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18560

DP/ID/SER.A/1379
31 August 1990
ORIGINAL: ENGLISH

ASSISTANCE TO THE ESSENTIAL OIL INDUSTRY - ZANZIBAR

DP/URT/86/026
TANZANIA

Technical Report:
Maximizing the capacity of the clove distillery of Chake Chake*

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

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United Nations Industrial Development Organization
Vienna

7/50

* This document has not been edited.

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1. Summary:

The Project which started from July, 1989 is primarily concerned with streamlining the work of the Clove Stem Oil Distillery, Chake so as to process clove stems and / or buds to produce 90 - 100 tons of their oil per annum, add more aromatic crops for essential oils and develop sales methodology for sale of these oils. The Project has a budget of US \$ 423,960 involving technical expertise of 6 International Experts to work on different aspects of the Project. Only Marketing Expert has completed his mission, while C.T.A. has used about half the m/m of his assignment. Other Experts i.e. Analytical Chemist, Agronomist, Engineer and Perfumer have to complete their short term missions. Their mission is delayed due to non-receipt of all the inputs relevant to their mission.

Work in the Distillery was disrupted due to, first, lack of water and later on due to breakdown of boiler-furnace. Both these have been taken care of resulting in regular production from August 1990. However, during the first split mission of the C.T.A. in December 89 - March 90, the production work was organised in such a way that the quantity of clove stems and buds processed in 2.5 months surpassed the average annual processing of these items during 1984 - 88.

Work on the diversification of crops programmes is progressing well. Lemongrass area is 35 acres, vetiver 4 acres, cinnamon - 4 acres, cardamom - 1 acre. Lemongrass has come up well and regular production has started. Screening of local aromatic plants has shown possibility of producing an essential oil rich in methyl chavicol produced from *Ocimum basilicum*. Work on this species is being pursued.

Sales of clove stem and bud oils have picked up. Sales during 1989 - 90 at US \$ 220,660 were about 70 percent more than in 1988 - 89.

Considering the progress of work, the Principal Secretary, Ministry of Trade and Industry and the General Manager, Zanzibar State Trading Corporation have suggested for preparing a proposal for additional inputs, extending work to Unguja and extension of the Project. Further inputs by the Z.S.T.C. have been assured for successful implementation of the proposals.

2. Recommendations

1. Immediate action was taken by UNIDO, Vienna to place order for Project inputs in Nov - December 89. Goods were to be supplied by Jan - February 1990. Due to lack of information at Project site, there was inordinate delay in clearing these. It is recommended that goods lying in Dar-e-Salaam be cleared without delay.
2. The Project National counterpart should inform UNIDO immediately about the receipt of inputs to enable UNIDO to field the Experts as soon as possible.
3. Next field mission of C.T.A., Analytical Chemist and Engineer should be a joint mission.
4. Recommendation regarding i) additional inputs, ii) Extending Project activities to Unguja and iii) Extension of the Project made as per discussion with the Govt. of Zanzibar (Ministry of Industry) and Z.S.T.C. should be considered early for further action.

Zanzibar State Trading Corporation may indicate their contribution in cash and kind for the above recommendation (No. 4)

5. Appointment of a Chemist and Agronomist should be expedited to enable Experts to train them at site.

3. Introduction:

The Project DP/WRT/86/026 "Assistance to Essential Oil Industry Zartibar" is based in Pemba to "Maximise the Capacity of Clove Stem Oil Distillery" engaged primarily in the production of Clove Stem Oil. Production of lemongrass oil has started recently from the cultivated lemongrass of "West Indian Type". The Project came into operation from July 1989.

The Project has 3 main Immediate Objectives, viz:

- 1) Upgrading of Chake Chake Clove Oil distillation plant to process 1900 tons of clove stems on a two shift basis per year.
- 2) Development and cultivation of different species of plants yielding essential oils for diversification purposes.
- 3) Development of marketing strategy for the increased out put of clove stem oil.

To achieve the objectives, the Project has a budget of US-Dollars 423,960, comprising of the following components:

i) International Experts	26.5 mm	US 235,600
ii) Equipment		" 105,500
iii) Training		" 60,000
iv) Others & Miscellaneous		" 22,869
		<hr/>
		423,960
		<hr/>

Following International Experts have been recruited to work in the Projects:

<u>Name</u>	<u>Designation</u>	<u>Period</u>
1) Dr. Baldev Gulati	CIA-Chemical Technologist Essential Oils	12.0 mm
2) Dr. M. L. Malleshwari	Analytical Chemist	2.5 "
3) Mr. Klaus A. Duerbeck	Agronomist	4.0 "
4) Mr. A.M.A. Abeysinghe	Marketing Expert	2.0 "
5) Not yet selected	Perfumer	1.0 "
6) Mr. Shahid Ahmad	Engineer	2.0 "

The C.T.A. will be completing about 7 months assignment by end August 1990 (current mission). The Agronomist and Analytical Chemist have completed 1 mm and 0.5 mm respectively while Marketing Expert has completed his mission. Engineer Expert will start his mission in near future as also Agronomist and Analytical Chemist after the

requisite inputs reach the Project site. Perfumer has not been recruited so far.

The Project has progressed satisfactorily. The Progress report as per Project Document and Objectives as also on technical aspects is given in the following pages.

During this mission main emphasis was laid on the following:-

- i) Standardising parameters for distillation of lemongrass and clove bud oil.
- ii) Preparation of samples of oils from locally available aromatic plant materials for chemical and olfactory evaluation.
- iii) Diversification of aromatic crops especially lemongrass on large scale and introduction of more species.
- iv) Training of national staff in the cultivation, distillation and laboratory work.
- v) Miscellaneous work such as planning for training for national staff, follow up of arranging inputs for the work of the distillery.
- vi) Organising factory work for optimum production.

During the first split mission (December 1989 to March 1990) the C.T.A. had an opportunity to discuss with the Honourable Minister of Trade & Industry and the Principal Secretary of the Ministry to the Government of Zanzibar. Frequent meetings with the General Manager, Z.S.T.C. helped in the progress of the Project.

During the second split mission (29 June - 30 August 1990), more than desired time was spent in Dar es Salaam as DSA was given by UNDP on 4 July 1990 and due to cancellation of flights to Pemba (No flight operated till 13 July). In the meanwhile, at Dar es Salaam arrangements were finalised with the Tanzania Industrial Research and Development Organisation (TIRDO) to depute 2 persons for repair of furnace of the boiler at Pemba Distillery as the Distillery was out of operation since end March 90 resulting in loss of production. As a last resort, C.T.A. arrived at Pemba by charter flight along with TIRDO specialists for furnace repair.

The project work, inspite of some setback due to furnace breakdown and erratic and restricted electric supply from the Island power house is progressing well.

