followed up by Enteroil to guide producers. The provision of guarantee of purchase of oils produced should be ensured in order to prevent farmers dropping out of cultivation of aromatic plants. This is very essential as aromatic plants as such has only the limited market of the processing enterprises.

The above immediate objectives have been achieved as a means of realizing the overall development objective of contributing to national development by exploitation of natural resourses by increase in production of Vietnamese essential oils and related natural products . This will enhance rural development through production of raw materials for the process industry as well as be a means of foreign exchange earnings. The successes so far achieved clearly demonstrate the important contribution that the project has made towards the realization of the development objective. Enteroil has a network of contacts with growers and producers at grass roots level all over the country which enables it to transfer the required know-how and processes developed to ensure the sustainability of the industry. Although the direct and primary beneficiary of the project is Enteroil, the project impact has been widespread to include farmers and distillers in the rural areas, traders and exporters and industries using essential oils and isolates , making it beneficial to many sectors of the society.

Further contribution to the development objective has to be made in terms of increased sustainable harvesting of forest plants and systematic cultivation so as to conserve biodiversity. Agronomical studies, domestication of wild plants species, introduction of high yielding varieties and more propaganda work on benefits of the rural based small scale industry should be undertaken in order to extend the industrial production so as to compete in the world market for the large quantities of certain oils in demand.

V. CONCLUSIONS

The project has been successfully completed with the attainment of envisaged outputs as modified at TPR Meetings to include additional outputs thereby contributing fully to the achievement of the immediate objectives. It has also made an important and a significant contribution to the realization of the development objective. Enteroil has been strengthened to be a forward looking dynamic organization with infrastructural facilities for technology development and quality assessment, competent technical manpower resources and export marketing contacts. The leading role Enteroil could play in the development of the Essential oil industry has been duly recognised by the government by approving it as the export quality certification

laboratory. Enteroil in turn has demonstrated its responsible role by installing a model field distillation unit in an ethnic minority community area so as to encourage systematic cultivation and primary processing of raw materials.

The potentials and competence of local engineering capability has been well demonstrated by Enteroil by subcontracting the fabrication of an improved distillation unit and two fractionating columns. A number of new processes such as crystal menthol production, fortification, production of isolates etc.have been achieved. The activities set out in the project document as still relevant within changes in policy, have been largely carried out. The duration of the project was extended to accomodate completion of local fabrication and realization of the additional outputs agreed at the last TPR Meeting.

The UNIDO inputs of international experts, training and procurement of equipment have been properly executed. The inputs of the counterpart institution and the government have been more than expected in that certain new buildings have been constructed. The committment, hard work and dedication of the counterpart staff have largely contributed to the success of the project. The Chief Technical Adviser has discharged his duties very efficiently and effectively and some times beyond the call of duty. Monitoring and evaluation of the project activities and technical back-stopping have been carried out effectively and smoothly (Annex 13).

The initial and final budget (Annex 14) showed an increase of US $ 137,000 due almost entirely to increase of proforma costs of international experts and an increase of 2.0 m/m for CTA to conclude project activities and 1.7 m/m for additional experts to transfer know-how on sensory evaluation. However at the conclusion of the project activities, there was a saving of US $ 59,881 thereby bringing down the budget increase for the whole project (3 years and 9 months) to US $ 53,791 inspite of additional equipment and expert missions. This is due to the judicious manner in which the CTA managed the activities of the project.

One factor that has to be learnt was the need for timely planning of activities out of the savings resulting from local fabrication of equipment. If these savings were re-allocated without much delay, the project could have been completed without an extension of the project duration. The additional outputs and consolidation of original outputs which were possible as a result of the savings contributed additionally to the greater realization and achievement of the objectives and therefore the successful completion of the project.

VI. RECOMMENDATIONS

The transfer of technology and infrastructural strengthening of Enteroil should be regarded as an initial and a very successful step in the development of the Essential oil industry in Vietnam. It is therefore necessary to conduct more R & D work on new essential oils from indigenous aromatic plants and develop value added products having an international demand. Preparation of oleo-resins, concretes and absolutes can be an extension of the work using the equipment available. These products could be used by local food and perfume industries thereby saving foreign exchange used for importation. These activities may be pursued by allocating annually a percentage of the profits of Enteroil for R & D work.

There is an urgent need to establish an Information Centre on Essential oils at Enteroil.

The trade statistics, current market trends and prices, specifications of oils and demand situation should be made available to the producers in the rural areas. Other references books and current journals should be made available at this Centre.

A computerised system can be built up so that information storage and the retrieval would be quick and easy.

Research and development work on new oils and possible adulterants can be upgraded by the a aquisition of a Gas Chromatograph with mass spectral facilities. This would enable the easy identification of adulterants and determination of the composition of new oils produced.

