



**TOGETHER**  
*for a sustainable future*

## OCCASION

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



**TOGETHER**  
*for a sustainable future*

## DISCLAIMER

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

## FAIR USE POLICY

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

## CONTACT

Please contact [publications@unido.org](mailto:publications@unido.org) for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at [www.unido.org](http://www.unido.org)

RESTRICTED

DP/ID/SER.A/1408  
1 November 1990  
ORIGINAL: ENGLISH

PROCESSING OF VIETNAMESE ESSENTIAL OILS  
AND RELATED NATURAL PRODUCTS

DP/VIE/84/010

THE SOCIALIST REPUBLIC OF VIET NAM



Technical report: Findings, work performed and recommendations\*

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

Based on the in-depth evaluation mission of  
Dr. Nitya Anand, UNDP, Mission Leader  
Prof. Norman G. Bisset, UNIDO expert  
Dinh Trung Dinh, Government of Viet Nam

Backstopping officer: R.O.B. Wijesekera  
Chemical Industries Branch

United Nations Industrial Development Organization  
Vienna

\* Mention of company names and commercial products does not imply the endorsement of UNIDO. This document has not been edited.



## C O N T E N T S

	<u>PAGES</u>
I. SUMMARY	2
II. PROJECT CONCEPT AND DESIGN	
A. Context of the project	9
B. Project document	10
1. The problem and the technical approach	
2. Objectives, indicators and major assumptions	
3. Beneficiaries	
4. Work plan	
III. PROJECT IMPLEMENTATION	
A. <u>Activities</u>	12
B. <u>Quality of monitoring and backstopping</u>	12
IV. PROJECT RESULTS	
A. <u>Outputs</u>	14
B. <u>Immediate objectives</u>	20
C. <u>Development Objectives</u>	20
D. <u>Unforeseen effects</u>	20
E. <u>Sustainability</u>	20
F. <u>Follow-up</u>	21
V. FINDINGS	23
VI. RECOMMENDATIONS	24
VII. LESSONS LEARNED	
Acknowledgement	24
ANNEXES	
I. Terms of reference of the mission	25
II. Names of mission members	32
III. Itinerary of the mission	33
IV. Key persons met	34
V. Budget revisions	35

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 to 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 and 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.

## II. PROJECT CONCEPT AND DESIGN

### A. Context of the project

Project VIE/84/010 originated in a request made in April 1985 from the government of Vietnam for assistance in the processing of essential oils, aromas and flavours. Preparatory assistance in the form of a pre-feasibility study was carried out in April/May 1986. The project document was signed in October 1987, but implementation was not initiated until April 1988.

The Government of Vietnam has recognized the importance of (re)developing the cultivation and processing of essential oil plants, which are widely distributed up and down the country, as a major step in its plans to improve and develop the economy of the rural areas of the country. At the same time, if the oils distilled were of a quality that they could be sold on the international market, this would bring in much-needed foreign currency.

When the request was made, the Vietnamese essential-oil industry, which is situated largely in the rural areas and which in the earlier part of this century had enjoyed a high international reputation, was at a low ebb. The Vietnamese Government rightly saw that the industry could be modernized and restored through the input of expertise and equipment by means of a UNIDO project. Indeed, the project has entailed an expansion of the cultivation of essential-oil plants, including improved varieties, and consequently an increase in rural employment which has been shared equally between men and women.

At the time the project document was formulated, the intention was that the National Centre for Scientific Research (NCSR) would be the national implementing agency and that its Essential Oil Centre would be where the project would be located. In the meantime, the economic policies of the country have been undergoing considerable change and one consequence has been that the NCSR Essential Oil Centre has been converted into an autonomous commercial enterprise under the name ENTEROIL. This change in status has resulted in the unusual situation of an independent trading company being housed within a prestigious R & D organization and having complete freedom to deal in essential oils directly, both nationally and internationally; it is also able to set up joint ventures with domestic and foreign firms.

These events have meant that the project is now operating in greatly changed circumstances. Consequently, of the three immediate objectives as set out in the project document:

1. To increase the production of Vietnamese essential oils of internationally acceptable standard.

2. 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 particularly in regard to:
  - information on essential oils produced;
  - the ability to provide the required quantity and quality of products; and
  - forwarding of standard samples.
3. The development of an investment policy which will indicate the manner in which future production will be realized and how the transfer of technology from the National Centre for Scientific Research (NCSR) to the provincial production centres will be effected;

are no longer applicable in their original form. Instead, the development of marketing expertise has assumed greater importance.