During a visit to Pemba Distillery (27 July - 30 July) by the Principal Secretary to the Ministry of Industry, Government of Zanzibar and the General Manager, Zanzibar State Trading Corporation, detailed discussions were held on all the aspects of the Project, its progress and future course of action. The Principal Secretary and the General Manager, Z.S.T.C. while expressing their satisfaction on the progress of the Project work were of the opinion that:

- i) The Project needs further inputs. The extent of requirement was discussed and list of items to be purchased prepared.
- ii) Project activities should be extended to involve island of Unguja.
- iii) The Project should have additional input in respect of technical components i.e. International Experts and the Project should be extended by atleast 6 months. Z.S.T.C. would contribute by way of services, building, local man-power, transport, secretarial and office facilities to the Experts for work in Unguja. Necessary inputs in the Pemba Distillery would also be made as and when necessary.

A proposal on the above has been prepared and included in this report.

4. Extraction Methodology: Improvement:

Distillation equipment at the Clove Stem Oil Distillery, as the name indicates, was designed specifically for distillation of clove stems only. As the stem oil is primarily valued for and evaluated by its eugenol content, the parameters set for distillation were aimed at getting oil in a short time having eugenol content as per various Standards.

Oil produced in the Distillery meets with the British Standards (B.S.) as also I.S.O. Standards. Oil obtained is also light coloured, very clear and free from moisture and sediments. For the production of clove stem oil, there was, therefore, not much of a problem except that we wished to rework parameters so as to produce an oil which not only meets the B.S. & I.S.O. Specification for eugenol content but was also with improved odour.

Conditions of distilling clove bud and lemongrass are different than those for stem oil. Some consideration for distilling materials other than clove stem are enumerated as under.

Lemongrass: Citral, the main constituent of lemongrass, is sensitive towards heat. Condition for distilling clove oil are likely to affect adversely lemongrass oil quality. Distillation of grass was, therefore, done at atmospheric pressure keeping still temperature below 100°C. Under these conditions distillation was complete in about 2 hours. Oil quality appeared to be good.

One sample of oil from distillation analysed using sodium sulphite method was observed to contain 78 per cent citral (by volume). In some samples citral content was reported to be as high as 84 per cent.

Clove Buds: A good quality clove bud oil should have: Beta-caryophyllene, humulene, eugenol and eugenyl acetate. The last one being important (Work done elsewhere has indicated average percentage content of these compounds as: Caryophyllene 2.5 - 3.0 percent & humulene 0.35 - 0.45 percent eugenol 67 - 76 per cent and eugenyl acetate 17 to 28 per cent. Total percentage of these 4 constituents come to 96 to 97. Good quality clove bud oil has fairly high percentage of eugenyl acetate, ratio of eugenol to its acetate is about 3:1.

Under the condition of clove stem distillation (1.22 to 1.5 bars or 105 - 110°C still temperature), eugenyl acetate breaks down there by affecting oil quality. In view of this consideration, clove bud oil was distilled at an atmospheric pressure and at about 100°C still temperature. Duration of distillation varied from 24 to 30 hours.

A large number of oil samples at various stages of distillation have been collected for chemical and olfactory evaluation.

The distillation units are equipped with temperature and pressure controls which enabled us to distil simultaneously all the three different materials that is lemongrass, clove buds and clove stems under conditions considered favourable to get each having good quality in an optimum yield.

Improvement of Odour of Clove Stem and Bud Oils:

After the stage of filtration of clove stem and bud oils, these are treated for removal of moisture/water which remains as the specific gravity of the oils is nearly equal to that of water. Removal of water is done by vacuum distillation.

While removing water under vacuum a small quantity of oil, consisting of low boiling components, is obtained. These low boiling components contribute to the 'top note' of the oil. At the present, these low boiling components are treated as waste product. It is, however, possible that to get 'true to nature' stem and bud oils, these components need to be added back to the main oil. We have started collecting these low boiling rich fraction. Perfumery Expert will be consulted to ascertain if these should be added back to the oil before sale.

It is relevant to note that as a trial in laboratory, these low boiling components were added to the main oil. The resulting oil matched in odour the clove bud oil produced in Malagasy.

5. Quality Assessment and Storage of Essential Oils:

Under the current programme of production of essential oils and from those selected for introduction, following essential oils will be studied for quality parameters:

- | | |
|----------------------------------|-------------------------|
| 1. Clove stem oil | under production |
| 2. Clove bud oil | " |
| 3. Lemongrass (West Indian type) | " |
| 4. Vetiver | under trial cultivation |
| 5. Cinnamon leaf | " |
| 6. Citronella (Java type) | future programme |
| 7. Palmarosa | " |

All the above essential oils have definite standard specifications in respect of physico-chemical properties. Odour is also considered an important factor for practically all these essential oils.

It will not be necessary to develop standards for these oils but to standardise post-harvest technology and distillation parameters so as to produce oils meeting international standards. Some work has already been done on the production techniques and parameters. However, this work will be completed on receipt of all the laboratory inputs including G.L.C.

Simultaneously, odour evaluation will also be done and national staff trained by the Expert Perfumer.

Storage of oils prior to sale is an important factor especially for essential oils like lemongrass. This has been done for lemongrass which is now made clear of moisture, sediments and stored in cool dry place in clean drums excluding air to avoid deterioration of citral content.

6. Marketing Strategy:

It has been observed that sales of clove stem and bud oils has picked up during the last 2 years. Prospects for lemongrass are equally good. However, it is necessary to improve the tempo of sales so as to reach a target sale of about 100 tons of clove stem and bud oils to earn at least \$ 500,000 per annum.

Under the Project, a Marketing Expert has been provided who is to look into all the aspects of sales promotion and suggest a clear methodology to achieve the Objective. The Marketing Expert has completed his mission. His report, when submitted, will be examined for implementation by the ZSTC Zanzibar.

In the meantime following steps have been taken to improve sales:

- i) The Marketing/Export Manager of the ZSTC is proposed to go on a tour to contact prospective buyers in abroad, especially the Western Countries. This programme has been delayed as the Marketing/Export Manager has proceeded to Dar es Salaam for higher studies. The Government of Zanzibar will be nominating another person in due course.
- ii) The Marketing/Export Manager, ZSTC and the Plant Manager, Clove Stem Oil Distillery, Pemba, attended the International Congress of Essential Oils, Flavours and Fragrances held in New Delhi in November, 1989. They had a chance to meet a number of dealers and consumers of essential oils from all over the world. This participation has proved useful for sales promotion of essential oils produced in Pemba.

7. Alternate Sub-contracting of Repairs to the Manufacturers of Equipment:

In respect of Distillery equipment and vehicles, 2 important aspects of work needed attention:

- i) To prepare list of all the essential spares to make the Distillery operational.
- ii) To modify one distillation unit to enable distillation of aromatic plants other than clove stem.

List of essential spares was prepared with the active assistance of the Plant Manager and the Production Engineer of the Distillery, who are qualified engineers.

Regarding modification of the existing distillation units, considering the quantum of job and expenses involved, it was not considered advisable. As local expertise was not available, getting help from outside experts would have been expensive. Instead, a new distillation unit has been recommended.

