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18041

DP/ID/SER.A.1318
9 February 1990
ORIGINAL: ENGLISH

PROCESSING OF VIETNAMESE ESSENTIAL OILS AND RELATED NATURAL PRODUCTS

DP/VIE/84/010

VIET NAM

Technical report: Agro-technology of essential oil crops grown in Viet Nam*

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

Based on the work of Mr. Rajendra Gupta,
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* This document has not been edited.

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SUMMARY

The Socialist Republic of Vietnam is located in the eastern part of south-east Indo-chinese Peninsula, bordering sea on the east and south-east. The southern edge has a nearness to equater whereas the northern part extends above 23oN. This together with larger part of mountains, plateau land, river valley and delta lands gives the country a unique feature.

Vietnam has inter-continental humid tropical climate with high rainfall and very high humidity almost throughout the year. It has an ancient tradition of agriculture and grow a large and diverse variety of food, fruit and industrial crops. It has a tradition in growing aromatic and essential oil plants for use in culinary medicine, perfumery and related fields. In the last several years, the country has organized the production and export trade in certain essential oil crops by establishing ENTEROIL. UNIDO has granted a project to support this activity in essential oils and a consultant was assigned to ENTEROIL for a period of 1 month to adivse and upgrade the agro-technology used in growing these crops and make them more productive and cost competitive.

After deliberations with NPD and CTA, this consultant was assigned a programme of six seminars on the thrust crops namely Japanese mint, Java citronella, basil, vetiver and palmarosa oil grass as well as in house discussions and consultations at farm level through field visits to co-operative farms. During these seminars and deliberations, the consultant has given detailed practices on the cultivation of these crops, has identified areas of gaps and weak spots and made suggestions on remedial measures including areas for R & D work for each crop in the near future.

ENTEROIL is a unique organisation as it continues to draw scientific and technical support from its parent body, the CNRS. Whereas it concentrates in the extention, production, trade and export, it has planned to expand the activities, improve its skill and facilities to enter the markets of EEC and other major trading countries. This is possible by developing certain long-term facilities and strengthening and re-organizing manpower and their skills. In particular, the consultant has recommended that CNRS should expand its activities to carry out evaluation of exotic plants and identify new high yielding lines on a continuing basis. It should also establish a seed testing laboratory; a plant protection and surveillance (control) unit; an agonomic team for field trials to back up ENTEROIL with data for devicing and moderating suitable crop rotations, develop improved schedules and publish "Farm Bulletins". ENTEROIL should also maintain a "national register of varieties; develop seed farms and seed storage facilities and study integrated farm economics on growing these crops in order to transfer the knowledge to growers by demonstrating new cost cutting devices and make the production of essential oils more profitable, quality concencus and competitive for export.

1. INTRODUCTION

A project document on processing of Vietnamese Essential Oils and related natural products was drawn up between the United Nations Industrial Development Organization (UNIDO) and the Socialist Republic of Vietnam to develop an essential oils industry by utilizing the country's natural resources in soil, climate and essential oil crop plants. Whereas, the natural flora of Vietnam possesses a large component of essential oil plants, it currently produces cassia oil (Cinnamomum cassia), star anise oil (Illicium verum) , litsea oil (Litsea cubeba), eucalyptus oil (Eucalyptus globolus) from the forestry sector. A small quantity of illang illang oil (Canaga odorated) and pemou oil (Fokiena hodginsi) is also produced but the quantities vary from year to year widely. In the Farm sector, Japanese mint oil (Mentha arvensis), citronella oil (Cymbopogon winterianus and C. nardus), Basil oil (Ocimum gratisimum and O. basilicum) and vetiver oil (Vetivia zizanioides) are produced. Amongst these, the latter two cultivations (Basil and Vetiver) are based on native plant stocks while the others are based on introduced cultures from outside, and acclimatized in the country.

The Government of Vietnam has established the Centre National de Recherche Scientifique (CNRS) as a nodal organisation of 40 research, development and production oriented institutes and enterprises at a national level. Amongst these, essential oils enterprise (ENTEROIL) is the one responsible for the development and production of essential oils. It is a link between co-operative farms in the provinces to which it provides technical guidelines for cultivation and distillation of essential oil plants and from which it buys these on commercial scale for trade within the country and for export.

The consultant was assigned to ENTEROIL and had worked under the direct supervision of its General Director (NPD) and the Chief Technical Adviser (CTA). The consultant had detailed discussions with NPD and CTA upon his arrival and they identified several crops such as mints, citronella, basil, vetiver and palmarosa crops as the thrust areas. Advice to limit seminars and deliberations on these commercial crops were given. The immediate objectives (read with duties assigned in annexure 1) were:

(i) To provide agro-technology to the scientific and technical personnel in ENTEROIL for a cultivation manual, updating information on growing the above listed crops.
(ii) To carry out feasibility studies on local modalities on the cultivation adopted at co-operative farms by field visits and discussions with crop specialists in the production division.
(iii) To formulate modalities for improving cultivation practices and;
(iv) To give outline of future development infrastructure for long-term impact in crop production and improvement of yields at farm level.

2. AGRICULTURAL SCENARIO

Agro-technology for any group of crop production and farm research is initimately related to soil, climate and general agriculture of the region. It is therefore essential to have a broad view on land, climate and main agricultural crops raised in the Northern parts of Vietnam (assigned to the project) in order to utilise these resources efficiently.

2.1 Geography and Meterology

The Socialist Republic of Vietnam lies in the inter-tropical monsoon belt of the eastern Indo-Chinese Peninsula, between 8o30' to 23o22'N latitute (excluding the islands) and between 102o10' to 109o30' longtitude. It has an area of 329,600 sq.km with coastline of 3,000 km touching the South sea and Pacific Ocean on its South and South-east side. The national boundary joins China, Laos and Kampuchia on its North, North-west and South-west side respectively. Almost three-fourth of the country is mountaneous with a population of 60 million people depending mainly upon farming. The river-delta lands and, to a great extent, the plateau part are extremely fertile and support a dense population. The humid tropical climate in Vietnam has some special features of its own and these greatly influence its vegetation and agriculture. The summer season is from May to September when south-westerly equatorial winds sweep the land and bring heavy rainfall (average 1700mm) in North Vietnam. The winter is from October to March. Dry polar north-eastern winds lower the temperature and bring the real cold season. During this period it rains only occasionally. In particular, the winter is more severe than in other countries also situated on the 18th parallel latitude. In general, Northern Vietnam, which is the area assigned to this mission, has sub-tropical climate upto 600m elevation and temperate climate at and above 2000m elevation. There is an average of 130 rainy days in a year. Spring is short. The region receives occasional drizzle during spring which is considered valuable for sowing. The relative humidity remains high (80-90%) throughout the year. Although the seasonal temperature varies from 23.4oC (June) to 6.9oC(Jan) at Hanoi, 19.7oC to 6.4oC at Hue and 20.6oC and 7.2oC at Dalat, there is minor difference in temperature in day and night during a season. The insolation is intense (Sun-shine hours are 1700, of which 1100 hours are in summer) with frequent fog and rain. It is obvious that most varieties of crops introduced from outside have to undergo a period of acclimatization and selection to realise their maximum yielding ability.

