AOAD - UNDP

OILSEED CROPS DEVELOPMENT PROJECT
RAB/ 89/024/A/01/99
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TERMITE PROBLEMS IN TIHAMA WITH PARTICULAR REFERENCE TO OILSEED CROPS AND RECOMMENDATIONS FOR CONTROL STRATEGIES

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By

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Acknowledgement

The consultant would like to express his gratitude and thanks to Dr. Mohammed Ali Hubaishan, National Coordinator, Development of Oilseed Crops Project, for his efficient organization of the itinerary, his help and assistance in different ways to make this mission a success. Special thanks are extended to Mr. Wadie Sief Ahmed who accompanied me to most visits and put the facilities of the Plant Protection Laboratory of TDA at our disposal .

I would like to thank all TDA staff who have accompanied me on field visits and participated in sampling. My thanks are extended to Dr. Abdelmomin, Hazaa Director General TDA and to Dr. Abdo Fare'a Project Manager Wadi Mawr who gave freely of their time for discussions and exchange of ideas.

Special thanks are extended to Dr. Yahia Bakour - Director General AOAD, Dr. Abdel Wahid Othman Mukred, Director General AREA, Prof. Bader Ahmed Saleem, Regional Coordinator of Oilseed Crops Project, and Mr. Ismaeel Al Mutawakil, Director of AOAD Sanaa, who gave me this opportunity to carry out such an interesting consultancy.

Acronyms and Abbreviations

AOAD	**Arab Organization for Agricultural Development**
AREA	**Agricultural Research and Extension Authority**
DG	**Director General**
DOSCP	**Development of Oilseed Crops Project**
EEC	**European Economic Community**
FAO	**Food and Agriculture Organization of the United Nations**
FRG	**Federal Republic of Germany**
GCC	**General Cotton Company**
GTZ	**Gesellschaft fur Technische Zusammenarobeit (German Agency for Technical Cooperation)**
ICRISAT	**International Crops Research Institute for the Semi Arid Tropics**
IDAS	**Innovation Development in the Agriculture Sector**
IPM	**Insect Pest Management**
MAWR	**Ministry of Agriculture and Water Resources**
NRI	**Natural Resources Institute**
ODA	**Overseas Development Administration**
STD	**Sciences and Technologies for Developing**
TDA	**Tihama Development Authority**
UK	**United Kingdom**
UNDP	**United Nations Development Programme**
UNIV	**University**
USA	**United States of America**

EXECUTIVE SUMMARY

1- Field visits were made to survey termite damage to crops and buildings in Tihama.

2- Almost all damage to field and tree crops in Tihama is caused by one species, *Microtermes najdensis*, while a small preparation of damage and specially to fruit trees is caused by Microcerotermes diversus.

3- Termites caused significant losses to cotton, maize , pepper groundnuts and sunflower. Other crops like tomato, onions, okra and fruit trees less infested, while millet and sorghum were almost not attacked

4- Aldrin ad dieldrin insecticides are widely used for the control of termites in Tihama. The consultant, recommends stopping using these insecticides as they have been burnt in most areas of the world due to their residual toxicity and hazards to man and his biosphere. Alternative insecticides like chlorpyriphos, pyrethroids and plant extracts e.g. neem could be tried.

5- In this report, historical background of termites in Yemen with particular reference to Tihama, past and current termite research activities in Tihama and recent aspects of termite research in the world., have been reviewed.

6- A proposal for a 5 year research program on termites in Tihama has been discussed. The program included :-

- Culturing of *M. najdensis*
- Evaluation of insecticides
- Studies on the biology and ecology of M. najdensis
- Cultural methods
- Plant resistance studies

7- It is strongly recommended to clean all crop residues, collect all trash and leftovers in fields and burn them in order not to be used as a source of further infestation of termites to crops in the area.

8- Damage to buildings is caused largely by Psammotermes hybostoma and Heterotermes aethiopicus and to some extent by M. najdensis.

9- Several modern buildings (e.g. Health Institute) in Hodeida were severely damaged by termites. Therefore, the consultant feels that it is time that the Government should think of endorsing by laws or regulations for pre-construction or pre-foundation treatment of all buildings in the future. This business should be carried by experts in termite control or even reputable pest control companies.

10- Academic and technical training plan was suggested and farmers involvement in training and discussions is recommended.

