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ASSISTANCE TO THE ESSENTIAL OIL INDUSTRY - ZANZIBAR

DP/URT/86/026

UNITED REPUBLIC OF TANZANIA

Technical report: Maximising the capacity of the clove distillery of Chake Chake*

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

Based on the work of Mr. Klaus A. Duerbeck, expert in cultivation of essential oil bearing plants

Backstopping Officer: Mr. R.O.B. Wijesekera, Chemical Industries Branch

United Nations Industrial Development Organization
Vienna

* This document has not been edited.

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Explanatory notes

Exchange rate:	1 USD is equivalent 144 TSH
ZSTC	Zanzibar State Trading Company, Zanzibar Town
Kilimo	Ministry of Agriculture, Livestock and Natural Resources, Zanzibar Town
TDRI-ODA	Tropical Development and Research Institute, Overseas Development Administration, London, UK

List of botanical Terms

	English name
Cananga odorata	Ylang-Ylang
Cinnamomum zeylanicum	cinnamon
Cymbopogon flexuosus	lemongrass
Elettaria cardamomum	cardamom
Eugenia caryophyllus	clove
Myristica fragrans	nutmeg, mace
Pimenta dioica	pimemto
Piper nigrum	black peper
Vetiveria zizanioides	vetiver
Zingiber officinale	ginger

List of Keywords

crop diversification, clove, cardamom, cinnamon, vetiver, ocimum, lemongrass, fertilizer trails, farm management

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Introduction

In the course of DP/URT/85/026 the agronomist expert had been fielded to perform the first part of the assigned split mission at Aug. 1, 1989.
The job description as per annex 1 had been revised during the initial meeting with the counterpart agency at duty station and reads now as follows:

1. Initiation of methods selecting locations, collecting seed and planting material, for cropwise cultivation of other essential oil bearing crops.
2. Advise on appropriate methodologies for farm management, irrigation and harvesting.

The deleted issues are already taken care in the course of the ongoing TORI-ODA project within the Kilimo in Zanzibar. Since the UNIDO counterpart agency is ZSTC within the Ministry of Industry, these issues can not be included in this UNIDO project. The General Manager of ZSTC reaffirmed this viewpoint later during a meeting held at ZSTC-HQ in Zanzibar Town.
Sensibilized on this topic the expert focussed his fieldwork therefore to create a broad basis for close collaboration with the respective Kilimo extension in Pemba Island.
There is already an ongoing Kilimo project to facilitate the introduction of new essential oil bearing cashcrops for the diversification of small scale cultivation - beside clove.

Recommendations

To ZSTC, Chake Chake Clove Stem Oil Distillery:

- Chake Chake Clove Stem Oil Distillery should employ an agronomist counterpart incharge of Magome Experimental Farm on a permanent basis.
- The farming area should be extented by another 25 acres to achive representative agricultural results of all envolved plant species providing basis data for the Kilimo extension service.
- The grounds for a successful extension service should be prepared in collaboration with Kilimo by removing the adverse effects due to the actual pricing policy and by providing incentives to farmers interested in cultivation of these types of cash crops.

To UNIDO:

- After implementation of the three above mentioned issues the agronomist expert should be fielded at the begin of a rainy season preferably during April to May 1990.
- Introduction of new plant species and varieties from abroad should be envisaged only after attending to the economical important local plant species of essential oil bearing plants.

Body of the report

ACTIVITIES AND OUTPUTS

a Evaluation of cropping conditions

The evaluation of the conditions of crop production on Pemba Island, with special reference to the area of cultivation in Magome (25 to 42 m o.s.l.) and Changwe (10 to 34 m o.s.l.) has been performed in the initial days at the duty station. Both areas are located in the vincinity of the Chake Chake Clove Stem Oil Distillery. In order to start cultivation of essential oil crops, the evaluation of the present cropping conditions is essential.

The crop production is mainly determined by three factors:

- the climatologic conditions

These areas are located in the undulating central part of the island with a variation of rainfall ranging between 1500 mm and 2000 mm per year. The climatological data sheet of Wete will serve as a representative source of information (annex 4). The climate of Pemba is dominated by two annual and reliable wet seasons, the Masika rains from the south through March to May, and the Vuli rains from the northeast during November and December. Wet season showers and storms are usually scattered, local torriental and of short duration. The most important fact influencing the plant growth is, that the evapotranspiration rate comes up very near to the total amount of rainfall per year.