With the liberalization of the economy, there are a number of other firms in the country producing and/or exporting essential oils, but ENTEROIL is by far the largest enterprise in this field and as a result of the project now enjoys considerable prestige abroad for the quality of the oils it exports.

#### B. Project Document

The project document is perfectly clear about the problem to be solved, viz the increase in production of essential oils for export and the upgrading of their quality to international standards. Again, the document is quite clear about the technical approach, primarily the provision of modern distillation and fractionation equipment for demonstration and research purposes, the equipping of an analytical quality control laboratory and the transferring of technology through the fabrication locally of improved stills for use in the field. Training is also an important component of the project. This overall approach is highly effective, particularly the demonstration aspect both of the modern equipment at ENTEROIL and of the improved stills to be used in the field. The farmers who grow the essential-oil plants will only be convinced by actually seeing the improved stills in operation and the better yield and quality of the resulting products.

The objectives and outputs as specified in the project document are clear and specific and certainly in accordance with the institution-building function of the project. The targets are

also clearly marked and the chains of inputs-activities-outputs-objectives form a logical and coherent series of events. But, as discussed in Section A, the context in which the project is now operating has undergone considerable change and marketing is seen as an aspect which is in need of development.

The assumptions regarding the technical aspects of the project made at the time the project document was drawn up are still valid in spite of the changed economic circumstances.

Although not specifically mentioned in the project document, comparisons in the quality control laboratory between oils produced in the modern equipment with those obtained by the older technology provide a self-evident indication of the progress being achieved in upgrading the quality. Similarly, export data show whether the production of oils of an internationally acceptable standard is increasing.

While the direct beneficiary, and at the same time user of the outputs and objectives, of the project is ENTEROIL, it is also indicated that in seeking to develop field distillation technology rural farmers will benefit economically by the introduction of better yielding varieties of essential-oil plants and also by the transfer of an improved distillation technology.

Appropriate work plans were included in the project document.

### III. PROJECT IMPLEMENTATION

#### A. Activities

The programme of activities set out in the project document, insofar as it is still relevant in the changed circumstances of the project, has been largely adhered to, although with implementation dates some 6 months later than those specified since the programme did not start until April 1988. Almost all the relevant activities have been completed and those still remaining, e.g. local fabrication of a fractional distillation unit and the transfer of technology to the field, will certainly be carried out by the time the project is due to end. The UNIDO inputs of international experts, training and equipment have been entirely appropriate to the objectives of the project and cannot be faulted. Inputs from the Vietnamese side have been more than was called for, e.g. the building constructed to house ENTEROIL was not included in the project document.

The initial and final project budgets (Annex V) show an increase of about US\$100,000, due almost entirely to an increase in the international and other personnel component, which, although almost the same in m/m, required some reallocation; the cost of some of the experts including the CTA, were evidently underestimated in the project document. The other components of the budget have remained the same and judicious management has allowed the acquisition of additional equipment, the menthol plant, and the purchase in Bangkok and Hong kong of materials for the fabrication of distillation stills and fractionating column in the NCSR workshop, without requiring additional funds.

#### B. Quality of monitoring and backstopping

The project management was effective in responding to the changed circumstances and objectives and no special comment is required. Monitoring has so far comprised three Project Progress Evaluation Reports and a Tripartite Meeting which was attended by the Backstopping Officer. No major problems have been encountered in the development of the project at present conceived.

#### IV. PROJECT RESULTS

Both the national government and UNDP have met their obligations fully. The study tour of the 4 senior staff members and the training fellowships of nine junior members were completed in time. These were followed by a National Seminar on Olfactory Evaluation which is a particularly important area of expertise required in the development of aromatic products, perfumes and blends. A more advanced level seminar on the same subject with an international faculty is planned for January 1991. All the expert missions have been fielded in time; a very useful part of all the expert missions was the seminars and lectures which the experts gave, so that others outside the project could also take advantage of the presence of the experts; the written technical reports based on these lectures were made freely available.