INTRODUCTION

As a result of a previous visit by Prof. Dr. SAEED Ba Angood to Tihama to assess termite damage in the area, several contacts and discussions were made by the Director General Agricultural Research and Extension Authority (AREA) Dr. Abdel Wahid O. Mukred and the National Coordinator Oil Seed Crops Project, Dr. Mohammed A. Hubaishan asking Prof. Ba-Angood for his availability for another visit to Tihama to assess termite damage to crops with particular reference to oilseed crops, to give recommendations and propose a research program for the control of termites in the area.

Prof. Ba - Angood agreed to carry out this mission provided that it would be devided into two periods two weeks in November (10-25 November 1993) and one week at the end of December 1993, as he can not be away from the University for the whole three weeks specially at that time of the academic year.

Subsequently the Arab Organization for Agricultural Development (AOAD) agreed to offer Prof. Ba-Angood a consultancy for 3 weeks with the following terms of reference , as requested by AREA and Development of oilseed crop project RAB/89/024/A/01/99:

1- To survey damage cause by termites with particular reference to oilseed crops in Tihama.

2- To review and evaluate past and current research activities on termite control in Tihama .

3- To overview the recent aspects of scientific research and foreign experience on termite control.

4- To propose a research program and recommend different means for the control of termites in Tihama .

5- To propose a training program for training the local staff on termite control in Tihama .

During his stay in Tihama, the consultant on his survey visits, made observations on termite damage to crops and buildings, with particular reference to oilseed crops, collected termite samples and identified them in the laboratory. He discussed general aspects of termite management with farmers, extension and plant protection officers, senior staff and the Director General of Tihama Development Authority (TDA). He discussed his final report with Dr. Abdel Wahid Mukred Director General of AREA and Dr. Mohammed Ali Hubaishanm the National Coordinator of Oil Seed Crops Project.

The consultant reports below the results of his findings, discussions and recommendations for better Insect Pest Management (IMP) of termites attacking crops in the Tihama Coastal Region in Yemen.

ITINERARY

Part I :

10 Nov. 93: Aden - Sana'a

11 Nov.

a.m. : Short discussions with Dr. M.Y Alghishim Director General, Depart, Plant Protection (MAWR) Mr. F. Bahakim, Dept. Plant Protection, Dr. Hasse, Yemeni - German Plant Protection Project (MAWR)

p.m. Sana'a- Hodeidah

12 Nov.
(Friday)

a.m. : Short discussion with Mr. Wadie Seif Ahmed, Senior Plant Protection Officer TDA, Planning the Itinerary.

13 Nov.

a.m. : Field visits Wadi Siham

noon : Short discussions with Director General, TDA, Dr. Abdelmomin haza'a , Mr. Ja'afer Aljifri, Director Agricultural Affairs TDA.

p.m. : Laboratory work

14 Nov.

a.m. : Field visits wadi Rihma'a and Wadi Zabeid

p.m. : Lab. work

15 Nov.

a.m. : Visit Surdud Regional Agricultural Research Station Trials (Alkadan)

p.m. : Field visits, Wadi Surdud, Surdud, local farmers.

16 Nov.

a.m. : Field visits Wadi Mawr

p.m. : Short discussion with Dr. T. Wood (NRI - UK) Dr. C. Martius, Dr. NM. Hubiahsan and Mr. W. Seif
Lab. work

17 Nov.

a.m. : Field visit - Wadi Siham
Gumaisha , Abyat Assofla, Dir Zawya, Alkarneish

noon : Meeting Dr. Abdulmomin Haza'a, D.G. TDA, Dr. T. Wood, Dr. C. Martius, Dr. M. Hubaishan, Dr. Babikir Hassan, Mr. Wadie Seif, Mr. Aljifri (Discussion)

p.m. : Lab. work - checking termite samples.