- the soil types

Pemba Island being part of the acient Miocene Rufiji/Ruvu river delta is a simple fault block raised higher than Unguja Island. Cliffs and broken country are a feature of the Pemba Miocene area. Erosion fronts have been advancing inland from the east and west coast. In places these fronts have overlapped producing sharp and jagged skylines.
The geology and topography are outlined by pattern of clove trees and spice plantations. The clove trees, in particular, do not grow on the shallow soils of the coralline and reef limestone, nor on the seasonally water-logged soils of the corridor zone of the coastal strip of eastern Pemba. Thus miocene rocks are conveniently demarcated by the vegetation, i.e. clove trees and spices on the Miocene. Grasslands, rice and sugar, etc. on the corridor zones and waterlogged areas; stunted trees, tangled scrubs and thicket on the corraline and reef limestone coral rag (see Soils of Magome and Changwe annex 5 and Pemba soil map annex 6).

- the land tenure system

All land in Pemba, in urban as well as in rural regions, belongs to the Government. This was achieved by confiscation and nationalization of land after the revolution (1964) and safeguarded by two degrees from 1965.
Nevertheless, existing land rights and habits, which originated in the Islamic laws and traditions are still respected.
In the rural areas of Pemba the following different kinds of land tenure systems are found:

3-acres-plot
Inherited land
Family plot
Bought land
Borrowed land
Seasonal allocated land
and Other land.

Special emphasis is given on major food crops like cassava, rice, banana and sweet potato, mainly in a multistored agroforestry-system, utilising export crops like coconuts or clove as an intercrop. In Pemba a wide range of plants is cultivated in numerous crop assoziations. Multiple Cropping systems as well as monoculture planting are known. Mixed intercropping plays the major role. Three main types of mixed cropping systems can be distinguished:

- mixture of tree crops only
- mixture of tree crops with perennial and/or annual crops
- mixture of perennials and annuals.

When clove is the leading crop the mixed stands are characterized as follows:

- Clove and tree crops 41.8 %
- Clove, tree crops and annuals/perennials 58.2 %

Clove trees are mainly cultivated in a mixed cropping system together with coconut and other tree crops as well as with annuals. They do not thrive well on shallow Kinongo and uwanda soils. The cropping husbandry is charcterized by minimal management. Weed- and pest control and fertilizer applications are neglected. Consequently, the yields are quite low.

b Initiation of methods for cropwise cultivation of essential oil bearing plants

Selection of locations

On the basis of the recommendations of the CTA report, and considering the tradition of cultivation of different essential oil bearing plants and spices by farmers in Pemba, the expert employed the following criteria for the selection of suitable locations:

- Marginal clove growing areas
- No competition with the cultivation of stable crops like cassava and rice
- Easily accessable from the distillery
- Presently unused land in the course of shifting cultivation systems.

Extensive surveys of the different parts of the Island have been carried out with the assistance of the Production Manager and Plant Manager resulting in the selection of the Magome and Changawe areas as fitting to these criteria.

In Magome the management of the Chake Chake Clove Stem Distillery already started clearing and plantation works for 20 acres before the time of the experts arrival at the duty station. For further extension of farm works, presently uncultivated areas in the east of the farm or in Changawe, resambling the area between the Karume airport and the military airport, had been recommended by the expert (see maps in annex 7).

Collection of seed and planting material

Inside Magome Experimental Farm a nursery has been established in a low land part near the only water source accessable. Seed and planting material for cropwise cultivation of essential oil bearing crops - others than clove - have been collected from the different Kilimo experimental farms on Pemba, i.e.

- Cinnamon — from Wesha and Mweni
- Cardamom — under procurement from Wesha and Kizimbani (Unguja Island)
- Vetiver — collection from wild sources in Pemba has been initiated and is ongoing
- Ocimum — from three wildgrowing species of ocimum seeds have been collected and broadcasted in the nursery.

The botanical identification of the Ocimum spp. has been initiated in collaboration with Kilimo, the herbarium in Zanzibar Town, University Dar Es Salaam, Dept. of Botany. The preliminary results are as follows:

Local name	Botanical Name	Characteristics
Kivumbasi	Ocimum kilimandscharicum	camphoreous odour, small herb
Mtulie	Ocimum suave	B-ocimene, eugenolic and caryophyllenic odours
Mrihani	Ocimum basilicum var. glabratum	needs irrigation, methylchavicol
as well		
Mipachori	no botanical identification available	blue oil

Other essential oil bearing crops of the Kilimo extension service in Pemba are Nutmeg, Pimento, Piper nigrum and Ginger.
Some scattered stands of Ylang-Ylang trees and Eucaliptus zanzibari had been located in the vincinity of the factory.
As a promotor of soil erosion any Eucaliptus sp. can hardly benefit the low input agriculture in the undulating topography of Pemba Island. The cultivation and harvest of Ylang-Ylang trees is even more sophisticated than clove production.
Competing with clove in the same location the crop will not provide any additional incentive to growers.
Due to unattractive pricing for the different cash crops, the farmers are reluctant to intensify cultivation of clove and other spices resulting in a very extensive way of farming.
The new crops to be introduced should be known to farmers and accepted by the Kilimo extension service.
The introouction of new exotic essential oil plant species is far beyond the scope of this particular project.
It is learnt from ZSTC, that the World Bank is already envolved in the preparation of a feasibility study for a large scale investment to promote crop diversification in the clove growing areas of Unguja and Pemba Islands.
Within the project the work on crop diversification has been started up with the following plant species:

Lemongrass
Vetiver
Cinnamon
Cardamom
Ocimum kilimandscharicum
Ocimum basilicum and
Ocimum suave.