2.2 Crops

Agriculture is organized into a system of State Farm and People's Co-operatives. The country has an estimated area of 8.56m ha under cultivation (1985) and grows a wide variety of food, fruit and industrial crops. Rice is by far the main crop, and the country increased production in recent years such that a sizeable quantity during 1989 was exported. Maize, potato and tapioca (manihat) are subsidiary crops. Sugarcane, pea nuts, soy bean, tobacco, jute, and vegetables are grown in substantial areas. Banana, pine apples and citrus fruits have sizeable areas under them. Similarly, tea, rubber, jute, cotton and coconuts are raised on commercial scale and their area is expanding progressively under the state plans. Vietnam has 13 canning and processing factories for fruits and vegetables and two-third of the production is exported. In essence, the country has an ancient tradition of good cultivation and because of the existence of a wide range of climate, it is able to raise diverse commercial crops.

3. FINDINGS AND OBSERVATIONS

In consultation with the CTA and under advice of NPD, a programme by the consultant was scheduled which included six seminars, followed by in-house discussions with over 20 scientist and technical personnel of ENTEROIL and related sister organizations in CNRS:

1st seminar:	Research and development including markets and sources of information on essential oils in world trade with particular reference to production, marketing and trade in India.
2nd seminar:	Cultivation and production of mint oils.
3rd seminar:	Cultivation and production of citronella oils.
4th seminar:	Cultivation and production of vetiver oil.
5th seminar:	Cultivation and production of basil oil.
6th seminar:	Cultivation and production of oil of palmarosa grass.

The Agro-technology presented in these seminars covered resource, utilization and choice of ideal types of soil, of climate desired for maximising yields, farm inputs (commercial varieties, seed, manures, fertilizers, pesticides, fungicides, irrigation), farm operation (inter-culture, inter-cropping, crop rotation and sequencing for restoring fertility), harvest index (time, stage, method), post-harvest handling (time of wilting, moisture content, transport losses). The distillation, oil analysis and quality control of desired chemical composition are related topics intimately connected with good cultivation practices and were generally discussed. These are taken care of under the Technical Servies Division in ENTEROIL, where a Quality Control Laboratory is established ar1 is well equipped by this UNIDO project. The salient parameters which, in the cpinion of the consultant, are needed to be taken care of in cultivation and production of commercial crops in the thrust area are briefly reiterated for reference as a manual. It is a matter of gratification that the CTA and NPD also participated in som e of these seminars and generated interest and encouraged discussion for obtaining more information on different steps involved in the given package of appropriate agro-technology on specific crops. During the stay, the consultant visited certain co-operative farms in the central and North-western parts of Vietnam which raise Basil and Citronella crops and had detailed dialogues wich farm managers and specialists at site. The mint crop was harvested all over the tract during this month.

3.1 Manual for Growing Mints

The Japanese mint (*Mentha arvensis* sub. sp. *haplocalyx* var. *piperascence*) is a choice crop for cultivation in Vietnam. It is a natural cross (2n=192) between *M. arvensis* x *M. aquatica* which grows to 80-90 cm tall with quadriangular purple stem and broady linear leaves, forming robust bushy growth at bloom. The plant bears white to blueish flowers in axil of leaves which do not produce seed. Two varietes are cultivated that were originally brought from China and North Korea and baptised as "N V-74" and N V-76". The latter is of Korean origin and is preferably cultivated because of its higher menthol content. In all, it is reported that 1000ha are under cultivation, largely over sandy alluvial acidic soils, rich in humus. There is a large demand for that oil in local medicine and for food stuffs. The government plans to expand its cultivation in six provinces for oil and menthol production and partly for export. The growing region receive 2200-2500mm rainfall, which keep the soils moist till Steptember.

In Vietnam, as elsewhere in sub-tropical regions, 10cm long freshly dugout stolons are planted in 7-10cm deep furrows at 45 x 10 cm spacing during January, February and March. It is necessary to treat these stolons with a 0.2% Benlate/Captan solution for 2 minutes to protect them against stolon rot, which is common in Vietnam.

Preparation of the land is carried out as for vegetable growing but 20kg of Aldrin should be given to the soil (5%) before the stolons are layed into fields. This protects the young growing plants from termites and root cutting caterpillars. Both of these maladies exist in the soil at different periods of the year. Lime is not applied but if soil tests give PH of 5 or below, it is desirable to give it at the time of land preparation lest the applied N2 will be only partly available to the growing crop. To the field 10t FYM (Farm yard manure) or org. manure are given at land preparation together with 60kg P205 and 40kg k20 basally (depending upon the soil test report of the field) In most cases N2 rich soils are chosen for this crop and top-dressing of 90 to 120 kg of nitrogen/ha is recommended in 3 equal splits. The first split is given 40-45 days after planting. The second 10 days after the first cutting and the third immediately after the second cut of herbage. In Vietnam, ratoon crop of mint is taken in the second year which, in a moist tropical country, is unsuitable for obtaining consistent high yields. In India, mint is followed by potatoes, soy bean, wheat, berseem or late paddy which keep the land free of tropical weeds, control the spread of soil born diseases, and farmers receive higher overall returns.

The mint crop demands weed-free conditions for high yields. In all, 5 to 7 intercultures (weeding/hoeing) are given which are manual addition to the over all cost of cultivation. It is possible to use a wheel-hoe in between the rows or a bulluck/tractor driven weeding, which is easy till the first crop is taken. On a broader spectrum, some selective herbicides like Terbacil (SINBAR) at 1.0 to 1.5kg (a.e./ha) or Delapon at 2.0 1/ha have been found to provide 30-40 days weed-free conditions but the availability of these chemicals is uncertain in Vietnam. It is to be noted that these weedicides are applied when the field has adequate soil moisture at post emergent weed stage.

In an earlier part of cultivation, irrigation is not generally needed and is provided through canal water during the dry season from September to November. The crops are recommended for harvest at bloom, when the lower leaves begin to show the pale colour and may shed if harvesting is delayed. At this stage, the crop has 0.5% to 0.8% oil. The crop is cut at 12-15cm high. It is necessary to harvest the crop on bright sunny days; cloudy weather changes part of menthol into menthone in the growing plants. It is our experience in India that when 14 hrs. day length is available, the oil has its highest menthol content. First crop is harvested 100-120 days after planting, the second 75 days, and the third 60 days after the last cut.