18 Nov.

a.m. : Visit General Cotton Company (GCC) Hodeidah - Various wood stores Health Institute Azzohra - Hodeidah

19 Nov.

(Friday): Holiday

20 Nov.

a.m. : TDA Plant protection Laboratory-
Discussing STD3 proposal

p.m. : Lab. work, checking termite sample

21 Nov.

a.m. : Visit Surdud Regional Agricultural Research Station - Visit trials and attending seminars on biology and ecology of termites by Dr. T. Wood (U.K.) and Dr. C. Martius (Brazil).

p.m. : Discussing STD3 proposal for termite control in Tihama (Dr. Karnab) D.G. IDAS Project, Dr. Wood, Dr. Martius, Dr. Hubaishan, Mr. W. Seif, Mr. AbdelNour Ahmed Mohammed, Deputy Director, Surdud Regional Agricultural Research Station.

22 Nov.

a.m. : Preparing the draft for STD3 Project proposal on IPM of termites in Tihama

p.m. : Checking termite samples in the lab.

23 Nov.

a.m. Lab. Work, checking termite samples and identification

p.m. : Hodeidah - Dhamar - Sana'a.

24 Nov.

a.m. : Visit AREA office in Sana'a meeting Deputy Director Dr. A, Da'amim Visit GTZ office Sana'a visit of Agriculture . University of Sana'a - Meeting Deputy Dean Dr. Amin Alhimyari (Entomologist) and staff of the Department of Plant Protection.

25 Nov.

a.m. : Visit AOAD office in Sana'a meeting Dr. Al Mutawakil Director AOAD office in Sana'a

p.m. : Departure Sana'a' to Aden

PART II

26 Dec. : Aden - Hodeidah

27 Dec. :

a.m. : Field visits Wadi Rihma'a and Wadi Zabeid Demonstration plots (Development of Oilseed Crops Project)

p.m. : Lab. Work

28 Dec.

a.m. : Field visits - Wadi Siham, Demonstration (Oilseed Crops Project)

p.m.. : lab work

29 Dec.. :

a.m. : Field visits - Wadi Mawr, Field sampling, Demonstration Trials (Development of Oilseed Crops Project)

p.m. : Visit Wadi Surdud Demonstration trials (Oilseed Crops Project) Meeting D.G. AREA. Dr. Abdel Wahid Mukred in the way to Surdud.

30 Dec. 1993 : Hodeidah - Aden.

Field Visits To Survey Termite Damage To Crops And Buildings In Tihama

To fulfill the first item of terms of reference the consultant made field visits to different sites in TIHAMA as mentioned in his itinerary.

Wadi Siham :

The following farmers and places were visited on 13th November 1993 : Kambahelah Extension Center Abulla Ali Huraish, Al Abyat Assuflam Alfuanini Salim Farm, Abdulla Assalla (First President of Yemen Arab Organization for Agricultural Development Republic) farm, Saber Farm.

The consultant was accompanied in these visits with Dr. M. A. Hubaishan, National 'Coordinator Development of Oilseed Crops Project. Dr. Marts (Brazil) Wade Sieve Ahmed, Senior Plant Protection Officer TDA, Rashid Ali Bin Ali and Ahmed Ali, extension officers.

Observations :

All cotton seeds were treated with Aldrin 40 by the General Cotton Company (GCC) prior to sowing . Cotton was given 8-10 irrigation in order to reduce termite infestation as farmers believe that, but still termite infestation ranged from 10-20 % in cotton fields sown in August, September and October.

Secondary infestation with termites was also observed on outerparts of the cotton stems and branches. It is worth to mention that most plant debris and leftovers in these areas which were found on the soil were heavily infested with termites.

Farmers and extensionists mentioned that their tomato and pepper nurseries till 1985/86 were not attacked by termites, but since then tomato, pepper and okra have been increasingly infested by termites. Infestation by termites on tomato and okra ranged from 20-25% while for pepper it ranged from 30-35% in the visited farms in the area.

It has been observed that local wild variety of cotton grown as perennial crop in the area was scarcely infested and if there was any infestation noticed, it was just a secondary infection outside the stems or branches that were hanging on the ground. Moreover, it is worth to mention that millet and sorghum crops were not found to be attacked by termites except for leftovers or dry ratoons. These are old crops in the area. This might conclude that exotic crops are more susceptible to termite than the indigenous crops or varieties of the same crop .

Sesame was grown very well, infestation with termites was not exceeding 1%.

Fruit trees were inspected. Most of the damage was superficial and usually the outer dead legnified tissue was consumed and has not significant effect on trees. However, there were very few trees of papayas, citrus and date palm that were weakened to some reasons and factors e.g. virus, wind drought ; and termites might get access to wounds or through broken branches and caused significant damage that enhanced the complete death of the tree. However, there were some cases of papaya seedlings that were transplanted to the field and suffered from a real attack of termites.