The crop diversification programme with Kilimo can be supported in the course of the project for the following plant species:

Ginger
Nutmeg and Mace
Black pepper and
Pimento.

Kilimo started working on these crops with special emphasis on the Unguja Island, where the plant-disease problems with cloves and coconuts became serious during the recent years. As one reason for the encountered phytosanitary problems, the missing of a quarantine ward for imported plant material can be traced.

c Appropriate methodologies for farm management, irrigation and harvesting

Farm management

The farm management is under the direct supervision of the plant manager.
Since there is no agricultural expertise available within the distillery, a Kilimo agronomist had been attached recently and on a temporary basis only. The expert had been able to brief the agronomist during the last day of his stay on the ongoing farm activities. It is not decided, if the assigned agronomist will be incharge of Magome Experimental Farm on a permanent basis. Presently the agronomist is incharge of all agricultural extension service of Kilimo in the Chake Chake subsector of Pemba Island. The agronomist has not yet acquired any knowledge on the cultivation of essential oil bearing plants. Once the agronomist or another qualified worker is employed on a permanent basis he should be sent for training abroad.
At present two foreman supervise 20 fieldworkers employed on a daily pay basis. The working hours are supposed to be from 7.30 am to 2.30 pm for a daily pay of 55 TSH.
The amount of work per worker is based on calculations of Kilimo, which allow for example for weeding 200 qm per worker and day.
The quality of work corresponds to the length and intensity of work. Very regularely the workers finish the assigned day work between 12 am and 1 pm.
To assure good quality work, close supervision accombined by incentives in terms of remuneration, are required of the farm management. After all the amount of daily sallery is no incentive to rise the motivation to work in the Experimental Farm of the Chake Chake Clove Stem Distillery. Early termination of work is very important for the workers to attend to other side business.

Fertilizer trials and preparation of compost

The very low pH of the soils of Magome area result in severe difficiency symptomes in the four months old lemongrass crop. It was observed, that in locations of fireplaces where ashes of the clearing residues are mixed with the soil, the plants thrive well.
Accordingly fertilizer trials with locally processed lime and ashes from the distillery firing-unit had been designed by the expert and implemented of lemongrass each as follows:

Lime plot 1:
8 bags of lime resulting 800 kg per 0.25 acre
Lime plot 2:
4 bags of lime resulting 400 kg per 0.25 acre

Ashes plot 1:
10 bags of ashes resulting 500 kg per 0.25 acre
Ashes plot 2:
20 bags of ashes resulting 1000 kg per 0.25 acre

Followed by weeding the lime and ashes get mixed with the topsoil raising the pH level considerably.
In the course of the present weeding cycle of 11 acres lemongrass, 40 bags equivalent to 2 tonnes of ashes per acre are applied to the crop beforehand.
As a result of the application of ashes in the farm, every output of the distillery is used in an economical way since the expert has advised on the usage of spent lemongrass for the preparation of compost inside the farm itself.

Nursery management

Near the only watersource available in the farm nursery, beds had been raised in a semishady area protected by trees, using the humose topsoil of the location mixed with ashes from the nearby traditional charcoal processing unit. The nursery plots comprise the following plantmaterial:
- Vetiver collections from Konde, Wete and Jonza (Mtambile).
- Cinnamon seedling from Magome and from Mweni nursery.
- Mipachori plants from Muwambe and
- seedbeds of Kivumbasi, Mtulie and Mrihani.
Watering is advised between 5 pm and 6 pm daily.

Lemongrass cultivation

The initial planting distance had been reduced from 3x3 feet to 2x2 feet as advised by the expert.
The plant nutrient deficiency symptoms had been discussed with the farm management und the Kilimo extension service.
The pesticide treatment has been suspended and successively replaced by the application of two tonnes of ashes per acre in accordance with the experts advise.
Fertilizer trials applying different quantities of lime and ashes have been set up.

Vetiver plantation

On an area of 2.5 acres vetiver has been planted on ridges along the contour, similar to the traditional type ridges used for the cultivation of cassava.
The publication of the World Bank office, New Delhi, 1987, "Vetiver grass, A Method of Vegetative Soil and Moisture Conservation" had been handed over to the counterpart. The expert advised on its practical application checking water erosion in lemongrass plots.