Agronomy and propagation methodology are areas where more inputs would have been beneficial. As the emphasis of the project was on the processing and export promotion, not much work has been done on systematic cultivation. Hence there has been an exploitation of spontaneous flora endangering biodiversity conservation. Certain plants take 5-10 years before they could be used for harvesting and some of them are uprooted to get the Essential oils bearing part such as roots. The only propagation is by natural means which cannot withstand the indiscriminate exploitation in terms of quantities. Hence there is an urgent need for systematic cultivation and domestication of wild varieties. This has to be carried out in collaboration with an Institute which has the technical resources for development of agronomical and cultivation practices, propagation method and domestication. Rural areas have to be selected for this purpose in order to conserve forest and spontaneous flora. Cultivation alone will not encourage farmers to grow aromatic plants as there is no ready market for the raw materials. Hence field distillation units have to be installed in all such areas to provide a demand for the raw materials. This aspect can be successfully implemented by the staff of Enteroil. Hence more extension work on processing should be undertaken in

collaboration with another institute which could initiate systematic cultivation.

Introduction of short term crops is necessary for the benefits of the farmers who are willing to grow long-term crops such as Cassia. Selected varieties of plant can be introduced as undercover crops for this purpose (Annex 15).

Such a programme for systematic cultivation could serve as a means of crop substitution in illicit growing areas as well. Furthermore rotation of crops could be introduced amongst the farmers engaged in the cultivation of food crops.

The 2000L distillation plant supplied by the project is not maximally used at Enteroil due to the large quantities of raw materials needed. Hence it is the strongly recommended that this unit be transfered to a suitable area for production purposes.

Most of the export promotion work is presently being done by correspondence with and visits of buyers. Some efforts were made during the project period to establish personal contacts between Enteroil and the buyers. This is a very essential activity that has to be continued. It is recommended that the marketing personnel should visit trading houses at least once a year to establish strong market contacts. Furthermore this will enable Enteroil to produce tailor made oils for the requirements of the buyers.

Trade promotion should therefore be strengthened by foreign visit and attendance at international conferences of trade and marketing participants.

Post investment support to purchase some necessary spare parts and current journals would be a welcome contribution by UNDP as support for the success of the project.

The achievements of this project are commendable and should be shared with other countries in the region. It is recommended that Enteroil would host a regional workshop on the establishment of small scale Essential oil industry in rural areas with UNDP/UNIDO support to share its experience with countries in Asia and South Pacific.

ANNEX 1

LIST OF EQUIPMENT

Equipment Item	Cost	Delivery Date	Status
Cooling Chamber RH 19B1	2,277.00	8/90	Good
Refrigeration Unit AFL-1.6	2,196.00	8/90	"
Freezer Chamber FS 19B1	3,095.00	8/90	"
Refrigeration Unit AFR-2	3,459.00	8/90	"
2 Sieves L610	1,622.00	8/90	"
Basket Centrifuge H-130E	8,446.00	8/90	"
Air Conditioner SA246S5	651.00	8/90	"
Mettler Balance	2,277.00	3/92	"
Vacuum Gauge Controller	1,317.00	3/92	"
4AS Ultra centrifuge Max. Speed: 19000	21,239.00		"
E2M40 Vacuum Pump	5,373.00		"
Spares Kit E2M40	615.00		"
Spares Kit E2M40 HS	1,156.00		"
Inlet Catchpot	756.00		"
Outlet Mist Filter	902.00		"
Oil Filtration System	726.00		"
Oil Level Monitor	281.00		"
Connexion Kit	497.00		"
3 Flexible connexion	191.00		"
Toyota Cressida Station Wagon SL	11,025.00	7/88	"
IR Spectrophotometer PU9706/15	15,761.00	10/88	"
Sampling Kit	1,808.00	10/88	"
Starter Kit	975.00	10/88	"
UV/VIS/NIR Spectro-photometer PU8620	6,689.00	10/88	"
Deuterium Lamp	401.00	10/88	"
Filter Set	455.00	10/88	"
Voltage Stabilizer	822.00	10/88	Good

Equipment Item	Cost	Delivery Date	Status
Gas Chromatograph GC-9APTF	23,097.00	10/88	"
Thin Layer Chromatograph Kit	14,476.00	10/88	"
HPLC LC-6A	23,807.00	10/88	"
Polarimeter (Polax D)	2,081.00	10/88	"
Automatic Specific Gr vity Meter	1,286.00	10/88	"
Hydrometer	343.00	10/88	"
Refractometer 1T	1,696.00	10/88	"
2 Integrator Chromatopac G-R6A	4,539.00	10/88	"
Unit for steam distillation of essential oils at atmospheric pressure, type tournaire 206 with extractor (2000 l)	39,055.00	12/88	"
Steam generator, oil fired with water softener and tank	22,520.00	12/88	"
Still with water bath type 241, capacity 1000 L, with accessories	45,591.00	12/88	"
Labset assembly for organic chemistry	808.00	6/88	"
Towers distillation apparatus laboratory type for fractional distillation	1,729.00	6/88	"
Toyota 4W Land Cruiser F J70 LHD	12,496.00	7/88	"
Toyota 4W Land Cruiser F J70 LHD	12,496.00	7/88	"
Pilot Scale Fractionating column complete	30,535.00	2/89	"
Philips Printer PU8600	637.00	10/89	"
Personal Computer	5,000.00	10/91	"
Steam Generator	4,000		Good