It has often been observed that black ants were good predators for termites in fruit trees (date palm, citrus, mango) and specially when termite galleries were open or being exposed to them.

On 17th November 1993, the following places and farms in Wadi Siham were visited : Gumaisha State Farm, Al Abyat assofla, Abdulla Hassan Shakhrour's farm, Abdulla Ali Hudaish's farm, Dir Zawya, Hassan Abkar Farm, Mohammed Albaghawi's farm, Kambaheiah village, Salh Darweish Zabila's farm, Alkarneish village, Alkushei Yahya Musawa, Kilo sitta'shar (16), Ahmed Nagi Sabh farm store.

The consultant was accompanied in his visits to the above places by Dr. M. A. Hubaishan, Dr. T. Wood (NRI-UK) Dr. C. Maritimes, Mr. Wadi Seif, ad other extensionists.

At Shakhrour's farm, sunflower was doing well and after one month of sowing termite damage was not exceeding 2%. Sesame was, so far, almost free of termite attack.

At Albaghawi's farm, groundnut (Kiriz) which was sown at the end of September was not so far heavily infested. The percentage of damaged plants by termites was not exceeding 5%. The crop had received 5 irrigation's which as farmers believe reduced the attack of termites.

At Darweish's farm, though cotton was treated with Aldrin, we noticed that three were some damaged plants due to termites. Counts of damage plants due to termites was 16.3% (Table 1).

Table (1) Percentage of damaged plants of cotton due to the attack of termites at Darweish's farm

No of plants taken at random	No of plants damaged by termites
100	6
100	17
100	26
Total 300	49
Mean percentage of damaged plants 16.3%	

The farmer was complaining of salinity in water and thought that it might increase termite attack..

Onion was grown in the area and percentage of damaged plants was not exceeding 1%.

At Al Kurneish village cotton was sown at the beginning of October in Al Kusheia' Musawa's field and was doing well due to the good cultural practices and percentage of damaged plants due to termites was not exceeding 2%.

A wooden house was visited at Kurneish village and the owner was complaining of termite attack.

As he said, he needs to renew its parts each 10 months. The house was covered by mud from the inner side; The ceiling and doors were of Wood . Some of tree logs and wood parts were attacked by termites.

At kilo sittashar (16) we visited some animal farm stores. The owner was complaining of termite attack. Termite galleries were clearly seen on the wooden ceiling and earthen galleries were spreading on the walls. Some of the wooden logs have to be replaced.

We concluded that termites in Wadi Siham were available everywhere, in crops, buildings and all leftovers were usually found attacked by termites.

Fifteen (15) samples of termites and predatory ants were collected from different sites and crops and were taken to the laboratory for identification.

On the 28th December 1993, the following places and farms in Wadi Siham were revisited to evaluate the progress of termite attack in the area with particular reference to oilseed crops.

Al Bayat assofla, Abdulla Hassan Farm, Ahmed al Baghwei Farm, Dir Zawya and Othman Ibrahim Sodam farm. The consultant was accompanied by Dr. M. A. Hubaishan and Dr. Mtahar El Kibsi, agronomist at Surdud Regional Research Station, Alkadan.

Sunflower Black seeds , a hybrid introduced by the Development of Oilseeds Crops Project was sown on 22/9/1993 at Abdulla Hassan Shakrour farm at Al Abyat assofla is doing well except that some plants were lodged probably due to the presence of 3 plants in one hole and this might explain why heads are small. Plants damaged due to termite ranged from 2-3%. In the same field another plot was sown at the beginning of October. We made random counts of plants and recorded the damaged plants due to termites in the field as shown in Table (2). We found that the mean percentage of damaged plants was 21.74%.

Table (2) Percentage of damaged plants of sunflower due to the attack of termites at Abdulla Hassan Shakhrour's farm. (Al Abyat Assofla)

No. of plants taken at random	No. of plants damaged by termites
50	2
50	5
50	6
50	12
50	4
72	41
Total 322 Mean percentage of damaged plants 21.74%	70

In Othman Ibrahim Sodam farm at Dir Zawya a local white seed variety of sunflower was sown on 21/9/1993. We made comparable counts of damaged plants due to termites as shown in Table (3) and the mean percentage of damaged plants was 17.52%.