All the instruments proposed in the project document were obtained quite early and the project has had a fully operational analytical laboratory with very modern instruments since early 1989. Essential oils have been analysed without interruption since then, amounting to more than 2500 samples. In view of the high-quality service that became available through this facility, the laboratory has been authorized by the Government to issue certificates of quality for essential oils destined for export.

The distillation stills and fractionation assembly to be imported have all arrived, installed and commissioned, and were being used continuously both for training and experimental production purposes. The material for the fabrication of the distillation stills which were to be fabricated locally procured, some from international sources, the designs finalised, and the units were in advanced state of fabrication. This activity will help in improving the field distillation stills which in turn will raise the quality and quantity of oils obtained at the grass-root level, where most of the cultivation of essential oil plants takes place and the initial distillation is carried out.

ENTEROIL, the newly created trading enterprise within NCSR, is a unique experiment in linking scientific and technological activity and expertise with economic activity. It was gratifying to note the wide network which ENTEROIL has established all over the country at grass-root level for the cultivation and distribution of planting material of improved quality, for the dissemination of knowledge of agronomical practices and for the collection of oils. This has already helped in improving the production and export of essential oils not only by ENTEROIL but by the whole of Vietnam.



As a follow up of this project, the UNDP Aroma Chemical Project VIE/86/033 was started in 1989, which utilised the outputs of this project and is more consumer-industry oriented. It was gratifying to note the close coordination between the two projects in terms of free exchange of knowledge and information, the availability of analytical services of VIE/84/010 to the Aroma Chemicals project and the joint training programmes.

### Outputs

1. An operational analytical laboratory with the following instruments

- 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 early 1989 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 for essential oils destined for export. 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  
These two stills are being used for demonstration/training purposes and also for optimising upscaling parameters and experimental production of essential oils.

- One stainless steel and one mild steel 1000 l capacity distillation unit, NCSR design, developed in consultation with international experts. The NCSR workshop has had a long experience and tradition in the design and fabrication of distillation stills. Many of the stills designed by NCSR workshop were seen by the mission during field visit to the farms. These new stills will be an improvement of the earlier stills and will give a better yield and improved quality oils. under fabrication  
in CNRS workshop

It is proposed to install one of them as a model/demonstration still in the field.

- A 25 l all-glass fully automated fractionating assembly for upgrading essential oils and preparing pure components. This assembly is also being used both for demonstration and training purposes and for experimental production. fully operational
- 150 l stainless steel vacuum distillation assembly for upgrading substandard oils and preparing pure isolates under fabrication

One of the international experts, who is helping in the design of the still described to the mission during the visit the special features of this assembly

- Menthol Plant: This is one of the last pieces of equipment to be received in the project. This arrived during the stay of the mission in Hanoi and will no doubt be installed and commissioned soon. It should run many experimental production batches before the termination of the project. This plant was not in the original document, and could be accommodated on account of saving by fabricating some equipment locally instead of importing it. under installation

3. Study tours and training

Training has been an important feature of this project, and consisted of a study tour by senior staff, training fellowships for junior staff to more advanced centres and fielding of experts for on-the-spot training. The itinerary and schedule of visits appears to have been quite well thought out so as to derive maximum benefit from the visits and to coincide with some major international conferences so that candidates could participate in the conference. Details of the study tour, the training fellowship and the reports of the experts were made available.

- (a) Study tour : Five senior staff members, including the NPD went on a 8-week study tour (total 9 MM) to India and France, West Germany and Austria and visited organizations connected with research on the cultivation and production of essential oils and perfumes and also some industrial enterprises.
- (b) Training Fellowship: Eleven staff members were sent to India for training (total 27 MM) in distillation technology, design and fabrication of equipment, agrotechnology and analytical quality control. Some of them also attended the 11th International Congress of Essential Oils from November 11-20, 1989, in New Delhi.
- (c) International Experts : The following international expert missions were fielded:
  - (i) "International Markets of Essential Oils",  
Mr. J.G. Meredith
  - (ii) "Agrotechnology of essential oil crops grown in Vietnam", Mr. Rajendra Gupta
  - (iii) "Odour Evaluation and Compounding of Perfumes",  
Mr. Sudhir Jain
  - (iv) "Design of a Fractionation Distillation Unit",  
Mr. M.B. Narasimha
  - (v) "Fractionation Techniques and Distillation Columns"  
Dr. W.S. Brud
  - (vi) "Fractionation and Distillation Technology"  
Mr. C.L. Tikoo
  - (vii) "Quality Control Analysis of Essential Oils"  
Mr. A.L. Jayawardane

These experts apart from giving expert advice in practical problems also gave series of lectures in their fields of speciality, and summary reports of many of these lectures are available.