It is always necessary to keep the harvested herbage for the field for wilting for 4-6 hrs. This reduces the bulk and saves on fuel. Do not heap the harvested crop which generates heat and causes loss in oil. It is advisable to cut the herbage into small pieces (10-15cm) through a power-driven chopper which allows more crop to be packed in a distillation still. The oil yield varies depending upon several factors, but should be above 100kg/ha with 75% total menthol. The commercial crop in Vietnam is reported to possess a lower menthol content which may be examined and could be improved upon by following the given cultivation practices.

In Vietnam. stolon rot caused by Rhizoctonia baticola and wilt caused by Verticillium alboatrum are reported to occur. However, not much efforts have been made to control these diseases. For stolon rot, the treatment mentioned earlier is necessary besides pulling out all infected plants and burning them to reduce the spread of the disease. Wilt is a soil-borne disease and can be kept in reasonable check by deep ploughing and opening the soil to sun (before planting), good drainage of field, planting of healthy stolons and soil fumigation; the latter is a costly operation. Instead, crop rotation is found better in several other countries. Leaf blight (Alternaria species) is also reported in Vietnam for which spraying of copper fungicides (copper oxychloride 0.02%) is effective. Leaf sucking insects and cut-worms are active on the crop during the rainy season for which Melathion (0.2%), Thiodan 35 E C at 400 ml/ha is found effective. The plant protection part on this crop in Vietnam, leaves much to be desired and should be organised in coming years.

Peppermint (Mentha piperita) and spear mint (M. spicata) are two other mint crops in experiemntal stage at present. It is advisable to grow Black mitcham (M. piperita var rubescens) and peper mint in sub-temperate areas. This variety has violet brown stems and produces superior oil (35 to 55% menthol). It is grown in USA, Argentina, Bulgaria, USSR, India and several European countries. The spear mint should receive low priority in the introduction, because this species is more succeptible to pests and diseases in a humid tract. However, U.K., France, USA, and Italy have good cultures on this crop for trial purposes.

3.2 Manual for Growing Citronella

The Java citronella (Cymbopogon winterianus) is the choice species. It produces a high yield of oil and citronellal in the oil. The other species viz Ceylone citronella (C. nardus) is also commercially cultivated in Vietnam. It is more hardy but has a low oil content and a lower percentage of cintronellal and geraniol. Between 500 to 700 ha, currently under this crop produce 700t of oil annually. There is a local demand for that oil in soap, detergent and pesticides industries. An export market in socialist countries was built up. Citronella is a tufted, tall aromatic perennial herb with fibrous roots and stout erect culms bearing long (1m x 1.5cm) tapering, greenish-yellow glabrous leaves with sharply scrabid edges.

It is a drought hardy plant but grows luxuriantly on moist land; the plant bears irregular flowers in southern equatorial regions. It has heterogenous flowers (male, neutral and bisexual) with irregular meiosis, ocassionally producing seeds, which are seldom viable. A fresh plantation is always raised from rooted splits made from an old grown clump.

The crop grows luxuriantly over well drained moist, fertile sandy loam to clay-loam soils of 5 to 8 PH (6 is ideal), over highlands. Water logged localities and those receiving frost should be avoided. Being a long duration (4 yrs.) plantation crop, it needs deep ploughing and sun-weathering to allow preparation of soil to a fine tilth. 20Kg. of Aldrin (5%) or 50 kg of Heptachloral dust (10%) should be applied to the fields at land preparation to prevent losses due to soil-borne insects. The crop is recommended to be given 10t FYM or organic manure together with 60 kg P205 and 40 kg K20 (preferably on soil test reports). It is a heavy feeder of nitrogen fertilizer and 120 kg. per ha/ annum is the recommended dose in India, given in 4 equal splits 30 days after planting and in 3 month internal after each harvest (except in the first year when the first harvest is taken after 5 or 6 months after planting).

The planting of rooted slips is done in the spring season, but is continued throughout the rainy season at 60 x 45, 60 x 60 and 60 x 75 cm spacing (depending upon soil fertility and implacement to be used for interculture in fields). Usually flat bed planting is practiced except in high rainfall tracts. The rooted plants take 10-15 days to sprout and cover the open spaces in next 60 days. The crop is given 2 - 3 interculture by hand or wheel-hoe (or tractor driven tillers). Pre-emergent chemical weedicides like Dicuron (1.5 kg a.e/ha) and Simazine (2 kg a.e/ha) can be applied in rows. These have been found effective in several countries. In India, spreading of exhausted grass (after distillation) at 3-5t/ha in between the rows has been found to suppress weed growth. In Vietnam, irrigation is given to this crop during dry season at an interval of 15-21 days. Where high rainfall occurs (200-250cm) throughout the year as in Indonesia, citronella is grown as a rainfed crop.

The foliage contains maximum oil. First harvest is taken after 5 to 6 months of planting and then in an interval of 3 months. In the humid tracts of Vietnam, farmers reported to cut the grass after 60 days which sometimes causes white etiolated foliage (lack of chlorophyll) and decline in oil yield. This should be avoided. It is caused because the plant grows fast in humid conditions but the synthesis of chlorophyll and oil in leaves do not keep pace with growth, affecting oil content and total yield. The affected clump should not be used for fresh planting. No serious diseases have been reported on this crop in Vietnam except terminal drying and browning of leaves. An occassional decline of yield (in older plantations) is mostly due to non-replenishment of nitrogen in the soil. The crop exhausts the soil of its nutrients and should be followed by growing legumes to restore its fertility.

In general, the herb yield is 20-25 t/ha for the second and third year which produces 100 to 150kg oil/ha in a year. The herbage should be kept in field for 8 hours and cut into small pieces before distillation to save on fuel and transportation. The herb contains 1.0% oil on fresh weight basis. In general, yield is dependent on soil fertility, favourable climate, age of plantation, weed management and efficiency of distillation in field. The commercial oil contains 32-35% citronellal which can be upgraded through careful selection of clonal population on the basis of growth vigour, bio-mass yield, oil content and citronellal content in the clones. Most other countries grow the same variety, originally selected from Ceylone citronella on the basis of leaf habit, oil content and oil composition. In particular, Indonesia, Sri Lanka, Taiwan, Guatemala, Brazil, China, India, Argentina and Equador are other producers from where planting material could be introduced and tested. The Ceylone citronella has low oil content, low citronellal (15%) and lower total gerianiol (50-60%) and fetches less price although it is more hardy and less demanding on moisture and fertilizer inputs.

3.3 Manual for Growing Vetiver

Vetiver (Vetiveria zizanioides) is a native tall perennial sedge which possesses highly fragrant fibrous roots. The plant is found in sandy low-lying coastal tracts of sub-tropical warm and humid regions with high moisture regime. The plant bears flowers annually but seldom produces viable seeds. Its commercial production in Vietnam commenced in 1978 and 200 ha are estimated under this crop. The cultivation is based on a local selection, made by NCRS Hanoi at present, the roots are used in insense sticks, shampoos, hair-rinses, fancy articles like fans and wind screens and to a lesser extent

in perfumery products. The export markets are being sought in the West, France is buying this oil bulk from Re-Union Islands.