Table (3) Percentage of damaged plants of sunflower due to the attack of termites at Othman Sodam's farm, Dir Zawya.

No of plants taken at random	No of plants damaged by termites
30	11
40	25
54	3
50	3
50	3
50 Total 274	3 48
Mean percentage of damaged plants 17.52%.	

It is important to mention that infestation with termites in sunflower usually started at head formation.

Groundnut at Ahmed Albaghwi field was sown on 21/9/1993. Percentage of plants attacked by termites was not exceeding 7%. However, the plants were scattered in patches in some areas and the crop in his field needs better agricultural practices or services.

Wadi Rima'a and Wadi Zabeid:

The following farmers and places were visited on 14th November, 1993. Al Husseinyah nursery and farm, Wadi Rima'a shoaib al fasha farm, Almahat, Algarahzah village, Ahmed Garhazi farm, Awad Gasour farm, Alrawdah camp (TDA), wadi Zabid, Al Girbah research station farm. Zabid village, Ahmed Salim Balkam farm, Altuhaitah, Yahya Mussayab farm.

The consultant was accompanied in this visit by Dr. M.A. Hubaishan, Mr. Wadie Seif, Mr. Mukhtar Al Dubaey, Yusuf Algarmouzi extension officers and Ibrahim Saad, plant protection officer (Southern area).

Observations

Sesame local variety was doing well and scarcely infested. Cotton in extension plots was apparently in good condition. Damaged plants due to termites were not exceeding 2%.

At Al Husseinyah nursery, small seedlings of Henna, conocarpus sp. (damas) and Hibiscus sp. were severely infested with termites.

At Almahat (wadi Rima'a) citrus trees at Shoaib Alfash farm were clearly infested with citrus canker, not pruned, a lot of branches were hanging on the ground and externally infested with termites. Almost all leftovers of crop residues in the soil were infested with termites.

Guava at Al Husseinyah farm was suffering from mealy bug attack. Banana was healthy, it usually received irrigation every five days elapse.

In Garahza village two farmers were visited where they grow pepper and tomato. In their fields, seedlings of pepper were dipped in dieldrin before transplanted to the field. The treated transplanted seedlings were eventhough infested with termites and percentage of attacked seedlings was almost 10%. Farmers believed that without dipping plant seedlings in dieldrin, infestation may reach 70%. This practice was also adopted by Yahia Almussayab farm at Al Tuhaitah.

In Zabied village, local variety of sesame was growig well and external infestation of termites in lodged plants might not exceed 1%. Cotton sown in September at Awa Gasour's farm was heavily infested with termites though the seeds were treated with alderin and was given 3 irrigations. The mean percentage of damaged plants was 40%. However , it worth to mention that 40% infestation does not mean 40% loss in yield. The relationship between damage and yield also is not clear and needs further investigation in the area.

It was observed that at Ahmed Salim Balkam's farm (Zabeid) cotton was apparently infested by termites through the wilted plants easily seen. Five people participated in counting a total of 500 plants to get the mean percentage of damaged plants due to termites which as shown in table (4) reached 43.2%.

Table (4) Percentage of damaged plants of cotton due to the attack of termites at Ahmed Bulkam's farm (Zabeid).

No. of Plants taken at random	No. of Plants damaged by termites
100	36
100	50
100	60
100	30
100	40
Total 500 Mean percentage of damage plants 43.2%	**216**

The farmer stopped growing pepper because of the heavy attack of termites he usually got during the past two years.

Fruit trees were also inspected in areas visited in Wadi Rima'a and Wadi Zabeid . Guava, date palm, mango, papaya were almost externally infested.

If the consultant insists in doing something in the area, it is CLEANING. Cleaning is very important method of control . If the farmers scratched the galleries on trees, exposed them to predatory ants available and cleaned all leftover and plant debris and burned them, they would have definitely reduced the population and damage of termites in the area.

We also visited TDA Rawdah camp stores at Zabeid. The buildings were nicely decorated with branched galleries of termites that were diffusely branching and covering wide areas of the ceiling and walls. Here we come to the importance of cleaning. A lot of stuff in the store have been damaged by termites.