Nevertheless, there is a need for a sub-contractor capable of repairs of existing units and related machinery. During the course of search for competent persons for repair of the boiler furnace, it came to the knowledge of the Distillery that Tanzania Industrial Research and Development Organisation, Dar-es-Salaam has professionally qualified technical persons to help the industrial units in Tanzania.

It may also be mentioned here that while repairing the furnace at the Distillery they were consulted about repair of the chimney, cooling tower fans and valves of the distillation units. One defective valve has been taken by them for repair after which other valves will be got repaired. They were confident about doing these jobs. Estimate of expenses involved for these jobs is awaited.

8. In - Training and Training of Local Personnel through Fellowships:

Training of national staff by the Experts at site will be an important on-going activity. Besides, six Fellowships/Training have been identified in the Project (Please see Report pages 9 - 11, 10 Aug, 1989 by Baldev Gulati). Following personnel were identified for training in suitable institutions abroad.

<u>Personnel</u>	<u>Status</u>
i) Plant Manager, (Mr. Nasib S. Omar)	i) Participated in the International Congress of Essential oils, etc, New Delhi (12 - 16 Nov. 89) ii) Left for training abroad for 10 weeks in August 90
ii) Marketing/Export Manager (Mr. Suleiman J. Jongo)	i) Participated in the International Congress of Essential Oils etc. New Delhi (12 - 36 Nov. 89) ii) Training scheduled from Aug. 90, has been postponed as Mr. Jongo has proceeded for higher studies. The Z.S.T.C. Zanzibar will nominate afresh a suitable person. Training schedule has been finalised. Mr. Ramadhan is expected to proceed in near future.
iii) Production Manager (Mr. Ramadhan K. Peruzi)	Distillation Foreman will accompany Production Manager for the training schedule worked out.
iv) Distillation Foreman (Mr. Ali Shaali Abeid)	Training schedule has been worked out. Mr. Badru will proceed for training towards end, 1990.
v) Maintenance Foreman (Mr. Badru Ali Zubeir)	Suitable qualified Chemist is yet to be appointed for Pemba Distillery. No action for training has, therefore, been taken.
vi) Analytical Chemist (Not yet recruited)	

Besides the above mentioned 6 fellowships/training programme, it was recommended that the Agronomist should also be sent for training as and when a suitable person is appointed. This training programme for the Agronomist is held in abeyance.

9. Co-ordination of Activities of Experts.

The U.N.I.D.O., Vienna, programme of fielding of Experts, which was well thought out, was to field the C.T.A. along with the Engineer and the Analytical Chemist at the start of the Project. The Engineer was required to examine the needs of the Pemba Distillery and prepare list of inputs for placing order. The Analytical Chemist was to look into the working of the Laboratory, suggest modifications for improving facilities in the laboratory and to prepare list of equipment, glass-ware and chemicals for quality control and analytical work on essential oils and related products. An Agronomist was also to visit the Project site while C.T.A. was present there.

The fielding of experts did not however follow the planned pattern due to reasons beyond the control of the executing agency. Accordingly so as to give optimum benefit to the project, the fielding of experts was re-programmed by the C.T.A.

The Analytical Chemist and Agronomist were briefed in UNDP office, Dar-es-Salaam by the C.T.A. and discussed his own findings to co-relate their activities. Both these Experts completed first phase of their mission. Later on marketing Expert came and completed his mission in May-June, 1990. He discussed his work and report with the C.T.A. in Dar-es-Salaam. His final report is awaited.

It is now suggested that the short term consultants field mission should, as far as possible, coincide with the next mission of the C.T.A. It is also suggested that the Engineer and the Analytical Chemist should be fielded only after inputs relevant to their mission are received at site.

All the spare parts and laboratory items are expected to be at site by end 1990. Fielding of these two experts as also of the C.T.A. should be arranged during that period i.e. November - December, 1990.

10. Production of Essential Oils:

Repair of the furnace of boiler was completed by mid-December, 1989. Work of distillation for the production of essential oils was started on 19 December. Distillation was organised keeping in view that 24 - 30 hours were needed to complete distillation of clove buds. It was considered advisable to distil clove buds without interruption. Following schedule of work was planned.

Monday to Thursday	Round the clock.
Friday	Maintenance and Cleaning
Saturday	One Shift only
Sunday	Weekly off.

(Occasionally, the work of distillation was carried out from Monday to Friday, maintenance work on Saturday and weekly off on Sunday).

Out of 10 distillation units, one was used for lemongrass, (modified with respect to florentine receiver only), 2 units for clove buds and 6 units for clove stem. One unit was out of order for want of a valve. This pattern of distillation was worked out due to the fact that clove stems after distillation are used as fuel for running the boiler.

Production schedule worked well. However, brick lining of the furnace using locally available material started falling after 2 weeks of the start of distillation. The distillery could work till end March 1990 only. Major repair of the furnace was again taken up from 6 July 1990. This work was entrusted to the Tanzania Research and Development Organisation (TIRDO), Dar es Salaam, having professionally qualified personnel. Two technical persons were brought by the C.T.A. to Pemba on 6 July 1990. Materials for repair was imported earlier from Mombasa (Kenya). The entire furnace was dismantled and redone. Work was completed on 25 July. After giving due time for drying and warming up, the boiler started on 31 July 90. Distillation and production of essential oils started from 31 July 1990 on trial basis.

In the meantime, the Electricity Department at Chake Chake refused permission to the Distillery for work after 6 PM. (According to the chief of Electricity Department the engines in the Power House had already worked for 22000 hours and needed repairs. In view of this it was considered risky to put heavy load on the engines-generators.

The Electricity Department provides electricity to the factory . . on alternate nights. However, day time supply of electricity is nearly regular).

In view of the above constraint, distillery operation schedule had to be modified. The schedule of production programme is given at Annex 2

After repair of the furnace, first in December 89 and then in July 90, distillation and production progress was as given below:

Production of following essential oils was taken up:

- i) Lemongrass oil
- ii) Clove stem oil
- iii) Clove bud oil

Lemongrass: Oil of lemongrass was produced from the crop being raised in Distillery premises and Magome.

Harvesting of grass in Distillery premises started from 19 December, 1989. In all, 2069 kg grass from 2755 clump was obtained which on distillation gave 5.46 litres of oil (effective area of 0.75 acres was under cultivation taking spacing at 4' x 3' used for planting lemon grass).

Average oil content came to 0.26 per cent (v/w).

In Magome, first harvest started from 27 December 89 and lasted till 15 January 90. Second harvest was taken from 7 Feb. 90 and completed on 27 March 90.

Yield of grass and Oil from the two harvests came to :

	<u>HARVEST</u>	
	<u>First</u>	<u>Second</u>
Lemongrass distilled	13.96 tonnes	24.09 tonnes
Oil Obtained	41.4 litres	72.55 litres
Oil content (v/w)	0.24 per cent	0.30 percent

Due to breakdown of furnace, distillation of third harvest was delayed resulting in partial drying of leaves. The harvesting was started on 30 July and distillation from 31 July, 1990.