- (d) National Workshop on Olfactory Evaluation: One of the most specialized jobs in the production of essential-oil products and perfumes is Olfactory Evaluation. A 3 weeks national workshop for this training was organized by Mr. Sudhir Jain. Out of a large number of applicants only seven qualified for this training. Out of these seven, four have been selected for a more advanced training in the next higher-level workshop which is planned for January 1990 with an international faculty in Ho Chi Minh City.
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 knowledge 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 a poor quality oil and low recovery, and they 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 and some facilities are also shared.
7. Production and export of essential oils : One of the main hard outputs expected of this project is the increased production of quality essential oils in Vietnam. While it was found difficult to obtain or compile accurate figures on this point, the general conclusion is that this project has resulted in an upward trend in the production of essential oils and has provided the possibility of quality assurance leading to their better acceptance in international markets, resulting in larger exports. Vietnam, of course, has yet to establish a niche for its essential oil products in the open international market, and the appropriate international expert has made some very sound suggestions in this regard.

ENTEROIL provided the following figures for the production and export of essential oils from Vietnam during the last three years.

Table 1

Production of major essential oils in Vietnam 1988 - 1990

Name of Essential Oil	1988	1989	1990 (expected)
Ocimum gratissimum	100 tons	150 tons	180 t
Mentha arvensis	25 t	50 t	60 t
Cajeput oil	50 t	70 t	100 t
Ocimum basilicum	10 t	15 t	20 t
Cassia oil	10 t	12 t	15 t
Star anise oil	50 t	60 t	80 t

Table II

ESSENTIAL OILS EXPORTED TO FOREIGN COUNTRIES FROM VIETNAM  
FOR 3 YEARS, 1988, 1989, 1990

Commodities	1988		1989		1990		1991 Expected Kg
	Quantity (kg)	Earning US\$	Quantity (kg)	Earning US\$	Quantity (kg)	Earning US\$	
- Ocimum gratissimum	8,200	11,232	32,000	44,160	7,000	7,065	60,000
- Mentha arvensis and Crystal (Menthol)	4,155	10,778	4,090	13,690	5,064	11,769	20,000
- Citronella oil	358	1,180	38,706	46,447	97,890	73,417	90
- Ocimum basilicum	800	11,786	3,088	6,485	3,088	15,375	3,000
- Litsla cubeba	136	270					
- Pemou oil & Casia oil	201	2,515			2,085	11,055	2,000
- Cajeput oil					6,840	6,810	5,000
<b>Subtotal</b>	<b>13,870</b>	<b>37,761</b>	<b>77,884</b>	<b>110,782</b>	<b>121,967</b>	<b>125,491</b>	<b>180,000</b>

**Total:**

Export quantity 88 + 89 + 90: 13,870 + 77,884 + 121,967 = 213,741 kg  
Export earnings 88 + 89 + 90: 37,761 + 110,782 + 125,491 = 274,034 US\$

B. Immediate Objectives

Most of the immediate objectives set for the project mentioned in Section II.B.2 have been achieved, and those that are left will no doubt be achieved during the rest of the project period.

C. Development Objective

The project has developed in the right direction to contribute to the fulfilment of the developmental objective. Much more, however, will need to be done and at a higher technological level over a long period of time to be able to meet the spirit and substance of the development objective. Some suggestions as to how this should be done are made below in the Section F. Follow-up.

D. Unforeseen effects

More outputs have been achieved than proposed in the project document; the quality control laboratory though meant initially for internal use became so useful for others as well that it ended up by being recognized as a government certification laboratory for export samples; the saving of budget achieved by local fabrication of equipment was used for acquiring a Menthol Production Plant though not initially included in the project.