Cardamom cropping

Since the cardamom harvest is expected to start soon, the expert advised on the collection of seeds from government experimental farms, raising seedlings at Magome nursery. Plantations of cardamom are scheduled for the begin of the forthcoming Vuli rainy season in December 1989.

The expert had been informed about the actual government pricing as follows:

Farmers price in the course of government procurement	*Approx. 200 TSH*
Sales price at local shops	*Approx. 800 TSH*
Black market sales in nearby Kenia	*Approx.2000 TSH.*

Irrigation

For rainfed upland cultivation of essential oil bearing crops no irrigation facility is available nor can be developed at present.

Harvest of crop

Advise on appropriate harvest methodologies and technologies will be included in the programme for the return mission during April-May 1990.

Farm infrastructure

The layout of the farm design, including an improved road network, had been discussed and outlined at the spot. The expert suggested the wideness of the road of approx. 4 m to facilitate smooth tractor and lorry service. The length of field shall be at maximum to reduce the time necessary for turning tractor to a minimum amout of time.

d Findings and results of the activities

- It is very difficult to manage 20 acres of different essential oil bearing crops without guidiance of an experienced agronomist counterpart employed on a permanent basis.
- The farm management has to respond to the very specific environmental conditions of Magome area by application of lime or ashes from the distillation unit.
- The management of the farm employees needs further strengthening in accordance with the special conditions and habits of fieldwork in Chake Chake.
- Trial cultivation for three essential oil bearing plants and a nursery are established; advise on the farm management has been given by the expert.
- A number of local essential oil bearing plant species are already under extension service for the crop diversification in Pemba Island. The expert has included some of these plants in the field and nursery cropping at Magome.

B UTILIZATION OF THE RESULTS OF THE ACTIVITIES

Factors, which might affect their effective utilization can be the following:
- Failure of crop management, especially the management of the weed control.
- Extended dry periods.
- Adverse soil conditions.
- Failure of smooth collaboration of Chake Chake Clove Stem Distillery, ZSTC and Kilimo.
- Change of priorities.
- Missing UNIDO and/or ZSTC inputs.

C CONCLUSIONS

The following conclusions have been presented to the Distillery management and the ZSTC Deputy General Manager during the final roundup meeting an Aug.25, 1989:
- The expert is not in a position to attent to outputs 1 and 2 of the job description.
- By using ashes of the distillery a considerable improvement of the conditions of cultivation at Magome can be achived.
- The work on already introduced plant species for crop diversification performed by Kilimo shall be encouraged through the UNIDO project activitites.
- The urgent need of revision of government pricing as a basis of ZSTC procurement of herbal raw material from cloves and other essential oil bearing plants.
- The performance of Magome experimental farm shall be closely monitored. The results achieved shall be considered as the experience for further extension of the farming area by 25 acres in Magome proper or in Changawe.

Annex 1:

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

11-52

JOB DESCRIPTION

Post title	Agronomist
Duration	3.m/m (1.5 + 1.5 split mission)
Date required	1989
Duty station	Chake Chake, Pemba
Purpose of project	Maximising the capacity of the Clove Distillery Chake Chake.
Duties	The activities for which the expert will be responsible for are as follows:

1. Evaluate practices currently in operation for clove and advise on improvement.
2. Initiation of methods selecting locations, collecting seed and planting material, for cropwise cultivation of other essential oil bearing crops.
3. Advise on appropriate methodologies for farm management, irrigation and harvesting.
4. Advise on storage of raw material and post harvest preparation.

At the conclusion of his field work, the expert will be expected to furnish UNIDO with a fully prepared report detailing his findings and recommendations.

..../..

Qualifications	An agronomist with a Bachelors or Masters degree in a subject related to plant propagation with intensive practical experience in the organization, management of essential oil crops and in allied research and development.
Language	English
Background information	Cloves (Eugenia caryophyllata) are the major crop in the Zanzibar Islands, which include Unguja and Pemba and are traditionally called the Clove Islands. There are two major facilities for the distillation of clove buds and clove stem under the control of the Zanzibar State Trading Company (ZSTC). One is an almost obsolete plant, nevertheless with a considerable production capacity situated at Malindi in Unguja Island. The other is a modern plant at Chake Chake in Pemba Island. In Pemba there is an established capacity but ensurement of maintenance is important. Atuned to the distillation capacity of the plant, the ensurement of timely collection and organized drying of raw materials is crucial. The Government expects UNIDO to provide support to enhance the economic, commercial and technological structure to modernise the industry in Zanzibar.