Considering the growth pattern of lemongrass it seems possible to take up to 6 harvests per year.

Clove Stem Oil:

Clove stem oil is the main and regular item of production. Production of oil from December 89 till date is summarised at Annex 3.

Clove Bud Oil:

Regular production of clove bud started from December 85 for the first time; small quantities only were produced in earlier years.

Production data is given at Annex 3.

Production of various essential oil from December 1989 till end August 1990 is summarised as under:

<u>Month</u>	<u>Oil of</u>		
	<u>Clove Stems</u>	<u>Clove Buds</u>	<u>Lemongrass</u>
December	2,379 Kg.	484 kg.	21.96 lit.
January 90	10,630 "	2,350 "	25.00 "
February 90	8,361 "	1,973 "	55.60 "
March 90	4,860 "	784 "	16.95 "
April "	-	-	-
May "	-	-	-
June "	-	-	-
July "	95 "	-	5.45 "
August" (1-14 Aug.)	4,923	552	63.60 "

Note: No production during April - July due to major breakdown of boiler furnace.

Details of raw material used and oil produced during December 89 to August 1990 are given in Annex 3.

For the sake of comparison, production of essential oils since the start of the Distillery in 1983 is given in Annex 4.

11. Work done in the Laboratory:

Even though the laboratory in the Distillery does not have requisite glassware, chemicals and equipment, work was carried out on the screening of locally available aromatic plants, with a view to study the oils for odour and G.L.C. Work done during the current 5 month's mission is summarised as under:

1) Artemisea spp. (Local name: Mpachori)

A species of Artemisea is grown as garden plant through stem cuttings. Leaves are fragrant and give a blue coloured oil. Oil content was observed to be:

	<u>Percent Oil content on (v/w)</u>	
	<u>Fresh weight</u>	<u>Dry weight</u>
i) Leaves (Fresh)	0.77	2.34
ii) Leaves (dry)	1.00	-
iii) Leaves (one day dry)	0.80	1.60
iv) Tender stems	0.17	0.34
v) a) Resinoid (alcohol extraction)		19.8 percent
Absolute		12.0 "
b) Resinoid from distilled material		6.5 "
Ratio of leaves: Stalks		
in the freshly harvested plants: 1.4 : 1.0		

2. Petitgrain Oil (Bitter Orange leaf oil)

Bitter orange tree is valued for its leaf, fruit and flower oils. The trees are reported to grow in Pemba though extent of their availability is not known. Oil content in the leaves is as under.

	<u>Percent Oil content on (v/w)</u>	
	<u>Fresh weight</u>	<u>Dry weight</u>
i) Fresh leaves	0.36	1.00
	0.70	1.70
ii) Dry leaves	0.55	1.04

3. Citrus grandis leaf oil

Oil content (Fresh weight basis)	0.35 percent
Oil content (Dry weight basis)	0.95 "

4. Ocimum Species:

1) <u>Ocimum canum :</u>	<u>Oil content on (v/w)</u>	
	<u>Fresh weight</u>	<u>Dry weight</u>
a) Green healthy leaves with inflorescens:	1.05	5.00
b) Small wilted leaves with mature inflorescens	1.47	4.40
c) Leaves from seeding plants	0.30	0.68
d) Leaves from viral infected plants	0.31	1.41

ii) Ocimum basilicum: (Local name Mrhani)

The oil from *Ocimum basilicum* found in Pemba has been observed to be rich in methyl chavicol (more than 90 percent). We observed 2 morphological varieties in the plant; one has smooth elliptical leaves, the other having serrated leaves. Oil content of these two varieties is:

	<u>Oil content on (v/w)</u>	
	<u>Fresh weight</u>	<u>Dry weight</u>
- Plants with plain elliptical leaves	0.40	2.50
- Plants with serrated leaves	0.47	2.35

5. Pogostemon plectranthoides:

1) Oil content in leaves plus inflorescens (v/w)	0.11 percent on fresh weight	
	0.48 " on dry weight	
ii) Leaves only	0.06 " on fresh weight	
	0.20 " on dry weight	

6. Vetiver roots:

Oil content (v/w)	1.0 percent on fresh weight
	2.35 " on dry weight

7. Cardamom (small), Elettaria cardamom:

Cardamom is grown in Pemba and Unguja on small scale. For the

present work, cardamoms were procured from Agriculture Station. The cardamom capsules were one year old and apparently were neither dried carefully nor stored properly. Data on oil content is given below:

Percentage of seeds in the whole cardamom was 71 while the husk (outer cover) was 29 percent. Moisture content of the capsule was 20 percent.

	<u>oil content on (v/w)</u>
i) Seeds only (whole)	7.00 percent
ii) Seeds powdered	5.10 "
iii) Whole capsule	4.00 %
iv) Whole capsule (crushed)	4.50 "
v) Husk only	Traces

Oil content in:

whole capsule	3.78 percent (by weight)
seeds only	5.40 " (" ")

Oil sample has been kept for G.L.C. and odour evaluation.

8. Ylang Ylang Flowers:

Ylang Ylang tree flowers in July in Pemba. A visit to an area having a few trees showed profuse flowering. This afforded an opportunity to distil the flowers. Besides distillation an attempt was made to produce centrete and absolute. In the absence of benzene or hexane, ethanol was used which posed problems due to high moisture content of flowers (over 75 percent). Even shade dried flowers (left over) had moisture content of about 50 percent. However, only freshly harvested flowers were distilled and extracted.

It was observed that the Extra quality and bulk of oil distills over in about 4 hours. However, distillation of flowers was continued upto 18 hours. to recover all the oil. Data on oil content is given below.

	<u>oil content on (v/w)</u>	
	<u>Fresh weight</u>	<u>Dry weight</u>
<u>Fresh Flowers</u>		
i) First Fraction	1.40	6.26
ii) Second "	<u>1.03</u>	<u>4.66</u>
Total	<u>2.43</u>	<u>10.92</u>
iii) Immature un-opened flowers	1.10	-

iv) Dry flowers

1.70

3.40

Oil content from fresh flowers is average of 8 distillations.
Sample of oils have been kept for odour and G.L.C evaluation.

12. Diversification of Aromatic Crops:

For work on cultivation of essential oil bearing plants considered suitable for introduction, land at Magome, situated at about 3 km from the Distillery, has been selected. So far about 62 acres of land has been cleared for cultivation. Present position of area under various crops is as under:

- i) Lemongrass 16 acres - Planted in 1989
19 " - " " 1990
- ii) Vetiver 4 "
- iii) Cinnamon 4 acres pure crop (2032 plants)
500 plants in lemongrass are planted in 1989 (1 acre).
Planting in lemongrass fields has been discontinued.
- iv) Cardamom 1 acre (500 plants)
(Small)
- v) Vacant area 32 acres (under various stages of preparation)

Details of cultivation and crop growth position is given below.