E. Sustainability

The partnership between ENTEROIL, a trading enterprise with its network of contacts with growers and distillers at grass-root level all over the country, and NCSR with a long tradition of high-quality research work on essential oils and experience of

fabrication of distillation stills gives no doubt about the sustainability of the present activity. The project activities have gone on quite smoothly, and the local project staff has been intimately involved in all the activities. In the case of the analytical laboratory the project staff has been operating all the instruments quite competently and successfully for over a year. The staff has also been involved in the installation and operation of all the distillation stills and fractionating assemblies, and also in the design of new assemblies and fractionating columns. The present level of activities will certainly be sustained by the national staff.

F. Follow up

The present project has involved the introduction of new technology for distillation and fractionation, establishment of a quality control analytical laboratory for essential oils at NCSR/ENTEROIL and attempts to improve distillation stills in the field, as well as putting up an experimental plant for the production of bold crystal menthol from mint oil and training of staff in all these and in extension work and marketing. This limited objective has been satisfactorily achieved. But all this work has been directed to the existing essential oils in Vietnam and does not raise the technological level and status of the essential-oil industry of Vietnam. This phase was an essential, but only a first, step and now the Vietnamese industry must enter a higher technology area. The Aroma Chemicals Project VIE/86/033 is a useful extension in that it utilizes the existing essential oils to make consumer products, but what is needed is to embark upon a well-integrated development plan for the introduction of new essential oils and new products made from essential oil and the development of perfumery and blended consumer products.

Some suggestions for this follow up are given below; all or some of these could be taken up:

- (i) Introduce new exotic aromatic plants, for which suitable climatic conditions seem to exist in Vietnam: *Mentha Citrata* for linalool, *Eucalyptus macarthuri* for geraniol and eudesmol, patchouli and vetiver.
- (ii) Develop new essential oils based on Vietnam's own flora and on which some work which has already been done at the NCSR.
- (iii) Enlarge the production of aroma chemicals, e.g. of citronellal, citronellol and esters, hydroxycitronellal, geraniol and esters, A and B-pinenes, perfumery grade terpineol and esters, citral, perfumery grade A and B-ionones, nerolidiol.



- (iv) Develop processes for resins, oleoresins and concretes such as benzoin siam resin, oleoresins of curcumin, ginger, and pepper, and concrete/absolute of tuberose.
- (v) Develop processes for some perfumery-grade chemicals, such as C8-C12 aldehydes, macrocyclic lactones and ketones, rose oxide, Yara Yara and anethole.

This work could be funded in various ways. ENTEROIL should invest a certain percentage of its sales turnover in R & D; between 5 - 10%, and should set up an R & D centre with this money. In this way it will also get the advantage of proximity to a range of scientific departments, instrumentation and workshop facilities at the NCSR. In case, however, the NCSR decides to stay as a purely trading organization, then the NCSR should enlarge and establish a National Centre for Essential Oil Research which should be funded jointly by NCSR and ENTEROIL.

Any future UNDP aid should be directed to these newer areas of work.

## V. Findings

The project as conceived judged by any criteria has progressed well. Most of the expected outputs have already been achieved, and whatever is left will no doubt be achieved before the project ends in April 1991. The observations on the outputs achieved have been discussed in Section IV A. A few additional relevant points are touched on below.

The establishment of the quality-control capability at the ENTEROIL analytical laboratory and the latter's appointment as a government-approved certification centre is a particularly valuable feature of the project. This will no doubt help in better acceptance of Vietnamese essential oils on the international market. In the changing situation in Vietnam towards a market economy in many industries, it is not appropriate for this certification work to be carried out by a trading enterprise, and it should be part of a government laboratory's function. It is therefore suggested that this certification work should not continue as an ENTEROIL activity but instead should become an autonomous independent activity of the NCSR.

During the course of its work the mission experienced considerable difficulty in getting dependable figures on the trade in essential oils: the areas under cultivation of different essential oil crops, the quantity of oils produced, the prices of the oils, the export and import figures for essential oils, comparisons between national and international prices of oils, etc. It would be useful to establish an Essential Oil Information Centre, perhaps to begin with as a part of ENTEROIL, to collect and supply this information.

## VI. 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 it should become 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 is made available to other laboratories and companies.
6. An Essential Oil Information Centre should be established to provide statistics on the cultivation, production, import, export and prices, national and international, of different essential oils.