In Vietnam, the crop is grown over poor sandy soils of 6 to 7 PH where the digging of the roots is easy and choice of other commercial crops is few. The crop is raised through live root splits planted at any time from spring (February - March) to rainy season till July. The crop gives out flowering shoots after one year in August when it is harvested maintaining a 12 months growing period. The roots are small, light to dark brown in colour at maturity. The root yield varies between 2 and 2.5t/ha (separated from the basal clump) and contains 0.5% of laevo-rotatory (-) oil, rich in vetiverol khosholool and other alcohols. The roots are cleaned, dried and stored for 1 to 3 months before distillation. Other vetiver growing countries are Indonesia, Re Union Islands, India, China, Brazil, Haiti, Guatemala and Angola. There is a high demand in grade (oriented type) for vetiver oil perfumery, soaps, detergents, and certain cosmetics. In India, two distinct types of wild vetiver plants are found. The annual flowering south-Indian type has a high oil content, laevo-rotatory oil and is relatively less fragrant than the north-Indian type which has lower oil content, dextro-rotatory oil but is highly fragrant and has distinct variation in composition. In India, a few chemical makers have been identified in this oil and the latter oil sell at higher price because of local consumer preference. Vetiver is also grown in India for stabilizing eroded lands because of the soil binding property of its fibrous roots. The live rooted slips are plant in 10 cm deep furrows in rows at 45 x 45 or 45 x 30 cm spacing with the advent of rainy season (July-August) in well prepared and suitably laid-out fields. Soils of relatively poor fertility, sandy to sandy-loam in texture and having PH of 8 to 8.5 are used for vetiver plantation in India. Whereas vetiver is a drought, hardy, salinity tolerant crop, which stands to seasonal flooding equally well. The plantation is raised generally in semi-arid regions and is given regular irrigation during dry season. 40kg each of P205 and K20 are basally given at land preparation stage and 60 kg nitrogen is recommended in two equal splits as top-dressing, placed along rows and mixed in wet soil 45 days after planting and during February/March the following year. The crop is given one weeding cum-hoeing during September and the growing plants cover the fields thereafter. In the next year, 2 to 3 weedings are given in March, June and August. Recent studies in India suggest that cutting of arerial parts in autumn season facilitate higher root growth. Whereas these trials are in progress, some encouraging results have been obtained in the use of chemical weedicides, inter-cropping of cluster bean, cow pea and mustard crop in the first year between the vetiver rows and irrigation regimes. The consultant would provide the results of these trials after one year, on request. Trial experiments on age of harvest in India has conclusively proved that 15 to 16 month old crop produce high root yield and optimum oil content in the roots. The oil yield declines at aging. Drying in shade is slow and takes 10 to 12 days in India. A hybrid culture (Hyb-8) has been released for cultivation which gives 10-14t/fresh root/ha containing 1.0% -1.5% oil on dry basis. The total oil yield/field is 10-12kg per ha. The oil of Hyb-8 is of dextro-rotatory in optical rotation which has the distinct odour of north Indian vetiver oil. A detailed chemical composition of oil has been worked out in the consultant's institute in India and has been reported on literature.

The oil is heavy (high sp.gr), dark brown in colour and takes long period of 16-24 hrs on steam distillation at pressure. The roots are wetted for 18-24 hrs in water, common salt is added in the distillation still to facilitate the extraction of oil. Sometimes a part of lighter oil which is soluble in water is lost if care is not taken in condensation during distillation.

There are no serious pests or diseases reported on vetiver in India except a leaf blight caused by Curvularia trifolii which causes dark oval spots over leaves, turning black at age. Any coppr fungicide which 50 per cent metallic copper at 500 l/ha in 0.3% concentration is recommended to control the disease. It is possible that selecting from wild growing population of vetiver in Vietnam may provide a high root and oil yielding alone which may upgrade both yield and quality of oil for international markets. This type of selection work which includes collecting of wild growing genotypes and their multi-locational evaluation on trial fields could be carried out in Vietnam.

ENTEROIL has received a high oil yielding culture from Re Union Islands which is under multiplication. The enterprise may augment the collection of such cultures for trial and selection from other producing countries (see annexure 4).

3.4 Manual for growing Basil

Basil is an age old culinary herb used in a wild range of traditional medicinal preparations, culinary, confectionary and related industries. The vietnamese grow two different basils for different enduses. The major basil oil comes from Ocimum gratissimum, rich (65%) in eugenol. This is grown on about 700 ha of land, scattered all over the country. This is a selection from native plants which produce oil similar to clove oil. The other species is sweet basil (O. basilicum). This is an old introduction, containing high Methyl chavicol and linalool contents with varrying quantities of other substances like frenchyl alcohol, citronellol, eugenol, methyl, cinnamate and a few others. Although there is a plan to expand the area under O. gratisimum in central and south Vietnam, the cultivated areas by and large vary from year to year depending upon exprt demand of the oil.

The oil is currently exported mainly to the Socialist Republic of USSR and East European Countries.

The basils are perennial, bushy aromatic herbs which produce profuse flowering and seed bearing. Farmers maintain their own seed stock. New plantations are raised from seed. The seeds are placed in hot water (tem. 40-50oC) for 2 hrs. to allow swelling of seed; it is mixed with ash 3 times by weight and further 3 to 4 times of it with sand before sowing in well prepared nursery beds during spring season (February/March). The seeds commence to germinate in 7-10 days(temp. 25oC). The germination is delayed whenever the prevailing temperature is low. The seedlings are ready for planting after 75-90 days when they grow upto 25-30 cm tall and are planted at 75x60 cm to 50x50xm spacing (and 60 x40 cm in Sweet basil) any time during the rainy season (April-September). Usually 4/t per ha of organic manure is recommended to be applied to fields at the time of land preparation together with 40 kg of P205. In all, 80 kg of nitrogen is recommended for this crop per year as top-dressing in 3 to 4 equal splits. The first split is applied 30 days after planting and then 10-15 days after harvest. Interculture and irrigation are given as and when needed; the irrigation is mainly needed in dry season.

The crop is raised over sandy-clay, acidic soils and is maintained for 5 to 7 years. The gratissimum basil is reported to decline in yield after 4 years in India and sweet basil even earlier. However, not much data on age of plantation vis-a-vis its yield, content, and oil quality are readily available in Vietnam but such data will be very useful to upgrade cultivation practices. In the first year, harvests of foliage are usually taken; however, 4 to 5 harvests of coppicing are obtained in the following years. The harvesting season is at flowering but farmers give more consideration to the growth of foliage to decide the time of harvest and may even be carried out in a 2 to 2.5 months interval. The growth of the crop during wet season is faster and the gratissimum plants attain 1.5 to 1.6m height with bushy growth.