- Lemongrass: Lemongrass under cultivation is Cymbopogon citratus (West - Indian type) available in Zanzibar and Pemba Islands.

Plants were cultivated in the premises of the Distillery in an area of 0.75 acres. This provided planting material for large scale cultivation in Magome.

Lemongrass was cultivated in 1989. (May - July) in an area of 16 acres. Initial planting of lemongrass was done at a spacing of 4' x 3' which was reduced to 3' x 2.5' and 2.5' x 2' as per advise of the C.T.A.

An additional row of lemongrass was planted in the wider spaced (4' x 3') planted fields. The whole area is now fully covered with profuse growth of the crop.

An additional 19 acera were brought under cultivations during May - 1990. The plants are coming up well.

Lemongrass planted in the premises of Distillery is maintained to serve as a regular source for planting material.

At the present 35 acres are under Lemongrass.

- Vetiver: Vetiver growing in Pemba was observed to give good yield of quality oil. An area of 3 acre has been planted with vetiver on ridges (during May - June 1989) to promote better root growth. The clumps have established well. Mortalities were replaced. Trial

harvesting of the plants is proposed for November - December 1990.

- Cardamom (Small): Seeds were sown in a shaded nursery in August 1989. Germination was good. Seedlings were tended well. Field planting was done in March - April 1990. In all 500 plants have been planted in an area of about 1 acre under shade.

(Raising cardamom for essential oil seems to be promising considering the whole sale market rate of cardamom at T. Schling 700 - 800/kg. Work done on laboratory distillation of cardamom is given in this report).

- Cinnamon: (True - Ceylon type). Cinnamon was planted as inter-crop of lemongrass in 1989 as clear area was not available. During 1990, 4 acres have been planted as a pure crop with 2032 plants. A small number of seedlings have died. The vacancies will be filled during rains this year.

Miscellaneous aromatic plants such as Ocimum, a species of Artemisia (giving blue oil), Ocimum basilicum giving an Oil rich in methyl chavicol have been planted in the nursery to observe their performance, for eventual pilot scale distillation.

Out of these, methyl chavicol rich oil from O. basilicum holds promise. It is now planted to cultivate in about 0.25 acres on trial basis to study economics and quality/market evaluation.

During current mission of 2 months, work on cardamom (small), a wild growing large cardamom and ylang ylang from naturally growing plants was done. Details of the work are given in this report.

13. ACTION TAKEN BY ZSTC AND UNIDO AS PER RECOMMENDATIONS:

During the first mission of the C.F.A. in July - August 89, recommendations were made for action to be taken by the ZSTC (Report 11 Aug. 89, pages ii, iii). Progress of work/action taken on various recommendations is as under;

1) Laboratory modification. Immediate action was taken by the ZSTC to procure wood for the laboratory. Work of laboratory modification was started from 29 January 1990 and has been completed.

Analytical and quality control work will start soon after all the equipment, glass ware and chemicals are received for which order has been placed by UNIDO Vienna.

2) Appointment of Qualified Chemist and Agronomist:

Steps have been taken to select a chemist. Candidates have been short-listed for selecting a suitable candidate willing to work in Pemba.

Department of Agriculture, Pemba, had loaned services of an Agronomist on part time basis. The Agronomist has now left. Appointment of an Agronomist should be made as early as possible.

3) Provision of a Tubewell:

Immediate action was taken on boring a tubewell for augmenting water supply for the Distillery. The tubewell became operational from 15 December 1989. This has helped in maintaining production level. (Water supply was disrupted from the town pumping station for about 2 weeks during December due to closure of electricity power house for want of diesel).

4) Preparation of land for cultivation:

A further area of 30 acres has been cleared of bushes. Fields were ready for planting by the onset of rains. Additional 10 acres have been planted now with lemongrass bringing a total area under lemongrass to 30 acres.

5) Procurement of Rectified spirit:

Ten litres of rectified spirit has already been provided. Regular supply of rectified spirit has been assured.

Progress on action taken by UNIDO Vienna:

Action on the following has been taken by UNIDO Vienna for the purchase of various items for the work of the Project.

- k, Inputs:
- i) Pickup-van Received at Project site on 7 July 1990.
 - ii) Motor Bike Order placed, not yet received.
 - iii) G.L.C. Equipment Order placed but not yet received. The equipment will be installed by the suppliers. A special room has been equipped in the Distillery exclusively for this equipment.
 - iv) T.L.C. Equipment Received at Project site.
 - v) Lab. Chemicals, equipment and glass apparatus. Order placed. Chemicals and glass apparatus not received. Equipment has been received.
 - vi) Spares for hoist, generator and distillation equipment. Order placed. Not received yet.

2. Participation of Plant Manager and Export Manager in the International Congress of Essential Oils in Delhi.

Immediate action was taken for the participation of both the Plant Manager of the Distillery and the Export/Marketing Manager of ZSTC in the International Congress of Essential Oils held in Delhi from 12 - 16 November 1989. They participated as registered delegates. This participation provided them a unique opportunity to meet large number of participants (Scientists, Technologists, Consumers, Suppliers of essential oils etc.) from all over the world.

As a result of this visit, useful contacts have been made resulting in enquiries about the sale of clove stem, bud oil and other essential oils. Sale of the stem and bud oil will get a boost not only in Europe but also in the USA and India as a result of this participation.

14. Achievement of Objectives:

The Project has 3 immediate objectives viz;

1. Upgrading of Chake Chake Clove Oil distillation plant to process 1900 tons of clove stems on a two shift basis per year.
2. Development and cultivation of different species of plants yielding essential oils for diversification purposes:
3. Development of marketing strategy for the increased output of clove stem oil.

Progress in the achievement of above objectives, outputs and related activities is summarised as under:

Immediate Objective one:

1. Upgrading of the performance of the Chake Chake Clove oil distillation plant.

1.1 Outputs: As a fully operational plant able to process upto 1900 tons per annum of raw material (Clove buds and/or clove stems)

<u>Activities:</u>	<u>Progress</u>
- To review existing buildings equipment process technology and manpower resources.	Completed
- To order spare parts for plant and lorries	Completed
- To train key personnel both on job and through fellowships: Plant Manager, Foreman Maintenance Section, Distillation section	Partly achieved, ongoing activity
- To order lorry for assisting in collection of clove stems from 56 buying stations at Pemba.	Could not be done for want of funds
- To instal spare parts on plant equipment	Spare parts ordered and partly received and being used; job will be completed on receipt of all the items.

- To start operation of plant in two shifts. Completed. Factory operated on 3 shift basis on trial for more than 2 months at a time.
- To design and implement an equipment subsystem with schedules of inspection and checks. will be completed by the Engineer Expert.

1.2 Output 2: Upgraded quality control system for grading and certifying the products to international standards.

Activities:

Progress

- To draw up requirements for building specifications for installation of quality control equipment. Completed
- To modify buildings according to requirements specified above Completed
- To order and install quality control equipment Equipment ordered; will be installed as soon as received.
- To develop procedures and practices for quality control certifying the quality of the products according to international standards. Partly completed, will be completed by the Chemist Expert in near future.
- To train counterpart personnel on the job and through a fellowship for the analytical chemist to carry out tasks described above Existing personnels being trained at site, chemist will be sent on fellowship when recruited.