Equipment Item	Cost	Delivery Date	Status
Canon Model PC-25 Copier	1,057.00	7/88	"
National Model NR-B 14 Refrigerator	308.00	7/88	"
2 National Model CW-120JS235 Room Airconditioners	976.00	7/88	"
Remington Model 150 Typewriter	315.00	7/88	"
Olympia Carina II Typewriter	128.00	7/88	"
Canon NP-1215 Copier	1,850.00	11/91	"
Denyo Model GA-5500 Generator	1,850.00	12/91	"
4 G.E. AHD21SC Dehumifier	1,080.00	12/91	"
Immersion cooler BD-22	1,680.00		"
Melting Point Apparratus MP-21	1,400.00		"
Electric Moisture Balance MM-30	1,984.00		"

Annex 2

TECHNICAL REPORTS PRODUCED BY ENTEROIL STAFF MEMBERS

1.	Propagation and trial cultivation of new Mint variety in Hai phong 1990	Khuc The Vinh/Haiphong
2.	Introduction of a new Mint variety with high Menthol content - 1990	Dr. Luu Dam Cu/CNSR
3.	Biological and chemical properties of the new Indian Mint variety - 1990	Prof. La Dinh Moi/CNSR
4.	Operators instruction for continuous high speed centrifuges	Dr. Dang Xuan Hao
5.	Installation and trial production of steam distillation unit in Yen bai	Dr. Dang Xuan Hao Nguyen Dinh Ngoc
6.	Report on essential oil trade and production in Vietnam (presentation at the 2nd UNIDO Workshop in Manila, 2/91)	Doan Thi Hoa Binh
7.	Citral and Ionone from essential oils of Litsea cubeba	Dr. Luong Si Binh Tran Khanh Ngoc
8.	Activities with the fractionation Unit	Dr. Dang Xuan Hao

Annex 3

TRAINING: FELLOWSHIP AND STUDY TOURS

NAME	PLACES	DURATION	FIELDS
		A. STUDY TOUR	
LE VAN THU	FRANCE/ INDIA	26/8-22/10/88	DISTILLATION TECHNOLOGY MARKETING
NGUYEN DON	"	"	"
NGUYEN CONG CHAN	"	"	"
LE NHI HOA	"	"	"
HOANG VAN PHIET	THAILAND GERMANY	4/8-25/8/89	VISIT TO RESEARCH AND TRADING CENTRES
LE TRONG VONG	ENGLAND	29/8-12/9/92	"
NGUYEN QUYET CHIEN	"	"	"
NGUYEN DUC HONG	"	"	"
		B. WORKSHOPS/INTERNATIONAL CONGRESSES	
NAME	**PLACES**	**DURATION**	**FIELDS**
DOAN T.H. BINH	PHILIPPINES	4-8/2/91	SEC. UNIDO WORKSHOP ON ESSENTIAL OILS
NGUYEN QUYET CHIEN	TURKEY	14-17/9/92	NPD'S WORKSHOP
LE TRONG VONG	VIENNA	4-8/10/92	INT. CONGRESS ON ESSENTIAL OIL
NGUYEN NHA DUC	"	"	"

NAME	PLACES	DURATION	FIELDS
LE TRONG VONG	INDIA	25/9-10/12/89	TECHNOLOGY/MARKET. OF ESSENTIAL OILS
VAN NGOC DANH	"	"	"
DANG XUAN HAO	"	6/10-12/12/89	DISTILLATION AND FRACTIONATION
NGUYEN TAN HUNG	"	"	"
NGUYEN Q. CHIEN	TURKEY	18-31/9/92	INSTRUMENTAL ANALYSIS
LA DINH MOI	"	8/01-11/3/90	AGRONOMY OF ESSENTIAL OIL PLANTS
NGUYEN NHA DUC	"	"	"
LE QUI MANH	"	"	"
NGUYEN QUOC DUNG	"	"	ANALYSIS OF ESSENTIAL OIL

Annex 4

REPORTS OF TRAINING PARTICIPANTS

1.	Report on study tour: Distillation technology and Marketing in France and India	-Le Van Thu -Nguyen Don -Nguyen Cong Chan -Le Nhi Hoa
2.	Report on study tour to research centres in Germany	Prof. Hoang Van Phiet
3.	Report on study tour: Visits to research and trade institutions in U.K.	-Le Trong Vong -Dr. Nguyen Quyet Chien -Nguyen Duc Hong
4.	Report on participation at the international congress of Essential oils and flavours in Vienna, Austria - 10/92	-Le Trong Vong -Nguyen Nha Duc
5.	Report on fellowship in the field of distillation and fractionation techniques in India	Dr. Dang Xuan Hao Nguyen Tan Hung
6.	Report on technology and marketing of essential oils (fellowship in India)	Le Trong Vong Van Ngoc Danh
7.	Report on agronomy of essential oil plants (fellowship in India)	Prof. La Dinh Moi Nguyen Nha Duc Le Qui Manh
8.	Report on instrumental analysis of essential oils (fellowship in India)	Nguyen Quoc Dung
9.	Report on HPLC techniques in natural product chemistry (fellowship in France)	Dr. Mai Van Tri