Annex 2:

List of persons met

UNDP	
Mr. F.Nebe	*Assistant to the Resident Representative*
UNIDO	
Mr. Jens Rasmusson	*Programmme Officer*
Dr. B.C. Gulati	*CTA*
Dr. M.L. Maheswari	*Qualitiy Control Chemist*
FAO	
Mr. M. Eisenbeis	*Programme Officer*
Mr. P.M.L. Hettige	*Land Evaluation Specialist*
Mr. J. Anim-Appiah	*Agricultural Economist*
Zanzibar State Trading Corporation	
Mr. Abdul-Rahman Rashid	*General Manager*
Mr. Hamad Khamis Hamad	*Deputy General Manager*
Mr. Badra Hasan Juma	*Administrative Officer*
Mr. Nasib S. Omar	*Plant Manager, Chake Chake*
Mr. Ramadan K. Feruz	*Production Manager, Chake Chake*
Mr. Shaib Ali Mossi	*Economic Adviser to GM*
Mr. Omar K. Abdalla	*Production Manager, Malindi*
Government of Zanzibar	
Mr. M.A. Ghassany	*Principal Agricultural Officer, Dept. of Agriculture*
Mr. Ismail S. Mgeni	*Agronomist, Project Leader, Clove Disease Research Project, Kizimbani*
Mrs. Zakia M. Abukabar	*Plant Pathologist, Clove Diseaese Research Project, Kizimbani*
Mr. Ahmed Muhammed S.	*Assistant incharge of Kizimbani Agricultural Experimental Station*
Mr. Rashid J. Hamad	*Project Leader, Forest Project Pemba, Konde*
Mr. Farid J. Shariff	*Officer incharge Agricultural Experimental Station, Matangatwani*
Mr. Khatibu Juma	*Officer incharge of Kilimo Wete*
Mr. Hashout Nassar Ali	*Plant Protection Division, Chake Chake*
Mr. Ludo Koenders	*Plant Protection Division, Chake Chake*
Mr. Mohammad O. Hamad	*Agricultural Extension Officer, Kilimo Chake Chake, Counterpart*

Annex 3:

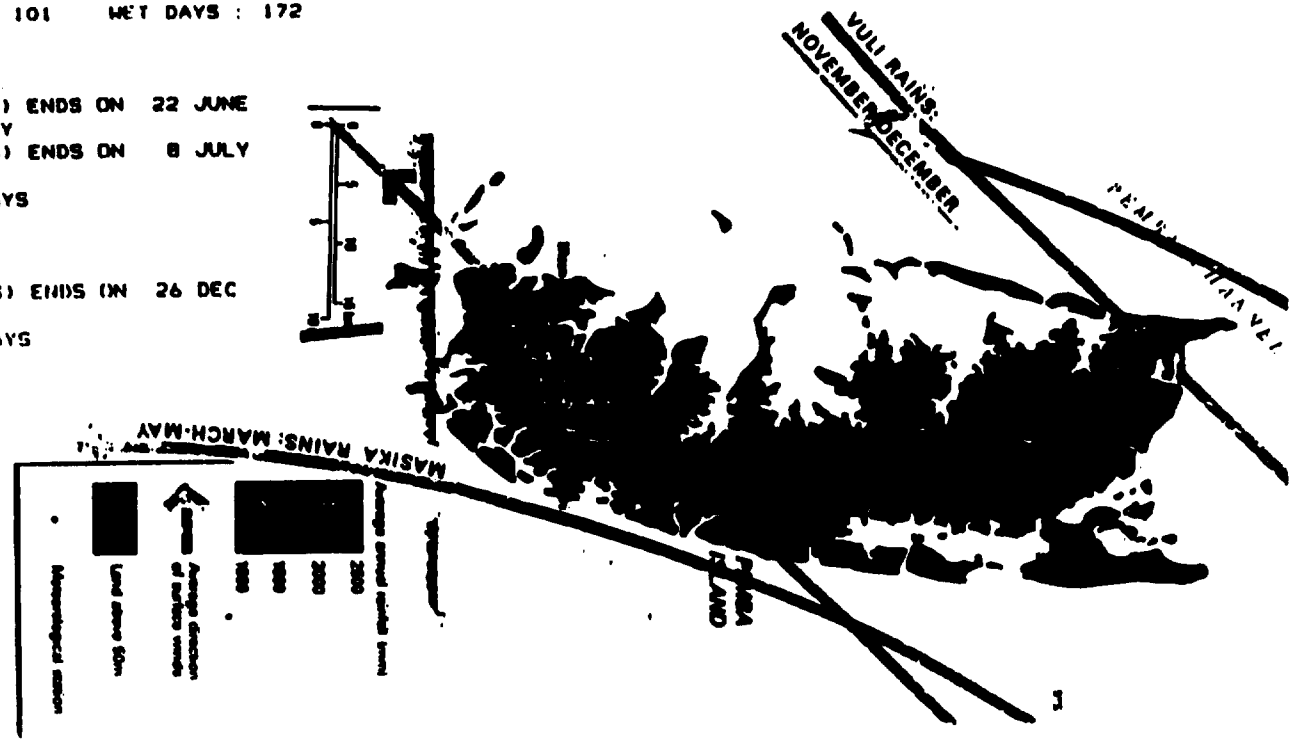
Travel Datas in Tanzania

04. Aug. 1989	*Arrival Dar Es Salaam* *Briefing at the office of JPO*
05. Aug. 1989	*Briefing by CTA, Dr. Gulati*
06. Aug. 1989	*Free*
07. Aug. 1989	*Travel to Pemba Island,* *ZSTC - Clove Stem Oil Distillery in Chake Chake*
08. Aug. 1989	*Visit to distillery and to Magome Experimental Farm*
09. Aug. 1989	*Meeting with the ZSTC - Management Pemba*
10. Aug. 1989	*Visit to Plant Protection Division Pemba, Chake Chake;* *Visit to Wesha Nursery*
11. Aug. 1989	*Travel to Matangatwani, Konde, Wete and Mweni;* *Travel to Chamanagwe*
12. Aug. 1989	*Travel to Muwambe and Mjikunju*
13. Aug. 1989	*Travel to Kiuyu and Makangale*
14. Aug. 1989	*Travel to Unguju Island*
15. Aug. 1989	*Visit to Kizimbani Experimental Station*
16. Aug. 1989	*Meeting with the General Manager in ZSTC - Headquarter in Zanzibar Town* *Visit to the Clove Oil Distillery, Malindi*
17. Aug. 1989	*Visit to Dept. of Agriculture and Zanzibar Herbarium, National Museum*
18. Aug. 1989	*Zanzibar Airport*
19. Aug. 1989	*Visit to FAO-Projects*
20. Aug. 1989	*Free*
21. Aug. 1989	*Travel to Pemba*
22. Aug. 1989	*:Chake Chake*
23. Aug. 1989	*:Clove Stem Oil*
24. Aug. 1989	*:Distillery*
25. Aug. 1989	*Travel To Dar Es Salaam*
26. Aug. 1989	*:Work*
27. Aug. 1989	*:on the report*
28. Aug. 1989	*Debriefing UNIDO/UNDP*
29. Aug. 1989	*Return travel*

COUNTRY : TANZANIA • STATION : PEMBA-MET I • NUMBER : 63845
• LATITUDE -5 15 • LONGITUDE 39 49 • ELEVATION 20 MET

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
PRECIPITATION	65	47	157	433	456	136	77	47	34	100	223	131	1926
TEMP AVERAGE	26.9	27.1	27.5	26.5	25.5	24.7	23.9	23.8	24.3	25.1	26.0	26.7	25.7
TEMP MEAN MAX	30.9	31.6	31.9	30.3	29.1	28.7	27.9	28.2	29.0	29.8	30.3	30.9	29.9
TEMP MEAN MIN	22.9	22.7	23.0	22.7	21.9	20.7	19.8	19.4	19.7	20.4	21.7	22.6	21.5
TEMP MEAN DAY	28.3	28.7	29.0	27.9	26.8	26.1	25.3	25.4	26.0	26.8	27.6	28.2	27.2
TEMP MN NIGHT	25.4	25.5	25.8	25.1	24.2	23.2	22.4	22.2	22.7	23.4	24.5	25.3	24.1
VAPOUR PRESS	28.8	28.8	30.0	30.2	28.6	26.1	24.9	24.3	24.9	26.8	29.1	29.7	27.7
WIND SPEED 2M	1.7	1.4	1.0	1.0	1.1	1.6	1.2	1.3	1.4	1.5	1.3	1.2	1.3
SUNSHINE %	45	35	30	40	35	35	33	35	40	45	40	40	41
TOT RADIATION	436	410	454	391	344	327	326	337	402	436	416	412	390
EVAPOTRANSP	131	126	132	107	95	90	89	99	108	121	114	120	1332

TYPE OF GROWING SEASON NORMAL GROWING SEASON (WITH DRY PERIOD)
DRY DAYS 92 INTERM DAYS 101 WET DAYS : 172
SEASON NR 1
SEASON BEGINS ON 24 FEB
BEGIN HUMID ON 13 MAR
HUMID PERIOD (102 DAYS) ENDS ON 22 JUNE
BEGIN HUMID ON 1 JULY
HUMID PERIOD (8 DAYS) ENDS ON 8 JULY
END OF SEASON ON 12 AUG
TOTAL LENGTH OF SEASON IS 170 DAYS
SEASON NR 2
SEASON BEGINS ON 2 OCT
BEGIN HUMID ON 23 OCT
HUMID PERIOD (65 DAYS) ENDS ON 26 DEC
END OF SEASON ON 14 JAN
TOTAL LENGTH OF SEASON IS 105 DAYS