Some growers told the consultant that the sweet basil is pulled-out after 2 years, followed by potatoes. In the field, the consultant recorded blight (dull white spots over leaves) and damages due to cut-worms. The blight is a common disease all over tropical countries, caused by two fungal diseases (Alternaria spp. and Colletotricum capsicii). The infection appears in a form of chloretic spots over the leaves which rapidly enlarge, coalasce and turn brown (-black) causing leaf shedding. This can be controlled by the use of Zineb or Mancozeb (0.2%) sprayed 2 to 3 times at an interval of 15 days after the appearance of disease symptoms. The leaf chewing, cutting and sucking insects are readily controlled by spraying Melation (0.2%) or Endosulfan (0.2%). Farmers indicated that a certain percentage of plant population is lost in the early part of wet season due to drooping and withering of growing plants, which ultimately die. This is caused by Fusarium oxysporum, a soil-borne fungus which finds favourable conditions of growth and spread in warm humid conditions. Improving drainage in field and exposure of soil to sun, helps to bring the spread of disease under control . The infected plants should be pulled out and burnt to localise the infection. The seedlings are recommended to be treated with 0.2% soln of methyl-ethyl mercury chloride at planting as a prophyllatic measure.

Elsewhere, in other producing countries basil plantations are raised over medium fertile and well drained light soils. It does not require high fertilizer use (like Vietnam) but (depending upon soil analysis report) 60kg of N2, 40kg of P205 and 20 (-40)kg of K20 are given in usual manner. The crop is harvested at full bloom stage on bright sunny days. Commencement of yellowing of lower leaves is an indication when the foliage possesses desired oil content. The harvested crop is wilted in the field for 4 to 6 hrs and cut into pieces before distillation. In certain countries sweet basil flower crop is distilled separately by cutting the flowering tops followed by a second cut after 20 days before harvesting the foliage and flowers together. The oil of basil flowers has a refined sweet note preferred in beverage and liquor industries in France, West Germany and sold at a high price. In all, 30-35kg of oil is obtained together with another 50-80 kg of basil herb oil.

The inflorescence part has an average of 0.4% oil and herb oils vary from 0.1 to 0.25% . In Vietnam, 15-25 t of herb per harvest or 120-150kg of oil is obtained from O. gratissimum per annum. The distillation at the co-operative farm is carried out in field units of old design distillary, which possibly may allow the escape of water soluble fractions; unless improved traps are used to prevent loss of these fractions and a part of eugenol in commercial scale production.

3.5 Manual for Growing Palmarosa Oil Grass

Palmarosa is a recent introduction from India into Vietnam and about 10ha are estimated under this crop, mainly in form of small field trial cultivation in different locations/provinces. This species (Cymbopogon martini var. motia) is of semi-arid and sub-tropical, open, shrub forests of south-east Asia. The plant grows upto 65 cm and 1.6 m tall under favourable conditions of cultivation. The terete smooth culm bears large, lanceolate, acute leaves covering a part of the stem. It flowers profusely and bears viable seeds. In north Vietnam, the flowering is during August, leading possibly to low seed setting and lower viability. But the central part of Vietnam, where commercial cultivation is planned, has a relatively dry sunny climate. India, Guatemala, Indonesia and some East African countries raise commercial plantations and there is a demand for the oil in soap-perfumery, blending of chewing tobacco and other products, perfumery, cosmetics and as starting material for production of geraniol. In India, a composive culture (Amravati type) is largely grown but another selection (I W-31245) and jam-rosa have also been released for cultivation. The latter has a high geraniol content in the oil, but of relatively poorer odour value of the oil.

Palmarosa is a drought-hardy, moderately salinity tolerant species and its shallow fibrous root-system binds the soils of eroded lands. It prefers well-drained light sandy-loam soils of 6 to 8.5 PH in semi-arid climate conditions. It is interesting that the crop can be raised both as rainfed crop (yielding one harvest every autumn) or irrigated (producing 3 harvests in a growing period of 15-16 months) in India. Where winter is severe, the crop is cut over-ground (in November) and remains dormant underground till the advent of spring season. Frost kills the plants so do water logged conditions.

A commercial plantation is preferably raised from seeds sown in partially shaded nurseries during the summer season (April-May). Seed is very light and remains intimately attached to the glume. Seed rate is 0.5kg. sown at 0.5 cm depth in rows at 12 cm spacing over 500 sq.m. well prepared beds to which a high amount of org. matter is applied. The seed beds are kept moist by periodic watering and covered with straw (till germination commence) to protect them from direct sun and high temperature. Germination commences in 3 days and is over in a period of one week. The seedlings attain a height of 12-15 cm in 45-60 days, ready for transplantation to field during rainy seasons (July-August in India) at 45 x 20, 45 x 25 or 45 x 15cm spacing. Direct sowing in rows in the field may also be done on higher quantity of seed availability, during rainy season. The population is thinned at first weeding to maintain plant to plant distance in a row.

10 t of farm yard or org. manure together with 40kg each of P205 and K20 per ha are given at land preparation. In dry climate termite and cut-worms cause considerable damage and hence 20kg of Aldrin (5%) or BHC (10%) is applied to soil at land preparation. Usually 60kg of nitrogen are given in 3 equal splits as top-dressing viz 45 days after planting, the following February-March and immediately after June harvest for a cycle of 15-16 months crop. Rainfed crop is given half the recommended dose in 2 equal splits. Usually 2 weeding cum-hoeing in the first year and 3 in next year are given and the crop closes-up to cover the entire field. Current studies on the use of chemical weedicides and irrigation schedule (IW/CPE ratio) have given valuable information, useful to test in Vietnam which the consultant will provide after one year when the trial data for 2 crop cycles is analysed and interpreted.

The crop has a high oil content in inflorescence (0.4 to 0.8%) and a low (0.2 to 0.25) in foliage. The oil is maximum in the growing crop at bloom but recent experiences in India have shown that oil of superior odour and quality is obtained by harvesting the crop at early seedling stage (due to higher primary alcohol content in the oil) and this is now included in the package of practices. The herb is cut 15cm above ground and allowed in the field to wilt for 1-3 days before cutting into pieces or loosely stalked, ready for transport to distillation. In this condition, it has a low moisture content which prevents loss of oil due to generation of heat in stalking.

The rainfed crop is maintained for 5 years (or more). It gives one harvest in autumn (October) per annum and the yield varies from 50 to 60kg/ha depending upon soil fertility and crop management. A 15-16 month duration irrigated crop give three harvests viz November, June and October and a small crop in April. The total average oil yield is 150kg/ha. The oil in India should have min. 89 per cent total alcohols scale as geraniol for receiving fair price. Summer crop is found to possess higher geranyl acetate content in the oil.

The palmarosa is a hardy crop, not seriously damaged by diseases or pests. A leaf blight caused by Curvularia andropogonis is reported in India where drying and browning of foliage takes place, commencing from the lip. This may cause loss of oil. Spraying of Mancozeb or Zineb (0.2%) at 15 days interval control the disease effectively.