Annex 5

LIST OF CONSULTANTS

Post Title	Names	Duration
Chief Technical Adviser	Dr. C.K. Atal	4/88-6/92
Marketing Expert	J.G. Meredith	12/4-3/5/89
Engineering expert	N.B. Narasimha	26/4-3/6/89
Industrial Chemist	Dr. A.L. Yayewardene	12/4-12/6/89
Agro-technologist	Dr. Rajendra Gupta	6/10 -28/10/89
Blending Expert	Sudhir Jain	18/2-13/3/90
Expert on fragrances	W.S. Brud	12/01-10/3/90
Plant Engineer	C.L. Tikoo	12/8-10/11/90
In-depth evaluation mission	Prof. N.Bisset Dr.N. Anand Dinh Trung Dinh	6-22/8/90
Menthol Expert	Y.J. Talwar	7/3-3/4/92

Annex 6

LIST OF TECHNICAL BOOKS

1. W. Jennings, 1980
   GC WITH GLASS CAPILLARY COLUMNS (2ND ED.)
   Academic Press

2. L. Grob (Ed.), 1985
   MODERN PRACTICE OF GAS CHROMATOGRAPHY
   John Wiley and Sons,

3. G. Zweig, J. Sherma (Ed.)
   HANDBOOK OF CHROMATOGRAPHY - GENERAL DATA AND PRINCIPLES
   Vol. I, 1985
   Vol. II, 1986
   CRC Press, Inc.,

4. N.A. Parris, 1984
   INSTRUMENTAL LIQUID CHROMATOGRAPHY, 2nd Ed.
   Elsevier,

5. D.J. Runnser, 1981
   MAINTAINING AND TROUBLE SHOOTING HPLC SYSTEMS
   John Wiley and Sons, Inc.

6. L.R. Snyder and J.J. Kiskland, 1979
   INTRODUCTION TO MODERN LIQUID CHROMATOGRAPHY , 2nd Ed.
   John Wiley and Sons, Inc.

7. L.R. snyder and J.L. Glajch, J.J. Kiskland, 1988
   PRACTICAL HPLC METHOD DEVELOPMENT
   John Wiley and Sons, Inc.

8. HAWLEY'S CONDENSED CHEMICAL DICTIONARY, 11th Ed.1987
   Van Nostrand Reinhold Company,

9. D. R. Knapp, 1979
   HANDBOOK OF ANALYTICAL DERIVATIZATION REACTIONS
   John Wiley and Sons, Inc.

10. Fried, J. Sherma, 1986
    THIN-LAYER CHROMATOGRAPHY, TECHNIQUES AND APPLICATIONS
    Marcel Dekker, Inc.

11. SUPELCO BULLETINS ON GLC, HPLC,
    SUPELCO

12. SHIMADZU BULLETINS ON GLC, HPLC
    SHIMADZU

13. PYE UNICAN BULLETINS ON IR-SPECTROMETRY TECHNIQUES
    Pye Unicam

14. J.K. Taylor
QUALITY ASSURANCE OF CHEMICAL MEASUREMENTS
Lewis Publisher, Inv. 1987 Chelsea MI

15. REAGENT CHEMICALS
7 Ed. American Chemical Society 1986, Washington DC.

16. H. Wagner, S. Bladt and E. M. Zgainski, 1984
PLANT DRUG ANALYSIS - A THIN LAYER CHROMATOGRAPHY ATLAS
Springer-Verlag, New York, NY.

17. E. Katz, Ed., 1987
QUANTITATIVE ANALYSIS USING CHROMATOGRAPHY TECHNIQUES
John Wiley and Sons, Inc. New York, N.Y.

18. 1981
THE ALDRICH LIBRARY OF INFRARED SPECTRA 3rd, Ed. C.J. POUCHERT, ALDRICH CHEMICAL CO. INC.
Milwankee, Wl.

19. P.Z. Bedoukian, 1986
PERFUMERY AND FLAVORINA SYNTHETICS
Allured Publishing Corp. Wheaton IL

20. HANDBOOK OF COMPRESSED GASED 3rd Ed. COMPRESSED GAS ASSOCIATION, INC. (1990)
Van Nostrand Reinhold Co. New York, N.Y.

21. D.D. Perrin, W.L.F. Armaego
PURIFICATION OF LABORATORY CHEMICALS 3RD.
Pergamon Press, New York, N.Y. Soft Bound

22. P.A. Carson and C.J. Mumford, 1988
THE SAFE HANDLING OF CHEMICALS IN INDUSTRY
John Wiley and Sons, Inc. New York, N.Y.

23. COSMETIC PRODUCTS TESTING (COSMETIC SCIENCE AND TECHNOLOGY SERIES)
Moskowitz

24. L.A. Swigar, R.M. Silverstein, 1981
SPECTRA, KOVATS INDICES
Aldrich Chemical Company INc. Milwat Kee,

25. W. Jennings, T. Shibamoto
QUALITATIVE ANALYSIS OF FRAGRANCES AND FLAVOUR VOLATILES BY GLASS CAPILLARY CHROMATOGRAPHY
Academic Press