### Acknowledgement

The evaluation team would like to thank Prof. Nguyen Van Hieu, President, NCSR, for many valuable discussions, Mr. Le Trong Vong, General Director, ENTEROIL, Dr. Chien, Deputy NPD, and Mr. Nguyen Nha Duc, Project Secretary, who provided all the background documents and arranged the programme. The mission would also like to thank UNDP, Hanoi, and particularly Mr. Phan Duc Thang, Programme Officer, for all the help during our stay in Vietnam. Above all, we would like to express our deep appreciation to Ms. Pham Thi Ngoc Lan who typed our report most efficiently, but for which it would not have been ready in time.

In-Depth evaluation of: Projects (I) DP/VIE/80/032 Pilot  
Production of Medicines using Indigenous Raw Materials and (II)  
DP/VIE/84/010 Processing of Vietnamese Essential Oils and related  
Natural Products

TERMS OF REFERENCE

1. BACKGROUND

The Government of Vietnam cognisant of the fact that the country has abundant resources of plants containing valuable phytochemicals, seeks to develop this resource base by indigenous technology. In seeking to achieve this end, two projects were initiated: project (I) to develop medicines using indigenous raw materials and; project (II) to develop the industrial production of Essential Oils and related Natural Products.

1.1 Project (I) DP/VIE/80/032 Pilot Production of Medicines using Indigenous Raw materials

The Vietnamese Government aims to evolve and promote a "Vietnam System of Medicine", combining the use of modern and traditional drugs. The Government strives to accomplish this by the following:

- a) Integrated teaching of traditional medicine as a compulsory component in the colleges training modern practitioners;
- b) supporting research on medicinal plants in traditional as well as modern institutes;
- c) bulk producing traditional drugs in conventional and for modern dosage forms;
- d) a clear-cut policy statement to increase production of traditional drugs by 28 per cent during the coming years.

The project, which was included in the Country Programme 1982-1986 for Vietnam under para. 63 will contribute to develop the country's pharmaceutical products from indigenous raw materials up to industrial scale production.

The immediate objectives as formulated in the project document were to upgrade the infrastructure and strengthen the research and development capabilities of the Institute of Materia Medica to enable it to accomplish the following specific objectives:

- i. Establish scientific proof and credibility regarding the efficacy and safety of Vietnamese traditional herbal medicines through conduct of pharmacological, toxicological and clinical trials as required under the 1981 legislation of Vietnam on the lines of rule 563 of WHO;
- ii. develop and demonstrate through a modern pilot plant the requirements of "good manufacturing practice";
- iii. meet regulatory requirements for new drugs developed at the institute, from the appropriate authorities of government, through data under i. and ii. above as an interface between research and industry.

## 2.2 Projects (II) DP/VIE/84/010 Processing of Vietnamese Essential Oils and related National products

Vietnam had during the term of the country, a reputation for production of essential oils. The events of the past decades had left the country bereft of the resource base that once was well developed. Accordingly, the resuscitation of the industry became one of the governments main aims and an important means of developing the rural economy. Distillation stills old and in need of renovation have been used over the years by the local community and the governments' intention as set

out in the Five-year plan of 1986-90 is to improve, by the application of modern technology, the earnings of the provincial as well as the national sectors. The policy required technical assistance in the form of the project whose objectives are defined as follows:

The development objective of the project is in line with the national development orientation consistent with the Five-year Plan for the period 1986-90 and will contribute to the increase in the production of Vietnamese essential oils and related natural products. This will serve in enhancing rural development and providing raw materials for local industries and ensuring their controlled development. It will also be contributing towards the increase of foreign exchange earnings.

The project is included in the Third Country Programme of Vietnam, para. 68, in the Chapter on "Assessment and Exploitation of Natural Resources".

Immediate Objectives are:

- i. The first immediate objective will be to increase the production of Vietnamese essential oils of internationally acceptable quality. This is to be achieved by the use of improved processing techniques derived from means of transfer of technology and the application of appropriate parameters for improvement of both yields and quality.
- ii. The second immediate objective seeks 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 quantity 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.

iii. A third objective will be the development of an investment policy which will indicate the manner in which future production will be realized 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.

## 2. THE EVALUATION

In order to assess the overall achievements of the projects and to identify the needs for further assistance, it has been agreed by all parties concerned to undertake an in-depth evaluation.