2. Immediate Objective two:

Selection and trial propagation of essential oil bearing plants based on International market prospects.

2.1 Outputs:

- Out put No.1 A short list of plants yielding essential oils which are suitable for the world market selected.

- | <u>Activities:</u> | <u>Progress:</u> |
|--------------------------------------------------------------------------------------------------|------------------|
| - To select varieties of species of plants yielding essential oils suitable for the world market | Completed |
- 2.2 Output No.2: Experimental cultivation of species selected under above.

- | <u>Activities:</u> | <u>Progress</u> |
|----------------------------------------------------------------|-------------------------------|
| - Experimental propagation of plant species selected. | On going activity |
| - ZSTC to cultivate crop-wise 2-3 essential oil bearing plants | Completed; on going activity. |
- 2.3 Outputs No.3: Essential oil from distillation of 2-3 species.

- | <u>Activities:</u> | <u>Progress:</u> |
|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| - To modify distillation equipment to enable it to distil essential oils from species selected | One unit modified, major modification of the existing unit not considered advisable. New distillation unit is recommended for which funds requested. |
| - To experimentally distil essential oils from species selected for cultivation. | Under progress as an on-going activity. |

3. Immediate Objective three:

Development of marketing strategy for the increased trade of clove stem oil:

Outputs:

3.1 Report on marketing strategy for clove stem oil:

- | <u>Activities:</u> | <u>Progress:</u> |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| - To develop marketing strategy for clove stem oil due increased output of Pemba Plant and possible need to attract present consumers of clove leaf oil. | Due to steps already taken sale of oil increased. Report of Marketing Expert under consideration. |

3.2 Output:

Sales promotion trip to major present and potential consumers of olive stem oil leading to increased exports:

Activities:

Progress:

- To plan and implement sales promotion study tour to major present and potential consumers of olive stem oil. Under consideration

15(i) Budget Utilisation and Constraints: Proposal for Additional Funds:

Equipment component of the budget i.e. expendable and non expendable at US \$ 20,000/- and US \$ 85,500/- respectively, comes to about 25 per cent of the total budget. While technical assistance and training components have been taken care of but considering overall condition of the factory, equipment allocation is considered inadequate. Following expenditure has been incurred so far on equipment.

<u>Item</u>	<u>Value (US Dollars)</u>
1. <u>Vehicles</u>	
i) Nissan Pickup - one	9,926
ii) Motor bike - one	1,893
2. <u>Spare Parts</u>	
i) Hoist	4,331
ii) Electrical	12,030
3. <u>Laboratory Inputs</u>	
i) C.L.C.	32,020
ii) T.L.C.	4,086
iii) Glass apparatus	14,247
iv) Equipment	24,709
v) Chemicals	1,469
Total US \$	<u>104,711</u>

It will, therefore, be seen that while budget allocation has been fully utilised, some essential items are still needed. These are listed hereunder:-

i) Distillation unit for Lemongrass & other Oils	US \$ 35,000
ii) Distillation unit (experimental) for Cleve bud oil with cohabation	US \$ 50,000
iii) Pilot scale distillation unit	US \$ 5,000
iv) Rectification Column and Reaction Assembly (40 litres each) Complete with stirrer and vac. pump	US \$ 20,000
v) Workshop tools and machinery	US \$ 30,000
vi) Truck	US \$ 30,000
vii) Jeep(Suzuki type 4-wheel Drive)	US \$ 10,000

viii) Planting material	US \$	20,000
		<hr/>
Total	US \$	200,000
		<hr/>

Justification

Justification for the purchase of the above listed items are given as below:

i) Distillation unit for Lemongrass - (3000 litre capacity)

Modification of existing distillation units was contemplated in the Project for the distillation of various essential oils bearing crops raised under diversification of crops programme. This was not considered advisable because of:

a) The existing distillation units are made of stainless steel of about 1 cm thick gauge fitted with all the necessary pressure and temperature gauges. Secondly, these are installed in a battery system and designed for efficient distillation of Clove stems only. It will be difficult to effect modifications using local resources. Getting help for this from abroad would be expensive and time consuming proposition.

b) All the 10 distillation units are housed in a hall. Loading and unloading of Clove stem is done in a streamlined fashion: the entire space becomes littered with stems even though cleaning is done regularly. Any new crop such as lemongrass, cintrenella, vetiver, palmaresa (under our programme of diversification of crops) is likely to be contaminated, odour wise, which will render these oils unfit for sale and use. The proposed distillation unit will be installed outside the main factory hall and near the boiler.

It is also visualised that all these existing distillation stills will be utilised for producing clove stem oil at optimum distillation capacity.

ii) Distillation unit for Clove buds:

As mentioned in this Report, the existing distillation units are designed specifically for producing clove stem oil. Clove buds, on the other hand, are distilled at atmospheric pressure and preferably without interruption over a longer duration ranging from 24 to 30 hours. More important aspect of distillation of clove buds is cohobation which

gives an oil true to nature as also in better yield. (Distillation without cohobation can result in a lower yield by 15 to 20 percent which comes to losing about 10 - 15 kg of oil per ton of the clove buds distilled resulting in a loss of about US \$ 150 per ton of clove bud distilled).

Now that clove bud oil is set to be a regular item of production, it is absolutely essential to procure one unit of about 3000 litres capacity with cohobation arrangement. This will enable us to standardise distillation of clove buds to produce a better quality oil at a competitive price.

iii) Pilot scale Distillation Unit:

At the present, plant materials can be distilled in the laboratory in batches of 100 - 200 gms. only which does not produce oil in sufficient quantity for both physico-chemical and other evaluation. Next to distillation on this batch size are units which take a charge of 700 kg or above of plant material for distillation. It is, therefore, absolutely essential to have a unit which can take a charge of about 5 - 10 kg to produce sufficient product under various parameters for complete study. It is pertinent to mention that both flavour and fragrance industries are looking for new essential oils. Such a distillation unit affords an opportunity to work on not only established products but also new aromatic raw materials.

iv) Rectification Column and Reaction Assembly:-

So far, only oils from clove stems and buds and recently lemongrass have been produced. Clove stem oil is being produced on a limited scale; one of the reasons being marketing constraints. However, due to efforts made in the recent past and due to participation of Plant Manager of Pemba Distillery and Export/Marketing Manager of Z.S.T.C., Zanzibar, in the International Congress of Essential Oils, Fragrances and Flavours held in New Delhi, in November 1989 expert of clove stem and bud oils is picking up. Enquiries are also being received for other essential oils such as lemongrass. It is an opportune time to think ahead and plan for producing value added downstream products especially from clove stem oil.