26. Pruthi J.S. E.
SPICES AND CONDIMENTS - CHEMISTRY AND TECHNOLOGY
(Advances in Food Research Support 4)

27. Gunther
THE ESSENTIAL OILS (6 VOLUMES)

28. O. Simon
MANUEL DE LABORATOIRE POUR INDUSTRIELS PARFUMS
Beranger, Paris

29. Jellinek
PRAKTIKUM DES MODERNEN PERFUMERS

30. R.A. Scanlan, 1977
FLAVOUR QUALITY: OBJECTIVE MEASUREMENTS
American Chemical Society

31. Leung A.I. 1980
ENCYCLOPEDIA OF COMMON NATUREL INGREDIENTS USED IN FOOD, DRUGS AND COSMETICS
Wiley - Enterscience

32. Morton I.d., 1986
FOOD FLAVOURS, PART B: THE FLAVOUR OF BEVERAGES
Elsevier

33. MAJOR ESSENTIAL OIL - BEARING PLANTS OF INDIA

34. Sukh Dev., 1982
CRC HANDBOOK OF TERPENOIDS: MONOTERPENOIDS
Vol. I, II
CRC Press, Inc. Florida

35. Erman, W.F., 1985
CHEMISTRY OF MONOTERPENES - AN ENCYCLOPEDIC HANDBOOK
PART A,B.
Marcel Dekker, Inc. New York, N.Y.

36. Gildermeishes, Hoffman
DIE ATHERISCHEN OLE
Vol 1-17

37. Shinskey, F.G., 1983
DISTILLATION CONTROL
Mc Graw Hill

38. L.M. Rose, 1985
DISTILLATION DESIGN IN PRACTICE (COMPUTER AIDED CHEMICAL ENGINEERING SERIES NO. 1)
Elsevier

39. Haselden G.G., 1988
DISTILLATION AND ABSORPTION
Vol. I, II
Hemisphere Publications

Annex 7

FIELD ACTIVITIES

1. Installation of field distillation equipments in rural areas commissioning, technical guidance and training of operators for:

   -1 unit in Cheim hoa/tuyen quang for Citronella
   (Dr. Dang Xuan Hao/Luc)
   -1 unit in Yen binh/Yen bai for Citronella
   (Dr. Hao/Ninh)
   -1 unit in Thanh liem/Ha Nam Ninh for Ocimum gratissimum, aid in agro-technology, Introduction of New Seperator type (Dr. Hao?manh /Khoi)
   -1 unit in Son tay for Ocimum gratissimum, Rehalibitation of old equipment (Mr. Thu/Dr.Hao/Thai)

2. Installation commissioning of improved distillation equipment using steam boiler in Cassia production region, Van yen district of Yen bai province/trial distillation of Cassia by-products (leaves and twigs) and Pemou woods (Dr. Hao/Ngoc/Thang/Tinh)

3. Introduction of a new Essential oil bearing plants: Celery (propagation, cultivation, distillation, analysis and trial sale in Khoai chau/Hung yen (Dr. Hao/Manh/Knoi/Son/Pho)

4. Introduction of a new Indian Mint variety with high Menthol content (seed raising, cultivation, distillation) at:

   -CNSR experiment garden (Prof. La Dinh Moi, Dr. Luu Dam Cu and Co.)
   -Hao phong production site (Khuc The Vinh)
   -Hai hung production site (Nguyet/Lich)

Annex 8

EXPORT FIGURES OF ENTEROIL

Essential Oil	1988 (ton)	1989 (ton)	1990 (ton)	1991 (ton)	1992
O. gratissimum	8.2	32.0	7.0	40.0	0
Mint	4.1	4.0	5.0	20.0	1.0
Citronella	0.3	39.7	97.8	90.0	22.5
Ocimum basilicum	0.8	3.0	3.0	3.0	3.0
Litsea cubeba	0.1	1.0	1.0	1.0	1.0
Cassia	0.2	-	2.0	2.0	9.0
Cajeput	0	0	6.8	5.0	3.5
Sassafras	0	0	1.0	5.0	130.0
Staraniseed	0	0	10	15	30
Palmarosa	0	0	0	0.1	0.5
Eucalyptus citriodora	0	0	0	0.1	0.1
Gum Benzoin	0	0	0	1.0	4.8
Pemou	0	0	0	0.6	1.0

Annex 9

LIST OF EQUIPMENT FABRICATED IN VIETNAM

Equipment Items	Unit Price in US$	Delivery Date	Status
Steam distillation unit 300 kg/batch (1 set) for distillation of the oils	10,000	9/92 (to Yen bai province	Fully operational
Boiler 200 kg steam/hour	3,000	9/92 to Yen	-ditto-
Fractionation unit 150L -Reboiler 150L -Height of column 4M -Heating: Immersion heater 9KW, oil bath	24,000	1990	-ditto-
S.S. fractionation unit 260 L -Reboiler 260L -Height of column 6.6M -Immersion heating 18KW with oil bath	25,000	11/92	operation expected by Aug.93
Electronic digital control unit for 260L fractionation column	2,900	11/92	Fully operational