RECOMMENDATIONS

ENTEROIL is a unique premier enterprise under CNRS for the production and trade of essential oils in Vietnam. It came into existance several years ago as one of the division of CNRS, which is the first National Research and Development Organization. The uniqueness lies in imbibing the highly scientific and technological base of the parent CNRS and developing the enterprise into a profitable, productivity oriented centre for trade and export of essential oils in a short period. Because of this success, the government of Vietnam wisely decided to give the enterprise an independent, autonomous status. ENTEROIL continues to maintain a close linkage and co-operation on scientific and technology base with CNRS. During my short stay in the enterprise and visits to co-operative farms, I have come to understand that it has a very strong extention net-work for production and export oriented trading activity. I understood that the Government of Vietnam as well as the management of CNRS and ENTEROIL are working towards making this enterprise to enter substantially the markets of European Economic Community, Asian and other consumer economics, even outside the Socialist Block countries. If this objective is to be achieved in a reasonably short period, ENTEROIL and CNRS will collectively have to implement a number of new ideas and develop short & long range facilities which in essence will mean reorganising and strengthening the existing manpower and improve their skills by training and instrumentation, to equip them to take the new responsibilities.

The consultant is of opinion that ENTEROIL can further develop into a nodal enterprise for registration of exotics and other high yielding varieties, together with seed testing, production, storage, certification and distribution facilities in the field of essential oil crops. The CNRS will further develop and improve the R & D part to make production cost competitive. For this purpose, CNRS will organise field evaluation of exotic, commercially interesting varieties to identify superior cultures by multi-locational testing in different agro-climatic regions in the country. It should establish a seed testing laboratory, a plant protection and surveillance unit and reorganise agronomy research to generate appropriate field data for backing ENTEROIL to develop suitable crop rotation and crop sequencing in consistence with soil and climatic conditions prevailing in different provinces. Crop sequencing is essential to replenish soil fertility and keep weeds, pests and diseases in reasonable check in a natural way. ENTEROIL will bring out "Farm Bulletins"; maintain a national register of varieties; develop seed farms and seed storage facilities with temperature and humidity control, lay-out demonstration trials for transfer of new crops and improve agro-technology to co-operative farms. It shall develop a system of crop economic analysis to facilitate it to advise the growers on cost effective cultivation practices for adoption.

As mentioned below, I have given ten major recommendations in the sequence to follow in the farming sector, beginning with seed. Each of them is important and shall have its bearing on the overall development of R & D used in production of the essential oil crops. It is my belief that with these operational innovatives and facilities, ENTEROIL will grow further in its task of building up production and trade of essential oil based crops in Vietnam.

4.1 Crop Priorities

Amongst the crops in the thrust area for commercial cultivation, Japanese mint, eugenol-rich basil and java citronella should receive high priority both in the explanation of area as well as in R & D input at ENTEROIL. The thrust should be to produce higher content of major aroma-chemicals like menthol, eugenol, citronellal in the commercial oils at economic price. In consideration of the current world trade and demands, pepper, mint, spearmint, and lemongrass should also receive priority in the development of suitable cultures and appropriate agro-technology for their production in the country. It is note-worthy that ENTEROIL and its sister institutes under CNRS have several promising genetic lines of Cymbopogon like Khasianum (RRL-58), flexuosus (Jam-rosa), citratus, vetiver (Re Union type) and peppermint which may do better in the humid tropical climate of Vietnam for commercial production.

There is considerable interest and enthusiasm amongst crop specialists at ENTEROIL to carry out regular breeding programme as a part of crop improvement in essential oils. The consultant instead, considers selection from the collection of commercial varieties from outside (which have met trade specification) to be a shorter route for upgrading yield and quality of these oils. Further, in vetiver and basil, ENTEROIL should (in collaboration with sister enterprise like the Centre of Ecology and Natural Resources) draw up a 5-year programme on plant exploration. This is to collect genetic variability from wild growing populations within the country such as of basil and

vetiver. Agro-biotanical and chemical evaluations for purifying selection of superior lines for domestication have to be carried out. It may be of interest to record that a breeding plant population gives rise and stabilises variations in form, content and composition under a long period of continuing selection pressure of environmental stress, such as soil (nutrients, moisture, PH) and climate (temperature, rainfall, solar intensity and sun-light hrs). The variations occur more often at the periphery of distribution of a species. In this region sampling should be planned to collect the genetic variability for commercial purpose.

4.2 Augment Collection of Commercial Varieties from Outsite

ENTEROIL has developed a strong base in collecting a few varieties in all the crops grown in Vietnam. This could be further augmented by obtaining sample seed and planting material from known sources, multiplied under isolation to study their yielding ability and quality under Vietnamese conditions. In most countries, nucleus seeds and vegetative propagative material are supplied for exchange of live materials under a system of phyto-sanitary certification. Source of material and addresses of Institutes are given in Annexure 4.

4.3 National Register of Varieties

At present there is no registration and documentation of varieties introduced into the country. Once these cultures or selections made from them are given local (Vietnamese) names, their original source and characterisation is lost. The information on parentage, source and characterisation is necessary for breeding and segregating populations, and helps in breeding new pure-line genotypes. The documentation of varieties will help in separating the population of undersirable old cultures from high yielding new introductions, which may decline in yield over long years of use. It is therefore advisable to begin maintaining a National Register of Varieties at ENTEROIL with a description of the characters obtained from the country where the variety was bred or released, and maintain the culture at a farm (in isolation) in pure form to facilitate multiplication.

4.4 Soil Testing Laboratory

This laboratory can provide day-to-day service to farm division in making recommendation to state farms and large co-operatives for different essential oils from year to year. It will thus make savings in a costly input like inorganic fertilizers. The laboratory will need a small amount of funds to equip with the essential instruments for testing texture, PH, EC, availability N2, P2O5, K2O and Ca in the initial stage, and will facilitate the layout of simple field trials and demonstration trials in farms in different regions.

4.5 Seed Farm, Seed Storage and Testing Laboratory

A modern agro-based institute needs a seed farm for the multiplication of seed and vegetatively propagated materials. An equipment for testing seed viability (with temp. control for humidity and light hours) is necessary. Seed drying, moisture meter, seed grading, packing and storage bins and storage room with cooling facility; to maintain the working collection at 4-5oC, as well as dehumidifiers (so that ability is maintained at desired level despite the humid tropical weather are necessary. Scientists from ENTEROIL could be trained in seed technology at any advanced institute of agriculture in Vietnam or outside, to handle this system.