The initial steps required would be to procure an experimental pilot scale rectification Column and Reaction Assembly (with stirrer). This will enable the distillery to produce isolates like

eugenol and there from iso-eugenol, and derivatives of eugenol and iso-eugenol.

With the installation of Rectification Column and Reaction Assembly, it will be possible to utilise the lower grade of clove stems also which otherwise cannot (rather should not) be used for production of an oil which is inferior in quality and may not be readily acceptable in the industry.

v) Workshop tools and machines:

Clove Stem Oil Distillery has a small workshop which caters to day to day repair and maintenance work. It is, however, not fully equipped with the necessary tools and machines for taking care of most of the vital aspects of repair and maintenance. The Island of Pemba is not only not connected with Zanzibar and mainland of Tanzania but does not also have requisite facilities of repair, maintenance, and essential spare parts for equipment.

It is, therefore, of utmost importance that the Distillery should have its own facilities for repair, maintenance and for fabrication of small components.

The existing workshop facilities should be augmented to make the Distillery self-sufficient to the extent desirable..

List of workshop tools and machines is given at Annex 5 vi, viii) Truck and Jeep:

Within the budget allocation under the Project, as stated earlier, it is not possible to purchase a truck as one of the essential requirements of the Project mentioned in the Project Document.

At the present, there is no transport for the use of Project Experts to perform their duties effectively especially for the Diversification of Aromatic Crops which is an important aspect of the Project. One pickup van was purchased under the Project. However, pick-ups are hardly the type of transport which can be used for day to day work when more than 2 to 3 persons have to travel for Project work.

It is, therefore, strongly recommended that reasonable transport facility must be provided in the Project without which the time and services of Experts cannot be utilised effectively.

viii) Planting material: Under the programme of diversification of essential oil - bearing crops, it is advisable to import and introduce planting material of improved quality. It is also recommended that

sufficient planting material of recommended species to cover 2 - 5 acres each should be imported. To begin with, planting material of the following species is envisaged:

- Citrenella (Java type)
- Palmarosa
- Lemongrass of improved variety
- Basil, French and Reunion types
- Vetiver

15 (ii) Proposal for work in Unguja Island:

The current Project DP/UR/86/026 is concerned primarily with developing the essential oil industry in Pemba through the Clove Stem Oil Distillery at Chake Chake with the following Objectives

- i) Upgrading of Clove stem oil Distillery to process 1900 tons of clove stems per year.
- ii) Development and Cultivation of different species of essential oil bearing plants for diversification purposes.
- iii) Development of marketing strategy for increased output of clove stem oil.

The Project which started from July 1989 is progressing well and is expected to achieve fully the Objectives set in the Project Document.

During the course of work in the Project it was realised that if the activities are extended to cover the island of Unguja (Zanzibar), the pace of development of essential oil industry in the islands will be much more than if confined only to Pemba. The current Project with some additional funds can take care of the increased work.

There are 2 main reasons for extending the Project activities to Unguja.

- Even though Clove Stem Oil Distillery is an excellent one, and will work more smoothly due to inputs by the U.N.D.P., it still suffers by virtue of its location away from Zanzibar and the Mainland. Pemba is not well connected due to irregular and erratic air flights and ship service, facilities of repair of machinery and vehicles and non-availability of essential and even simple spares. These factors, more than often, affect the working of the Distillery and hamper production.

- Prior to establishment of Pemba Distillery, Zanzibar was the only place where clove stem oil and lime oil were produced. Even though distillery at Zanzibar is no longer functional, the island of Unguja still has potential for producing essential oils. It is now more relevant

as the UNDP Project has embarked upon diversification of essential oil bearing crops suited to Pemba which also hold good for Unguja.

In view of the above mentioned facts, it would be advisable to extend the scope of Project work to Unguja also. As the current team of Experts will be able to do this work to a great extent, additional requirement of funds will be limited.

It is suggested that production of essential oils, mainly, clove bud and lime oils should be taken up in Zanzibar. Production of clove bud oil will enable Pemba Distillery to concentrate on stem oil, lemongrass and other oils. It is also essential to revive production of lime oil in Zanzibar due to its excellent quality very well received in the International market. In due course, other items will be added for production in Zanzibar.

15(iii) Extension of the Project:

The Project has provision for the following experts for the duration listed as under:

<u>Expert</u>	<u>Duration</u>	<u>M/M used</u> (Till end Aug.90)
i) Chemical Technologist (Essential Oils) C.T.A.	18 m m	6.75
ii) Analytical Chemist	2.5m m	0.50
iii) Agronomist	4.0m m	1.00
iv) Marketing Expert	2.0m m	2.50
v) Engineer	2.0m m	Nil
vi) Perfumer	1.0m m	Nil
Total	23.5m m	10.75

It will be seen from the above that only Marketing Expert has completed his mission. The C.T.A. has completed a little more than half the period of his assignment. The Agronomist, Analytical Chemist, Engineer will complete their assignment as soon as all the inputs relevant to their mission are received at site. The Perfumer will join the Project when sufficient samples of essential oils are produced from trial distillation of clove stem and bud and locally available aromatic plants. All the man - months are, therefore, expected to be utilised fully by mid - 1991 at the latest.

The production and sales of clove stem and bud oil in the past (as per data in the Project Document) and the export of clove stem and bud oil was as under:

<u>Year</u>	<u>Export of oil of kg</u>		<u>Sales (US Dollars)</u>
	<u>Clove Stem</u>	<u>Clove bud</u>	
1984	1,320	-	12,125
1985	9,040	-	64,380
1986 - 87	4,926	-	31,452
1987 - 88	14,740	-	102,619
1988 - 89	20,200	1,980	152,230
1989 - 90	30,992	1,540	220,660

It will be observed from the above data that production and sale of both clove stem and bud oil has increased, especially after the start of the U.N.D.P. Project. During the Project period, oil of lemongrass is also being produced on commercial scale. Due to the efforts of ZSTC, there is perceptible improvement in the sale of these

oils with the prospects of further improvement in the future. Sales of clove bud oil is also expected to improve substantially due to its quality and competitive price.

It can be safely inferred that the UNDP Project has contributed substantially to the overall improvement of the working of the Peaba Distillery resulting in improved sales and foreign exchange earnings.

One of the Objective of the Project is to process 1900 tons of clove stem and / or buds equivalent to about 100 tons of the oils. Processing of this quantity is feasible as was seen from actual work in the Project. (clove stems, 574.7 tonnes giving 23.85 tonnes of oil and 36.8 tonnes of clove buds giving 5.1 tonnes of oil was produced between mid December 1989 to March 1990 i.e 3.5 months using only 8 units out of 10 units in the Distillery. Production of lemongrass, as a minor item, was an additional product). Computing these figures, it may be inferred that achievement of production of about 100 tonnes of stem and bud oil is not an unrealistic target which would be worth US dollars 500,000 per annum. However, to achieve this figure of sales and earnings on a sustained basis will need concerted efforts of both UNDP and the Government of Zanzibar (through Z.S.T.C.).