Annex 10

TECHNICAL REPORTS OF INTERNATIONAL CONSULTANTS

1.	International markets of essential oils	J.G. Meredith
2.	Design of a fractionation unit	N.B. Narasimha
3.	Agro-technology of Essential oil crops grown in Vietnam	Dr. Rajendra Gupta
4.	Fragrance production-Findings work performed and recommendations	Dr. Wladyslaw S. Brud
5.	Perfume blending-Findings work performed and recommendations	Sudhir Jain
6.	Completion and commissioning of fractional distillation unit	C.L. Tikoo
7.	Menthol production techniques	Y.P. Talwar
8.	Progress reports of the Chief Technical Adviser	Dr. C.K. Atal
9.	In Depth Evaluation Report	Dr. N. Anand, Prof. N.G. Bisset, Dinh Trung Dinh
10.	Processing of Vietnamese Essential Oil and Related Natural Products, Quality Control of Essential oils	Dr. A.L. Jayewardene

Annex 11

LIST OF LABORATORY EQUIPMENT AND GLASSWARE

Item No.	Goods and/or services	Quantity	Unit	Unit Price	Amount
Project: DP/VIE/84/010- Essential Oils				DM	DM
Laboratory Glassware + Equipment					
1.	Beakers 250, 600, 1000, 5000 ml	lot			210.00
2.	Aspirator Bottles/ Stopcock 5000 ml	3	ea	23.70	71.10
3.	Bottles, Reagent (Narrow) 1000 ml.	10	ea	5.10	51.00
4.	Bottles, Spec. Grav. Pyenometer + Thermometer 50 ml.	4	ea	38.25	153.00
5.	Bottles washing 500 ml.	4	ea	1.60	6.40
6.	Bottles weighing 10 ml.	10	ea	7.45	74.50
7.	Burettes, straight bore, 10.25 ml	lot			127.40
8.	Condenser liebig (standard) 24/29 (400 mm)	6	ea	21.90	131.40
9.	Condenser Allihn (24/29) 300, 400 mm	lot			459.00
10.	Cyliner, drying Tower 340, 25 ml.	lot			367.00
11.	Cylinder, measuring 100,50,250,500, 1000 ml.	lot			146.90
12.	Cylinder, measuring, 100, 250 ml.	lot			97.80
13.	Dessicator with knob, top ordinary with plate diameter 150 mm.	4	ea		220.00
	Grand Total				14,900

Item No.	Goods and/or services	Quantity	Unit	Unit Price	Amount
14.	Deasicator vacuum with plate dia 200, 300 mm	lot			830.00
15.	Extraction apparratus, soxhlet, 250, 500 ml	lot			282.00
16.	Flasks, flat bottom 250, 500, 1000 ml.	lot			117.00
17.	Flasks, round bottom 500, 1000, 2000, 4000 ml.	lot			388.00
18.	Flasks, round bottom short neck, 500 ml.	1	ea		20.00
19.	Flasks Distilling 500, 1000, 2000 ml.	lot			557.50
20.	Flasks, Erlenmeyer plain 500, 1000, 2000 ml	lot			205.20
21.	Flasks, Glenmeyer/ stopper 100,200, 500 ml	lot			315.00
22.	Flasks, Filtering 100, 250, 1000 ml.	lot			204.00
23.	Flasks, volumetric 25, 100ml.	lot			66.30
24.	Flasks, cassia, 0-10; 0.1 ml. 0-06: 0.1ml	lot			38.00
25.	Buchner funnel, porcelain 45, 155, 280 and 1140 ml	lot			330.00
26.	Buchner funnel glass 50, 125 ml	lot			144.00
27.	Funnel separating 250, 500 ml (Pear)	lot			98.00
28.	Funnel separating (globe) 250, 500 ml	lot			90.40
29.	Glass tubing, 26, 30,50 10 mm	lot			109.00
30.	Labset assembly	lot			1,455.00
31.	Stopcocks	lot			171.20

Item No.	Goods and/or services	Quantity	Unit	Unit Price	Amount
32.	Connecting tubes	lot			158.00
33.	Dean and stark moisture determination	4	ea	120.00	480.00
34.	Essential Oil Determination assembly comprising a)Oil lighter than water b)Oil heavier than water	4	ea	220.00	880.00
35.	Towers distillation apparatus	1	ea		3,225.00

SUMMARY OF PROJECT EVALUATION
PERIOD AUGUST 6 - 22, 1990
PART A

Project No. and Title

Processing of Vietnamese Essential Oils and Related Natural Products VIE/84/010.

Executing Agency

United Nations Industrial Development Organization (UNIDO)

Government Implementing Agency

National Centre for Scientific Research (NCSR)

	UNDP Budget	Government Budget (in kind)
Original	US$ 990,155	Dong 17,568,000
Revised	US$1,089,392	Dong 200,000,000

Prior phases and duration

Initial project request April 1985. Preparatory assistance mission April/May 1986.

Date project approved 26 October, 1987

Date project began 04 April, 1988

Period of Project 3 years

I. Objectives of Project

A. Development Objective

To increase the production of essential oils and related natural products in Vietnam.

B. Immediate Objectives

(i) To increase the productivity of Vietnamese essential oils and to improve the quality to international standards by improving processing techniques.

(ii) To enhance the R & D capability of the NCSR in the field of essential oils and transfer technology to provincial production units.

(iii)To improve the field distillation units.

(iv) Training of technologists from different parts of Vietnam in the above.