4.6 Demonstration Trials and Farmers Fairs

It has now been established that demonstration trials laid-out at co-operatives or small farms are effective means of transfer of agro-technology. This has revolutionalised farm production, in several Asian countries, in the last two decades. ENTEROIL may develop a suitable programme to layout demonstration trials on all the five essential crops in different regions and invite growers from neighbouring farms to see for themselves how yields can be upgraded by the use of recommended practiced, demonstrated in the trial plots.

4.7 Plant Protection

This is one area in essential oils cultivation in Vietnam which leaves much to be desired. It is but natural that crop losses would be sizeable in a humid tropical country. The losses could be effectively prevented by disease surveillance and timely plant protection measures. The technical staff at farm level could be trained to identify the symptoms of major diseases, the pests infecting these crops and their control measures. The farm co-operatives have to be provided with dusters/sprayers in an adequate number and those fungicides/pesticides that are considered necessary to control major maladies have to be brought within easy reach. It is experienced in other countries that such losses rise fast when sizeable cultivation of these crops come in a continuous geographical region.

4.8 Introduce Mechanisation

ENTEROIL will have to introduce mechanisation to the farm sector to maintain cost competitiveness. The enterprise can adopt, from locally available machinery, and import suitable prototypes, say of wheel hoes, bullock and tractor driven inter-culture machines chemical weedicides, electric chopping machines, mechanical pully to fill and exhaust the distillation stills, etc. It may also lay-out manure pits to recycle farm waste and distillary exhaust herb to reduce production cost.

4.9 Publication of Farm Bulletins

Some effort was done into bringing out Farm Bulletins. This could be made more comprehensive and periodically updated, based upon the experience gained through farm demonstration and fertilizer trials in the years to come.

4.10 Crop Rotation and Crop Economics

Crop rotation is an effective tool to replenish soil fertility and keep weeds and diseasess in reasonable check. In Japanese mint, expenditure on weeding could be reduced considerably by crop rotation with several food and industrial crops (instead of maintaining a ratoon second year crop which weeds in a humid tropical climate). In India, experience on this crop has shown that mentha-wheat, soy-bean, potato-mentha; mentha-paddy, and mentha-mustard are some crop rotation practices which are effective, not only in controlling weeds but also in giving an over-all higher yield to the grower of the combined crop sequence in a year. This could be practiced in a perennial crop of 3-4 years such as java citronella, basil or lemon grass. The farm division in ENTEROIL could develop suitable rotation and crop sequencing by keeping climate and local demand in consideration.

Farm costing and its economic analysis is another device which helps in keeping cost on input in check and maintain the competitiveness of production. The farm division could initiate studies in this field to work out the costs of production for each oil in different regions and the age of plantation so that they identify the relative profitability of each in the different provinces. It is ultimately the economy of production and the quality of the oils offered that will allow Vietnam's entry in the markets of countries of the European Economic Community and the geographical region of south-east Asia, which have built up a sizeable demand of these oils.

ACKNOWLEDGEMENTS

The consultant expresses his sincere thanks to the UNIDO and the Minister of Science and Technology and Director General of CNRS for having given him this opportunity to visit the country and work for ENTEROIL. Dr. R.O.B. Wijesekera, Special Technical Adviser of the Project (UNIDO, Vienna) and Dr. C.K. Atal, CTA of the Essential Oils Project, who has provided him with background information on the assigned task, Mr. Le Van Thu, General Director, ENTEROIL for the various facilities for day-to-day work at the enterprise. The scientific and technical staff in the enterprise have provided the consultant a warm and friendly atmosphere during seminars and numerous deliberations which he admired. This made it possible for him to understand the work and make useful recommendation during his short stay in Vietnam.

The consultant gratefully acknowledges the support provided to him by the United Nations Resident Representative and his colleagues in Vietnam. Particularly to Mr. Nguyen Nha Dut, the Project Secretary and his interpreter who constantly kept his link live with the staff and workers of the enterprise; and for typing his final report.

Rajendra Gupta

Annexure-1

JOB DESCRIPTION

Post title : Agro-Technologist
Duration : 1 man/month,last quater of 1989
Duty station : Hanoi,with internal travel
Purpose of Project : Processing of Vietnamese Essential oils and related products.

Duties : The Expert will work under the direction of the Projects Chief Technical Adviser.The expert will assist the organisation,ENTEROIL within the National Centre for Scientific Research in Hanoi in the development of its resources of aromatic plants for the industrial processing of essential oils.

The expert will be required to make an assessment of these resources to prioritise candidate species for crop wise production.The expert will work in close co-operation with national counterparts and develop an agrotechnological strategy which will serve the purpose of the project.

The expert will,under the guidance of the CTA prepare a report setting out his findings and recommendations.A draft form of this report should be discussed with the CTA and UNIDO Headquaters technical staff following which the expert will be required to furnish UNIDO with a finalised report complete, edited and in a form ready for publication.

Annexure-2

WORK-PROGRAMME FOLLOWED DURING STAY IN VIETNAM (6 OCT.TO 28 OCT.)

Date	Contents
6.10.89	Arrival at Hanoi.Prepare work programme
7.10 to 11.10.89	Meetings and discussion with General Director,ENTEROIL and the team of scientists on soils,climate and essential oil crops commercially grown,their production and yield.Also identify crops for major thrust in developing improved agro-technology under local conditions to be of immediate utility.
12.10.89	Seminar on R and D and markets of essential oils in world trade with particular relation to production, marketing and trade in India.
13.10.89	Seminar on cultivation of mint oils
14.10.89	Mentha arvensis,M.piperita,M. spicata,M.citrata and discussions.
16.10.89	Seminar on cultivation and production of citronella: Java citronella,Ceylone citronella and discussions with scientists and CTA on the Project work.
17.10.89	Seminar on cultivation and production of oil of vetiver and discussion.
18.10.89	Visit to Ha trung farm,Thanh hoa Province,in central part of Vietnam.
19.10.89	Seminar on cultivation and production of basil oils: Ocimum basilicum,O.gratisimum,O.sanctum.
20.10.89	Visit to Kim boi Farm,Ha son binh Province,in western part of Vietnam.
21.10.89	Visit to farms and vegetation around Hanoi and in the suburbs.
23.10.89	Seminar on cultivation and production of oil of palmarosa.
24.10.89	Visit to Me so Farm in Hai hung Province.
25.10 to 27.10.89	Discussion on draft Report with CTA and NPD and finalisation of recommendations.
28.10.89	Departure for Vienna

Annexure 2 (contd)

Scientists in NIMPROIL and other Organisations met during stay in Hanoi.