Taking overall view of the situation such as achievement and progress of work, future scope and creation of capacity and capability in the Distillery as also in Zanzibar, it would be necessary for additional technical input in the Project. Provision of additional 9 man months, 6 m/m for the Chemical Technologist, (Essential Oils), C.T.A. and 3 m/m for short term consultants would be in order.

It is also relevant to mention that we visualise production of additional essential oils both from introduced cultivated crops as also from the locally available aromatic plants resources. Work on the essential oils from such sources is an on-going regular activity of the Project:

Taking into consideration the need for additional funds both for equipment, technical support (additional) the budget enhancement position is as under:

<u>B.L.</u>	<u>Description</u>	<u>Allotment</u>	
		<u>M/M</u>	<u>Dollars (U.S.)</u>
11.01	Chemical Technologist (Essential Oils) C.T.A.	6	59,000
11.50	Short term consultants	3	25,000
32.99	Study tours/Training	-	20,000
42.99	Non-Expendable Equipment	-	180,000
51.99	Sundries (such as Planting Material etc.)		20,000
99-99	Project Total		304,000

Note: In case work in Unguja is approved an additional sum of US Dollars 20,000 will be needed.

Clove bud oil distillation unit suggested for Pemba Distillery would be installed in Zanzibar.

Job Description:

Job description during the second mission of 5 months (Split mission of 3 and 2 months respectively) is as under:

- During the first joint mission with the Engineer to review present state of clove industry in Chake Chake and specifically, the infrastructure centred around. To discuss with all relevant technical personnel of the Distillery and make recommendations with regard to the following:

- a) Improvement of extraction methodology
- b) Improved method of quality assessment and storage of essential oils and related products.
- c) Marketing strategy
- d) Alternate sub-contracting of repairs to the manufactures of equipment.

- Second Mission (2 months).

To co-ordinate activities of the experts and will be specifically involved in "In training" programme by lectures, seminars or any other periods of instructions that may be required.

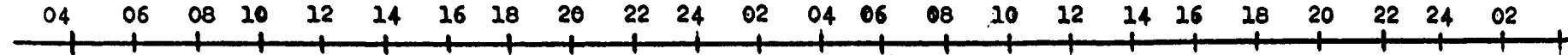
To prepare final report setting out the findings of mission and recommendations to the Government on further action which might be taken.

DISTILLATION SCHEDULE

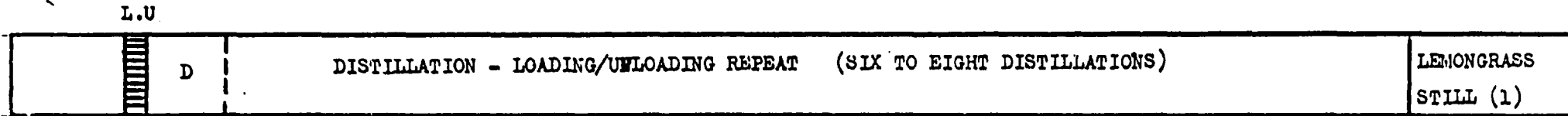
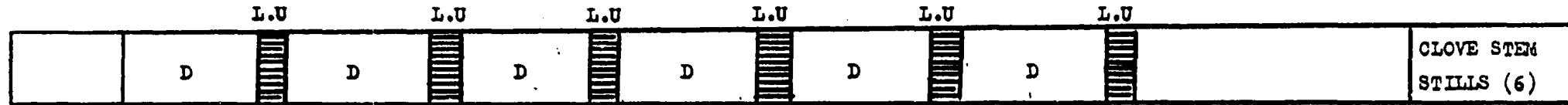
(GRAPHIC PRESENTATION)

ANNEX - 2

TIME IN HOURS



L.U



S.B - Starting boiler B.D - Boiler furnace deoclogging L.U - Loading/Unloading D - Distillation
 R.R - Rolls Royce - 160 KVA generator Daf - 90 KVA generator Ford - 30 KVA generator

NOTE: In the event of non-supply of power from the town, work may have to be continued using generators.

Production of Oils and Raw material consumed
(December 1989 to August 1990)

<u>Month</u>	<u>Oil of</u>					
	<u>Clove Stems</u>		<u>Clove Buds</u>		<u>Lemongrass</u>	
	<u>Stems</u>	<u>Oil</u>	<u>Buds</u>	<u>Oil</u>	<u>Grass</u>	<u>Oil</u>
December 89	56.0	2.38	3.61	0.48	6.62	21.86 lit
January 90	246.4	10.63	16.57	2.35	9.41	25.00 "
February "	191.1	8.36	14.71	1.97	18.09	55.60 "
March "	137.2	4.86	5.52	0.78	6.00	16.95 "
April "	-	-	-	-	-	-
May "	-	-	-	-	-	-
June "	-	-	-	-	-	-
July "	2.1	0.10	-	-	2.20	5.45 "
August "	119.7	4.92	3.6	0.55	23.00	63.60 "

Note: i) Quantity in tonnes except oil of lemongrass which is given in litres.

ii) No. production from April to 30 July 1990

Production of Essential Oils - 1983 to 1990

<u>Year</u>	<u>Oil of</u>					
	<u>Clove Stem</u>		<u>Clove Bud</u>		<u>Lemongrass</u>	
	<u>Stems used</u>	<u>Oil</u>	<u>Buds used</u>	<u>Oil</u>	<u>Grass</u>	<u>Oil</u>
1983	735.5	24.4	-	-		
1984	425.0	22.7	-	-		
1985	311.9	17.74	-	-		
1986	195.3	10.0	-	-		
1987	606.7	27.10	-	-		
1988	422.	20.31	6.40	0.90		
1989	659.4	26.5	10.82	1.453	5.60	6.13 lit.
Average (1983 - 89)	479.5	21.29	-	-	-	-
1990 (January- March)	574.7	23.85	36.8	5.107	33.50	97.55

Note: Quantities in tonnes except oil of lemongrass which is given in litres. Final weight of Lemongrass oil will be given in kilogrammes after filtration and packing.

MACHINES & TOOLS FOR WORKSHOP

1. Milling machine, medium column & knee type (with all necessary accessories, all attachments and tools)
2. Lathe machine (medium size) - with all necessary, attachments and tools.
3. Tool & cutter grinder - with all necessary accessories, attachments and tools.
4. Shaper (medium size) - mechanical with all necessary accessories, attachments and tools.
5. Medium size horizontal hacksaw machine
6. Welding machine for mild steel and stainless steel.
7. Set of tools and instrument for the workshop.
8. Electrical spanner box with various tools.
9. Megger tester.
10. Avometer
11. Mechanical spanner box with various tools
12. Torque
13. Injector tester
14. Large & medium hydraulic jack
15. Soldering gun & wire
16. Vices - 0, medium & large, one each
17. Stainless steel welding rods
18. Cast iron welding rods
19. Mild steel welding rods
20. Aluminium welding rods
21. Brazing rods (cu-zn) with fluxes
22. Drawing board and Drawing instrument set.