Annex 5:

Soils of Magome and Changawe

Two types of soil are dominant in the Experimental Farm at Magome:
In the north-western higher part the utasi soil typ can be traced as part of the central line of the plateau reminants. It is a deep grey to brownish grey firm sandy soil which cementing material is possibly silica. The pH is ranging between 4.5 and 5. The intervening bopwe patches have been formed by cutting back of the utasi plateau. According to the FAO-UNESCO soil classification (1971-1981) this soil typ represents a "Xanthic Ferralsol" characterized by a yellow colouring of the subsoil. The main characteristics - level, largely undifferentiated sand nature - are due to the soil development from a old marine platform. This soil type has got a favourable soil moisture regime, but are likely to vary in nutrient levels due to marine sorting.
In the south eastern lower part of the farm and in the Changwe-area the semi-utasi soils occur as a strip to the east of the utasi plateau reminants. This soil type is prevailing in the undulating areas of the planned farm extension by 25 acres. The semi-utasi soil closely resembles the utasi at the surface, but it has some grey and brownish red cutting in the subsoil. The chemical reaction is similar to utasi soils. The exchange capacity is little higher. The clay fraction which is uniform in composition is largely kaolilite, but with a small amount of montmorillonite. This type is more dissected than the utasi, because it is less water absorptive. It is not clear, wether it is a more silicous variant of the utasi due to check of leaching solutions by underlying imporious material or wether it is derived from orginally more clayey sediments. According to the FAO-UNESCO soil classification this soil type represents a "Rhodic Ferralsol" characterized by a redish colouring of the subsoil.
In regard to soil utilization some of the main soil types are clearly differentiated by the crops. Responses to nitrogen have been observed when nitrogen is applied lavishly to annual crops. Growing on soils of low moisture retaining capacity the rigorous vegetative growth caused by the fertilizers can not be supported by the needed availability of the soilwater resources.

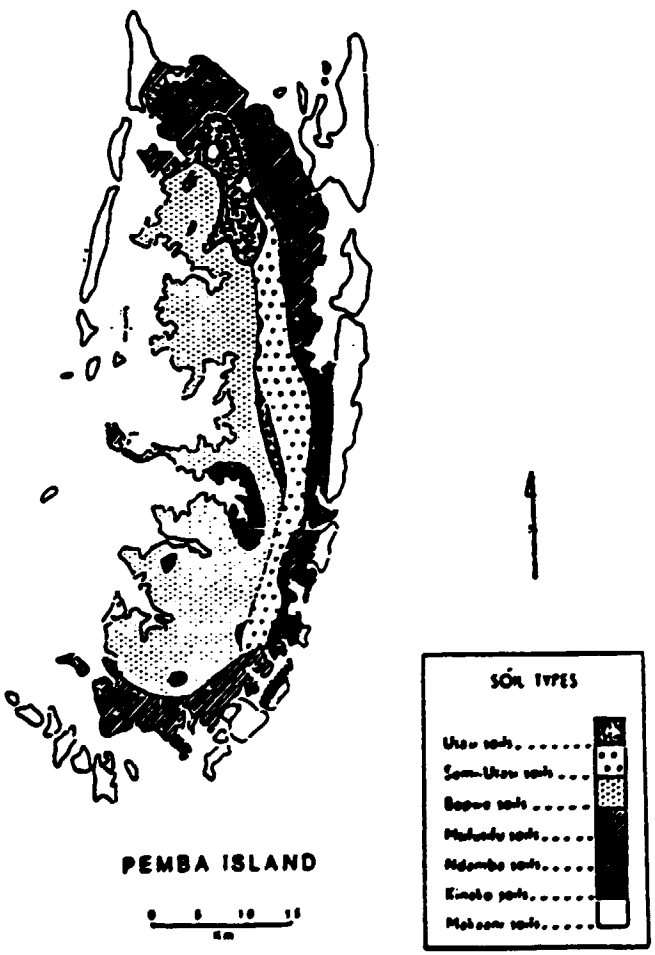
The availability of nutrients is characterized as follows:
- Due to heavy rainfall and leaching out of nutrients the deficiency of K, Ca, Mg and S is a common feature.
- The low content of organic matter results in a continous deficiency of N accombined by a N-fixation at the actual pH-regime.
- The accumulation of Al, Fe and Mn can reach the toxic levels of each of the elements for the plant growth.
- A extrem low catione exchange capacity is common under the low pH conditions.