Mr.Le Van Thu, Director

Mr.Nguyen Nha Duc,Project Secretary,Asstt. Marketing Manager

Mr. La Dinh Moi,Head,Ecological and Natural Resourses Division

Centre of Ecology & Natural Resourses

Mr.Le Qui Manh,Agrl.Engineer

Mr.Tran Minh Hoi : Agrologist

Mr.Dao Trong Hung,Ecologist,Centre of Ecology & Natural Resourses

Mr.Do Pho : Head Technical Division

Mr.Huu Thien : Director,Ha tuong Farm

Mr.Yen : Spl.in Basil Agronomy

Mr.Bach Tinh : Director,Kim boi farm (Ha son binh Province)

Mr. Nguyen Van Di : Vice-Director,Kim boi Farm

Institute of Materia Medica (Vien Duoc lieu)

Mr.Nguyen Dan : Vice Minister of Health

Dr.Chau : Dy Director

Mr.Tran Khac Bao : gene bank (Med Plants)

UN office

Mr. David Smith : Resident Representative

Mr.I.M.Bonnamy : Sr.Industr.Development Field Adviser

Mr.A.H.Qureshi : Adm.Officer

Mr.Phan Duc Thang : Programme officer,UNIDO Projects

Annexure 3

ORGANISATIONAL CHART OF ENTEROIL

1.Centre National De Recherches Scientifiques(CNRS)

National Centre for Scientific Research.It has 40 Research Development and Production oriented Enterprises.

2.Essential Oils Enterprise (ENTEROIL) is one such enterprise under CNRS.

3.The ENTEROIL is headed by General Director, Le Van Thu, assisted by Deputy General Director Mr.Le Trong Vong and five working Divisions.

3.1.Marketing Division : Mr Van Ngoc Danh,Head

3.2.Technical Division : Mr.Do Pho,Head

3.3.Production Division : Mr.Le Khi Hoa,Head (Liason with Co-operative Farms and Production Centres)

3.4.Administration,Liason,Finance Division : Mr.MaiVan Toan,Head

3.5.Workshop : Mr.Nguyen Tan Hung,Head

(Engineer unit).

The ENTEROIL enterprise is responsible for development and production of essentail oils in Vietnam.It advises the co-operative farms in Provinces on the cultivation and distillation of specific essential oils and on marketing them in the country and exporting them outside Vietnam.

Annexure -4

SOURCE OF SEED AND PLANTING MATERIALS FOR ESSENTIAL OILS INDUSTRY IN VIETNAM

	SOURCE INSTITUTES
INDIA	
Japanese mint (has two commercial varieties)	1.National Bureau of Plant Genetics Resources,I.A.R.I Campus,New Delhi 110012
Java citronella-one composite culture	
Palmarosa-three:Amravati composite	
:Jam-rosa	
:IW-31245	
Lemon grass-OD-19 and RRL-58	2.Central Institute of Medicinal and Aromatic Plants,Ram Sagar Mishra Nagar Post Bag No.1 Lucknow (G.P)
Vetiver - Hyb-8	
Eugenol Basil-Clo-ocimum	3.Regional Research Laboratory Canal Road Jammu-Tawi 180001 (J + K)
Peppermint-Black Mircham	
INDONESIA	
Java citronella	Institute for Research and Development of Agro-based Industry,Essential oils Laboratory Jalan Ir.H.Juandas/5-9 BOGOR.
Vetiver	
Palmarosa oil grass	
Peppermint	
Patchouli	
PHILIPPINES	
Japanese Mint	
Java citronella	
Ceylone Citronella	
Peppermint	
Lavender	

Annexure-4 (continued)

Rose Geranium	Bureau of Plant Industry Dept. of Agri. and
Patchouli	Natural Resources.
Vetiver	MANILA

CHINA

Japanese mint	South China Institute of Botany
Peppermint	Chinese Academy of Sciences
Spearmint	GHANGZHOU
Barga mint	
Java citronella	
Vetiver	
Lavender etc.	

NEPAL

Japanese mint	Royal Drugs Research Laboratory
Peppermint	Ministry of Forests
Spearmint	Deptt.of Medicinal Plants
Java citronella	THANPATHALI P.O,KATH MANDU
Lemón grass	
Vetiver	
Palmarosa oil grass	

THAILAND

Japanese mint (S.O.P Culture)	Asian Institute of Technology
Peppermint (possess culture for	P.O.Box 2754
USA and one from Italy)	PATHUMTANI
Spearmint (possess culture from	BANGKOK
Italy, Israel and USA)	
Lavender (possess cultures from	
France and Italy)	

ROMANIA	
Spear mint	Centrala Industriala De Cosmetics,Colaranti
Pepper mint	Si Laboratori
Lavender	Bd.Ion Sulea No.246
Rosemary	BUCHAREST
Chamomilla	
Valerian	
NETHERLAND	
Peppermint	Wageningen Centre of Agrl.Sciences,Agricultural
Spearmint	Experimental Station
Lavender	WAGENINGEN
Chamomilla	
Valerian	
Sage,Dill	
Anise	
BRAZIL	
Japanese mint	Brazilian Association for Research in
Peppermint	Aromatic Plants and Essential oils,
Spearmint	Via Duta Dona Paulina-80
Java citronella	SAO PAULO
Lemón grass	
ARGENTINA	
Japanese mint	Camara Argentina De Perfumeria
Pepper mint	Avenales 1115
Java citronella	BUENOS AIRES
Lemon grass	

Annexure-4 (continued)

United States of America	
Peppermint	Purdue University
Spearmint	Agricultural Experimental Station
Berga mint	LAFAYETTE , INDIANA-47907
Lavender	
Hops	
FRANCE	
Peppermint	Syndicat National Des Industries Aromatique
Spearmint	Alimentaries
Vetiver	2 Rue de Penthiere
Sweet basil	F-75008,PARIS
Lavender	
Rosemary	
U.S.S.R	
Pepper mint	All Union Scientific Research Institute of Oil
Spear mint	and Essential oil crops,
Lavender	Ulitsa Filatova 17,
Valerian	KRASNODAR-38 (USSR)
Rose Geranium	
BULGARIA	
Two new varieties of	Rose,Essential oils and Medicinal Plants Institute
Peppermint	P.O.KAZALNIK
Four var.of Lavender	(Near SOFIA)
One var.of Valerian	
Two var.of Sage	
HUNGARY	
Peppermint	Gyogynoventry Kutato Instezez
Spearmint	P.O.Box 11
Lavender	JOZSEF ALTILA UTACO-68 , H-2011,BUDA KALAZ

Annexure-4 (continued)

Guatemala

Java citronella	Association De Productores De
Palmarosa	Aceites Essencialis
Lemon grass	Calle 2-56,No. 10 A
Peppermint	GUATEMALA CITY-1
Vetiver	

COSTA-RICA (S.AMERICA)	Institute Interamericano De Ciencias
	Agricolas De la OEA,
	Apartado 10290
	SAN-JOSE

KENYA (East Africa)

Java citronella	East African Industrial Research Organisation,
Lemon grass	P.O.Box 30650
Palmarosa	NAIROBI
Peppermint	
Lavender	

EGYPT (North Africa)	National Research Centre, Laboratory
Sweet basil	of Natural Products
	DOKKIE, CAIRO

Annexure 5

References on cultivation of crops grown in Vietnam

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