### 2.1 Scope, Purpose and Methods of Evaluation

In accordance with provisions contained in the UNDP Policies and Procedures Manual (PPM), the purpose of the evaluation mission would be to:

- a) Assess the achievements of the projects against the set objectives and expected outputs. This will include a re-examination of the projects designs;
- b) Identify and assess the factors which facilitated the achievements of the project's objectives, as well as those factors that impeded the fulfillment of those objectives;
- c) Examine the extent to which the results/outputs produced by the projects have contributed towards the building up of Government capabilities to produce herbal medicines on pilot-scale using indigenous raw materials;
- d) Examine if the approach utilized in both projects have led to optimum results;
- e) Assess the cost of present pilot-scale production and estimate cost of future commercial scale production of products as compared with international market prices thus deriving the potential economic impact of the projects. Due consideration should be given to socio-economic benefits that can be derived from domestic production using indigenous raw materials.

In addition, the mission would also assess the technical progress made in relation to the following (for project 1): DP/VIE/80/032 - Indigenous medicines.

- i) Establishment of efficacy and safety of products
- ii) Demonstration of GMP via use of pilot plant
- iii) Clearance of Regulatory requirements to provide a source of technology transfer to industry.
- iv) Manpower build-up to form a satisfactory R&D team.
- v) Procurement of Raw material supplies on a continuing basis.

for project (2) DP/VIE/84/010 - Processing of Vietnamese Essential Oils and related National products

- i) The extent to which compositional analyses of Vietnamese produced essential oils have been conducted by CNRS as a continuing R&D exercise.
- ii) The progress made with the construction/installation and use of pilot-scale equipment for distillation and rectification.
- iii) The extent training of manpower conducted towards ensuring acceptable competence in distillation technology, instrumental analyses and organoleptic assessment.
- iv) The Potential for services to the Industry by CNRS in the future and its continuing R&D role
- v) Liaison between CNRS and the project DP/VIE/86/033 in HCMC.
- vi) Identify any gaps in the technical assistance inputs hitherto delivered or programmed.

While a thorough review of the past in itself is very important, the evaluation is expected to also lead to detailed suggestion for further assistance to the industry within the country, realisation of the benefits to the target groups.



3. COMPOSITION OF THE MISSION

The mission will be composed of the following:-

One representative of UNDP

One representative of the Government of Vietnam

One representative of UNIDO

These representatives should not have been directly involved in the design, appraisal or implementation of the project.

4. Consultation of the Field

The mission will be maintain close liaison with the UNDP Resident Representative in Vietnam, the UNIDO SIDFA, the concerned Government organizations and the project's national and international staff.

Although the mission should feel free to discuss with the authorities concerned all matters relevant to its assignment, it is not authorized to make any commitments on behalf of UNDP or UNIDO.

5. Timetable and Report of the Mission

The UNDP and UNIDO representatives will receive briefings at their respective headquarters. Upon arrival in Hanoi, the mission will be briefed by the UNDP Resident Representative and the UNIDO Country Director, who will also provide the necessary substantive and administrative support. The mission will attempt to complete its work within 2 - 3 weeks starting in Hanoi in August 1990. Upon completion of its work, it will be debriefed in Hanoi by the UNDP Resident Representative, as well as the UNIDO Country Director. At the end of the mission, the UNDP Resident Representative will organize a meeting involving senior Government officials where the mission will present its initial findings, conclusions and recommendations, and be ready to discuss these. The mission would also discuss its preliminary findings during debriefing at UNIDO Headquarters, with the concerned officers.

The mission will complete its report in draft in Hanoi in accordance with the UNDP policies and guidelines. The mission will be required to leave behind a copy of the draft with the Resident Representative in Hanoi and one with the UNIDO Special Technical Adviser at UNIDO Headquarters.

The final version of the report in a format ready for reproduction will be submitted simultaneously to UNDP and UNIDO Headquarters (3 copies each) and to the UNDP Resident Representative in Hanoi, who will be responsible for formal submission of the report (6 copies) to the Government.