(v) To forge an effective link between the NCSR and the Ministry of Foreign Trade so as to enable the latter to service requests from external markets and the development of an investment policy for increased future production.

C. Expected Outputs

- Establishment of analytical facilities for quality assessment of essential oils at the NCSR;
- Installation of modern model distillation stills at the NCSR for demonstration and duplicating purposes;
- Upgrading of field distillation stills and technology and installation of a few demonstration stills in the field;
- A demonstration fractionation assembly at the NCSR for upgrading the quality of essential oils;
- Better and more trained people;
- Extension work to promote better cultivation and distillation practices;
- Improved and increased marketing and export of essential oils of Vietnam.

II. Purpose of the Evaluation Mission

To assess :

(a) the achievements of the project against the set objectives and expected outputs, any gaps in the programmed or delivered outputs and evaluate the factors which facilitated or impeded the achievements of the project's objectives;

(b) the extent to which compositional analysis of Vietnamese essential oils has been carried out by the NCSR;

(c) the progress made with the construction/installation and use of pilot-scale equipment for distillation and fractionation;

(d) the training conducted in distillation technology, instrumental analysis and organoleptic assessment;

(e) coordination between this project and the Aroma Chemicals Project DP/VIE/86/033;

(f) the potential for services by the NCSR to industry and its continuing R & D role;

(g) the extent to which the results/outputs produced by the project have contributed towards the increase in capability to produce essential oils on a pilot scale;

(h) the cost of production as compared with international prices;

(i) the socio-economic benefits that can be derived from the project;

(f) if the approach utilized has led to optimum results;

(k) suggestions for further assistance for the realisation of benefits to the target groups.

III. Findings of the Evaluation Mission

The project implementation has so far proceeded more or less according to schedule; all the major inputs committed by the UNIDO and the NCSR have already been made. The expected outputs are beginning to be realised. There is no doubt that the residual implementation will also proceed smoothly and there will be no overrun on the time or budget of the project. There have, however, been some organizational changes at the NCSR as a result of the liberalization of Government policies, which have a bearing on the implementation of the project, and it would be useful to record these. The major outlet of Vietnam's essential oils is as exports. Till 1988, there were only three Vietnam Government agencies, NAFORIMEX, GENERALEXIM, and VINAPHAR, which could export essential oils. With the new policy, industry or other agencies can export directly. Further, the Government of Vietnam is encouraging research organizations to meet part of their expenses out of their own earnings. In view of this changed situation, the NCSR decided to convert its essential oils section into an autonomous commercial

enterprise, ENTEROIL, which would be directly involved in trading and export and which would have the essential oil section of the NCSR, where the UNIDO project is housed, as its R & D laboratory. Due to these policy changes, objective III is no longer relevant and, instead, developing of marketing expertise has attained greater significance. Some efforts made in this direction appear to be quite pertinent and relevant.

Outputs

1. An operational analytical laboratory with the following equipment

   - GLC with automated integrator
   - HPLC
   - TLC equipment with densitometer
   - IR spectrophotometer
   - UV spectrophotometer
   - Refractometer
   - some other physico-chemical instruments.

All instruments have been commissioned and are in regular use. The laboratory is carrying out the routine analysis of essential oil samples for its own quality control needs and also for other laboratories/industries. This laboratory has worked without interruption since 1988 and so far has analysed about 2,500 samples from a large cross section of organizations. More recently, this laboratory has been given the status of a Government-approved Quality Certification Laboratory. This quality assurance has greatly helped to upgrade the status of Vietnamese essential oils in the international market and has thus helped in increasing exports.

2. Model Essential Oil Distillation stills at the NCSR for upgrading distillation technology

- One 1000 l hydrodistillation water-bath type unit, stainless steel, French design	fully operational
- One 2000 l steam distillation unit, stainless steel, French design	fully operational
- One stainless steel and one mild steel 1000 l capacity distillation unit, NCSR design.	under fabrication in NCSR workshop

It is proposed to install a few of these as model/demonstration stills in the field.

-	A 25 l all-glass fully automated fractionating assembly for upgrading essential oils and preparing pure components	fully operational
-	150 l stainless steel vacuum distillation assembly for upgrading substandard oils and preparing pure isolates	under fabrication

3. Training has been an essential component of this project; the following are the specific programmes carried out:

   (a) Five senior staff members went on a study tour tc India, France, West Germany and Austria;
   (b) Eleven staff members were trained in distillation technology, design and fabrication of equipment, agrotechnology and analytical quality control;
   (c) A national workshop organized in olfactory evaluation of essential oils with seven trainees. A higher level 2nd workshop is planned for January 1991 with international experts.
   (d) Five experts fielded to help in installation and operation of equipment and to give training by practical demonstration and lectures in different areas of essential-oil technology, such as agrotechnology, distillation and fractionation techniques and olfactory evaluation.

4. Marketing: An expert was fielded who gave lectures in the theory and practise of marketing, investment planning and mechanism of transfer of technology.

5. Extension work: A special feature of this project appears to be the close link which the national staff of the project has with the people involved in cultivation and distillation in the field. Any knowlege gained by them could be readily transferred to the field for application. They are aware of the defects of the distillation stills in the field, which give poor quality and low recovery of the oil, and are trying to improve the stills through this project. Similarly, some information on agrotechnology is also being disseminated.