The application of lime and/or ashes results in the following:
- Reduction of the toxic levels of Al and Mn.
- P-mobility will improve due to decreased fixation at Fe- and Al-iones.
However, to stabilize the improved conditions for plant growth additional organic fertilizer application may deem necessary.

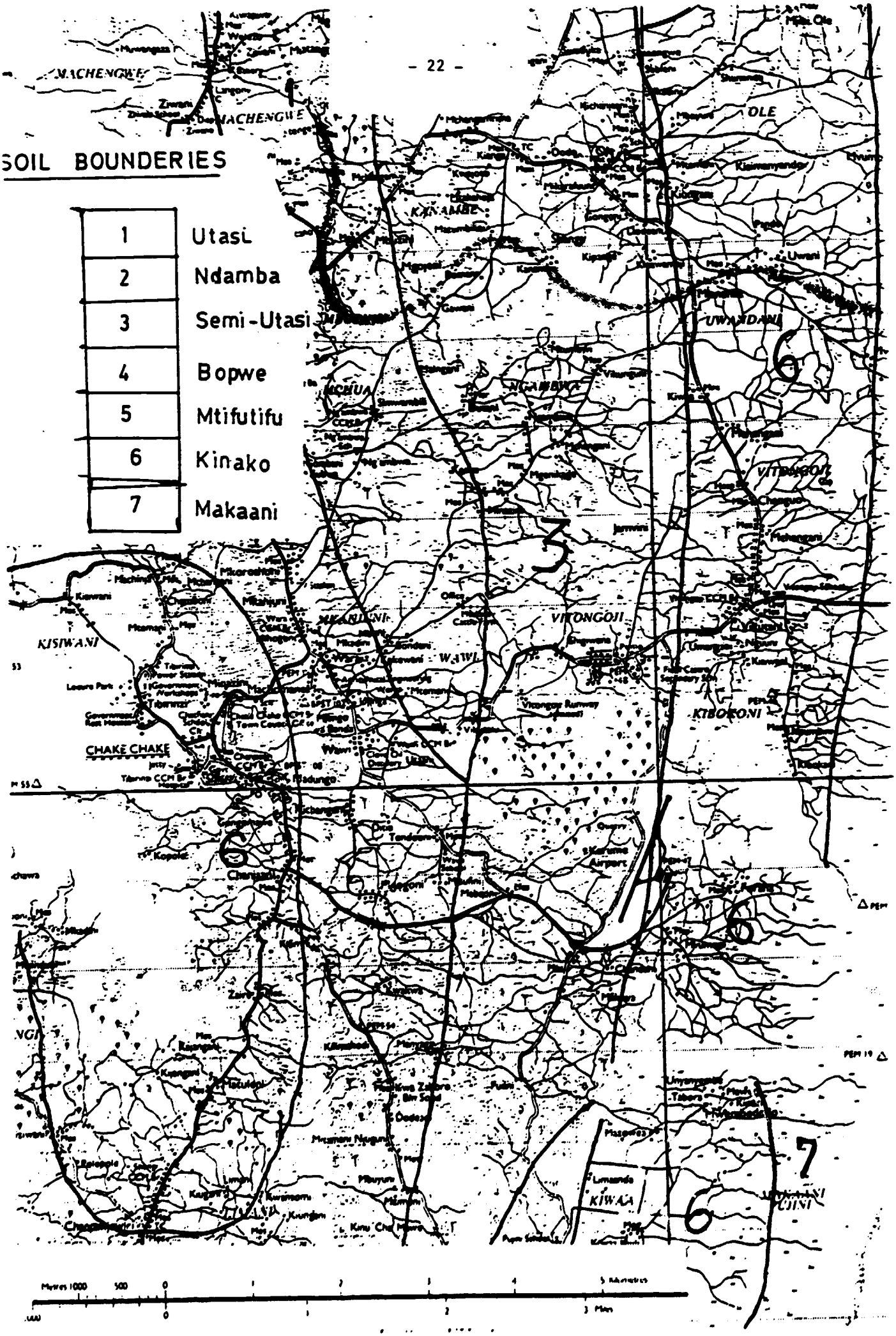
Annex 6:

Pemba soil maps

: Soil types in Pemba



Source: FAO/IFAD, 1987


SOIL BOUNDERIES
1 Utasi
2 Ndamba
3 Semi-Utasi
4 Bopwe
5 Mtifutifu
6 Kinako
7 Makaani
MACHENGWE
KISIWANI
CHAKE CHAKE
KINAMBE
WAWI
VITONGOJI
KIBOKONI
UWANDANI
NGAMBIKA
OLE
KIWAJA
6
3
7

Annex 7:

Farm map