Ten (10) samples of termites and predatory ants were collected and taken to the lab. for identification.

Another visit to Zabeid was made on 27th December 93, to follow up the progress of damage by termites and particularly to oilseed crops namely sesame, sunflower groundnut and cotton.

The following areas and farmers were visited; Sagheir Mohammed Sheikh farm, Ahmed Salim Bulkam farm, Abdan farm and Al Abdal farm.

The consultant was accompanied in these visits by Dr. M.A. Hubaishan, and Mr. Nagib Mohammed Ali, Head Extension Department, at Zabid Project.

Observations:

Sesame was almost free of termite attack except of lodged plants where external infestation was there.

At Sagheir Mohammed Sheikh's farm, sunflower was sown on 15 November 1993. It received 5 irrigations.

So far, damage with termites was not exceeding 1%. Jassids and whiteflies were abundant. Some of the plants were dead due to wilting but not due to termites. Sunflower at Tahr Al Ahdal farm sown on 23/10/1993. The percentage of attacked plants due to termites was not exceeding 2%. However, termites usually attack the crop at harvest time as farmers said. The progress of termite damage to cotton was almost stopped at Ahmed Salim Bulkam's farm.

Table (4) as most bolls were almost open and picking of cotton started. However, there were some plants showing external galleries of termites on their stems and branches and galleries were clearly observed on leftovers on the ground.

At Taher Al Ahdal farm groundnut (kiriz) which was sown on 23/10/1993 was doing well and percentage of infested plants due to termites was not exceeding 5%. While at Abdan farm (Zabeid), groundnut (Barberton) which was sown on 15/11/1993 showed yellowing symptoms, leaves were curled, and no branching was given. This was not due to termite damage as some believed, and the percentage of not due to termite damage as some believed, and the percentage of termite damaged plants was not exceeding 2%. There was also some absence of plants in his filed and in my opinion this was not due to termite damage. However, the farmer complained of having seeds of kiriz and Barberton varieties given to him and sown before 1/11/1993 which were not doing well and showed very poor germination. The crop was grown in light soils and might need fertilization.

It has been observed that barberton groundnut was more tolerant to termite infestation than kiriz variety. Wiliest the later got big seeds and relatively higher yield.

WADI SURDOUD
SURDOUD REGIONAL AGRICULTURAL RESEARCH STATION

The consultant visited the research station three times. The first was on 15 November 1993 accompanied by Dr. M.A. Hubaishan and Mr. Abdelnour Ahmed Mohammed Saher Acting Director of the Station and Dr. C. Martius.

Several experimental trials were visited. Some of oil crops experiments were just started, others were harvested. Groundnut varieties were doing well. Experiments on sunflower varieties were just sown. We decided to revisit the station at the end of December to see how oil seed crops are doing.

In our way to Hodeidah we visited several farmers at wadi Surdoud. At Gailan Abid and Ibrahim Mohammed Abdulla farms cotton sown on the middle of September was doing well and although it received only two irrigations termite damage was not exceeding 2%. Very slight infestation was observed on mango trees. Local variety of tomato was not treated with Aldrin and damaged plants due to termites were not exceeding 2%.

The second visit to the station was on 21 November 1993. The consultant was accompanied by Dr. M. Hubashan, Dr. Martius, Dr. Wood, Mr. Wadie Seif, Mr. Abdulnur Ahmed, Mr. Motahir Alkibisi and Head Sections of the research station.

We visited the stations trials and attended a seminar on recent aspects of termite control presented by Dr. T. Wood (NRI-UK) and termite ecological studies in Amazonia (Brazil) presented by Dr. C. Martius. Discussions were made later on , in different aspects of biology, ecology and control of termites.

The third visit to the station was on 29th December 1993. The consultant was accompanied by Dr. M. Hubaishan, Mr. Matahar Alkibse.

Groundnut varieties were doing well but it sounds like barberton was less attacked with termites compared with kiriz.

As quoted by the Acting Director Mr. Abdelnour Ahmed, the results of the last season experiment testing chemical insecticides for the control of termites on pepper had shown that Basudin 60 with irrigation water gave good control of termites on pepper. The pesticides in this trial will be tried again this season for the control of termites on cotton.

Termite infestation on soybean experiment was about 2%. Cowpeas varieties were slightly infested and we have been told that sunflower varieties had been heavily infested at head formation.