Evaluation Team

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

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

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

Itinerary:

Annex III

- 6.8.90 Joint meeting of the team members at UNDP, Hanoi  
Meeting with CTA, NPD, Director and senior staff of the  
Institute of Materia Medica (IMM)  
Visit to the Pilot Plant and Laboratories.
- 7.8.90 Meeting at IMM and visit to the Labs.
- 8.8.90 Visit to Pharmaceutical Factory No. 2  
Visit to Pharmaceutical Factory No. 1
- 9.8.90 Visit to the Central Medicinal Herb Trading Co., Hanoi  
Visit to the Van Dien Farm of the IMM  
Visit to the National Institute of Drug Quality Control,  
Hanoi
- 10.8.90 Meeting with Prof. N. G. Duan, Vice-Minister  
Visit to the Institute of Traditional Medicine Health
- 11.8.90 File Reading at UNDP, Hanoi
- 12.8.90 File Reading at UNDP, Hanoi
- 13.8.90 Meeting with CTA, NPD and Management of ENTEROIL at NCSR  
and visit to Distillation Labs and Workshop  
Discussion at the IMM
- 14.8.90 Meeting with Prof. N.V. Hieu, President of the NCSR  
Visit to private farms at Me So district Hai Hung
- 15.8.90 Visit to Ha Trung State Farm, Thanh Hoa Province
- 16.8.90 Report writing at UNDP
- 17.8.90 Report writing at UNDP  
Discussion at the IMM
- 18.8.90 Visit to the Faculty of Chemistry, Hanoi  
University and the Hanoi College of Pharmacy and meeting  
with staff of the NCSR Institute of Natural Product  
Chemistry
- 19.8.90 Report writing
- 20.8.90 Tripartite meeting
- 21.8.90 Final discussion at UNDP  
Discussion at the IMM

VIE/84/010

Annex IV

INSTITUTIONS VISITED AND PERSONS MET

I. UNDP, Hanoi

1. Mr. J.M. Bonnamy, UNIDO Country Director
2. Mr. Lars Adermalm, UNDP Field Officer
3. Mr. Phan Duc Thang, Programme Officer

UNIDO Staff

1. Dr. C.K. Atal, CTA of Project
2. Dr. C.L.Tikoo, Chemical Engineering Expert

II. National Centre for Scientific Research Hanoi

1. Prof. Nguyen Van Hieu, President, National Centre for Scientific Research of Vietnam.

Local Project Staff

1. Mr. Le Van Thu, National Project Director (away due to illness)
2. Mr. Nguyen Quyet Chien, Chemistry, Department Director of Project
3. Mr. Le Trong Vong, Director, ENTEROIL
4. Mr. Nguyen Nha Duc, Project Secretary
5. Mr. D. X. Hao, Chemical Engineer
6. Mr. Nguyen Don, Workshop Director, NCSR

III. HA TRUNG State Farm, Thanh Hoa Province

1. Mr. Dau Dang Doanh, Director
2. Mr. Do Huu Thien, Vice-Director

Annex V

	BUDGET REVISION		VIE/84/010/E/01/37		VIE/84/010/K/01/37	
	m/m		m/m			
<u>International experts</u>						
11.01	CTA	24	165,500	24.2		210,103
11.02	Chemist Essential Oils	4	27,700	6.0		50,020
11.03	Chemist Terpenoids	2	13,200	2.0		21,500
11.04	Engineer - Distillation Tech.	2	13,200	1.6		14,069
11.05	Marketing Specialist	2	13,200	2.0		23,177
11.50	Short-term Consultants	4	29,355	2.0		22,323
11.99	Sub-total International Experts	38	262,155	37.8		341,192
15.00	Project travel		6,000			16,000
16.00	Other personnel costs		14,000			24,000
					Surrender Py	
					Obligs.	715
19.99	Total Personnel Component	38	282,155	37.8		380,477
<u>Subcontracts</u>						
21.00	Subcontracts		20,000			20,000
29.00	Total Subcontracts		20,000			20,000
<u>Training</u>						
31.00	Individual Fellowships	27	81,000			75,802
32.00	Study tours	9	45,000			54,000
33.00	In-service Training		10,000			6,198
39.99	Total Training Component	36	136,000			136,000
<u>Equipment</u>						
41.00	Expendable Equipment		60,000			60,000
42.00	Non-Expendable Equipment		477,000			511,614
					Surrender Py	34,614
					Obligs.	
49.99	Total Equipment Component		537,000			537,000
<u>Miscellaneous</u>						
51.00	Sundries		15,000			15,915
59.99	Total - Miscellaneous Component		15,000			
99.99	Project total	37.8	990,155	37.8		1,089,392