6. Coordination with project VIE/86/033. A close working relationship between the two projects seems to have been maintained; having a common CTA certainly has helped in this. Joint training programmes and workshops are held [illegible] some facilities are also shared.

Beneficiaries

Though the primary and direct beneficiary is ENTEROIL (at present part of the NCSR), the project covers a wide span from farmers and distillers in the field to traders/exporters and industries using essential oils and/or their pure constituents, and thus the secondary benefits accrue to many sectors of society.

The project overall is well conceived, properly designed and carefully implemented, and should result in both technological and economic benefits at different levels.

Recommendations

1. The project as conceived has progressed well and should proceed to the end without any interruption.

2. The quality control capability of the ENTEROIL analytical laboratory and the latter's appointment as a government-approved certification centre is a particularly valuable feature of the project. However, such certification work should not continue as an ENTEROIL activity, but instead should become an autonomous independent activity of the NCSR.

3. ENTEROIL, being a part of a prestigious national scientific body, should gradually be converted from being only a trading enterprise to becoming a high-technology R & D-based essential-oil company and get involved in introducing new and high-value oils and products obtained from them. If, however, it is preferred to keep ENTEROIL simply as a trading company, a high-technology-based Essential Oil Research Centre should be created within the NCSR, financially supported by ENTEROIL and the NCSR, and any envisaged future UNDP support should be directed towards this centre.

4. A Board of Directors comprising members appointed from ENTEROIL, NCSR, appropriate ministries, and local scientific experts should be set up to aid and support the General Manager in the overall decision-making process.

5. Steps should be taken to ensure that the technology and planting material acquired during the project through the agency of UNIDO should be made available to other laboratories and companies.

6. An "Information Centre for Essential Oils" should be established to provide information/statistics on production, import and export, prices, national and international, and on world trends in the trade of essential oils. It could for the present be a part of ENTEROIL, and as it grows it should become an independent entity.

VI. Evaluation Team

Dr. Nitya Anand
Former Director
Scientist Emeritus
Central Drug Research Institute
Lucknow, 226001, India.

Prof. Norman G. Bisset
Pharmacognosy Research Laboratories
Chelsea Dept. of Pharmacy
Kings college, University of London
Manresa Rd., London, SW3 6LX, U.K.

Mr. Dinh Trung Dinh
Specialist in R & D Management
Dept. of Industrial Development
State Committee for Science
Hanoi, Vietnam.

ANNEX : 13

TPR MEETINGS

03-04/1988	Project starting date / actual
05-06/	
07-08/	
09-10/	
11-12/	
01-02/1989	
03-04	
05-06	
07-08	
09-10	
11-12	1.TPR
01-02/1990	
03-04	
05-06	
07-08	In-Depth Evaluation
09-10	2.TPR
11-12	
01-02/1991	
03-04	Project Completion Date (planned)
05-06	
07-08	Revision, Extension of Completion Date, starting new activities
09-10	
11-12	
01-02/1992	
03-04	
05-06	3.TPR
07-08	
09-10	
11-12	

Ligne budgétaire	Titre fonctionnel		INITIAL	FINAL	
11-01	CHIEF TECHNICAL ADVISER	$. HM.	165,500	229,375 26.0	
11-02	CHEMIST - ESSENTIAL OILS	$. HM.	27,700	29,720 4.0	
11-03	CHEMIST - TERPENOIDS	$. HM.	13,200	23,025 2.0	
11-04	ENGINEER - DISTILLATION	$. HM.	13,200	14,069 1.6	
11-05	MARKETING SPECIALIST	$. HM.	13,200	13,027 1.0	
11-50	CONSULTANTS COURT TERME	$. HM.	29,355	60,603 5.1	
11-XX	SUB-TOTAL	$. HM.	262,155	369,819 39.7	
15-00	VOYAGES EXPERTS PROJECT	$.	6,000	16,550	
16-00	AUTRES DEPENSES D.PERS.	$.	14,000	47,829	
18-00	SURRENDER PY OBLIGS	$.		4,409-	
1X-XX	SUB-TOTAL	$. HM.	282,155	429,789 39.7	
31-00	BOURSES INDIVIDUELLES	$.	81,000	35,420	
32-00	VOYAGES COLLECTIVE PNUD	$.	45,000	79,289	
33-00	FORMATION DURANT EMPLOY	$.	10,000	750	
38-00	SURRENDER PY OBLIGS	$.		10,679-	
3X-XX	SUB-TOTAL	$.	136,000	104,780	
41-00	MATERIEL CONSOMPTIBLE	$.	60,000	23,592	
42-00	MATERIEL NON CONSOMPTIB	$.	477,000	535,221	
48-00	SURRENDER PY OBLIGS	$.		64,101-	
4X-XX	SUB-TOTAL	$.	537,000	494,712	
51-00	DEPENSES DIVERSES	$.	15,000	15,498	
58-00	SURRENDER PY OBLIGS	$.		833-	
5X-XX	SUB-TOTAL	$.	15,000	14,665	
99-99	PROJECT TOTAL	$. HM.	990,155	1,043,946 39.7	