Intercropping experiment (cotton/groundnut) was doing well and we have been informed that both crops have been seed treated with Aldrin 40 before planting.

Wadi Mawr (Northern Region)

The following farmers and places were visited:
Al Marawgha area, Sheikh Abdel Monim Saghir Shami garden and farms, Almasani village, Hadi A'el farm; Al Rafaei village Extension center at Al Rafaei, Shami Mohammed farm; Allujam village Yahya Kuzabah farm; AlGurza village, mahal Hashid, Mohammed Hadi Jaij farm; Extension center at Alzuhrah.

The consultant was accompanied by Dr. M. Hubaishan , Mr. Abdo Fare'a , Director general Wadi Mawr Project. Dr. Matius, Nabil Murshid Abdulla - Extensions, , Nishtan Ahmed Hassan Plant Protectionist.

Observations:

The director of Wadi Mawr Project told us that a lot of termite flying insects were usually seen on the beginning of the rainy season in October. This is different from Zabeid which usually occurred in August.

Wadi Mawr area is suffering from termite attack on crops and buildings, that is why farmers are using Aldrin and dieldrin for the control of termites on cotton, pepper and fruit trees as a protective or curative method of control. Aldrin is sold in the black market as YR 3000-4000/kg (about $60) and it is often found mixed with other white material (soap or calcium carbonate).

It is clearly observed that all leftovers, plant debris or wooden sticks, stems, or branches on the soil were usually found attacked by termites and foraging termites were often seen.

Mango and citrus trees were attacked externally by termites. The farmers pointed out that one mango and two citrus trees were dead due to termites. It was observed that some citrus trees were suffering from a quick decline virus disease; they started to wilt and dry having a lot of fruits on them. There were more than three species of predatory ants that can feed voraciously on termites and when the termite galleries were open or exposed to them. We showed this technique to the farmers at Al Marawgha.

Maize, eight weeks after sowing, was heavily attacked at Al marawgha. An assessment of damage was made by 5 of us, each one counted 100 plants and the damaged plants were recorded in table (5). It is shown that the damaged plants ranged from 21-50 and mean percentage of damaged plants due to termite attack was 33%.

Table (5) Percentage of damaged plants of Maize due to the attack of termites at Al Marawgha (Wadi Mawr)

No. of plants taken at random	No. of plants damaged by termite
100	21
100	26
100	41
100	50
100	27
Total 500 Mean percentage of damaged plants due to termites was 33%	165

It has been observed that local varieties of tomato were more tolerant to infestation by termites than the introduced ones. Okra plants were infested at Al Rafaei.

Although cotton seeds were treated with Aldrin before sowing by the GCC, termite infestation or damaged plants ranged from 5 to 50% in cotton fields visited at Allujam in Wadi Mawr.

It is worth to mention that cotton grown at the Extension Demonstration field by the Development of Oilseed Crops Project at Azzohra, was so far the best in the area. Plants damaged due to termites were not exceeding 5%. The field was sown at the end of September. It received only one irrigation but it also received good attention and care and will definitely give good yield compared to other cotton fields neighbouring it.

Farmers started to grow groundnuts and we made counts of infested plants in a field 4 weeks after sowing and the percentage of dead plants due to termites was not exceeding 1%.

Ten (10) samples of termite species and predatory ants were taken to the laboratory for identification.

On 29th December 1993, the following farmers and places were revisited to see the progress of termites in Wadi Mawr: Ahmed Mohammed Abbadi's farm and Extension Demonstration plots at Azzuhra.

Observation :

Sunflower, which had been sown on 13/11/1993 at Ahmed Mohammed Abbad's farm was suffering from the cotton leafworm; *Spodoptera littoralis* rather than termites. The later constituted not more than 3% damage. Some plants in this field were suffering from drought.

We revisit the demonstration field at Azzohra. The termite damage to plants almost stopped except for some external infestation of the leftovers and open bolls. Picking already stared.

Visiting Cotton General Company, Wood Stores And The Health Institute At Hodeidah

On 18th November 1993, the consultant visited the above places with Dr. T. Wood, Dr. M. hubaishan, Dr. C. Martius, Mr. W. Seif and Mr. Ahmed Gasim.

Cotton General Company :

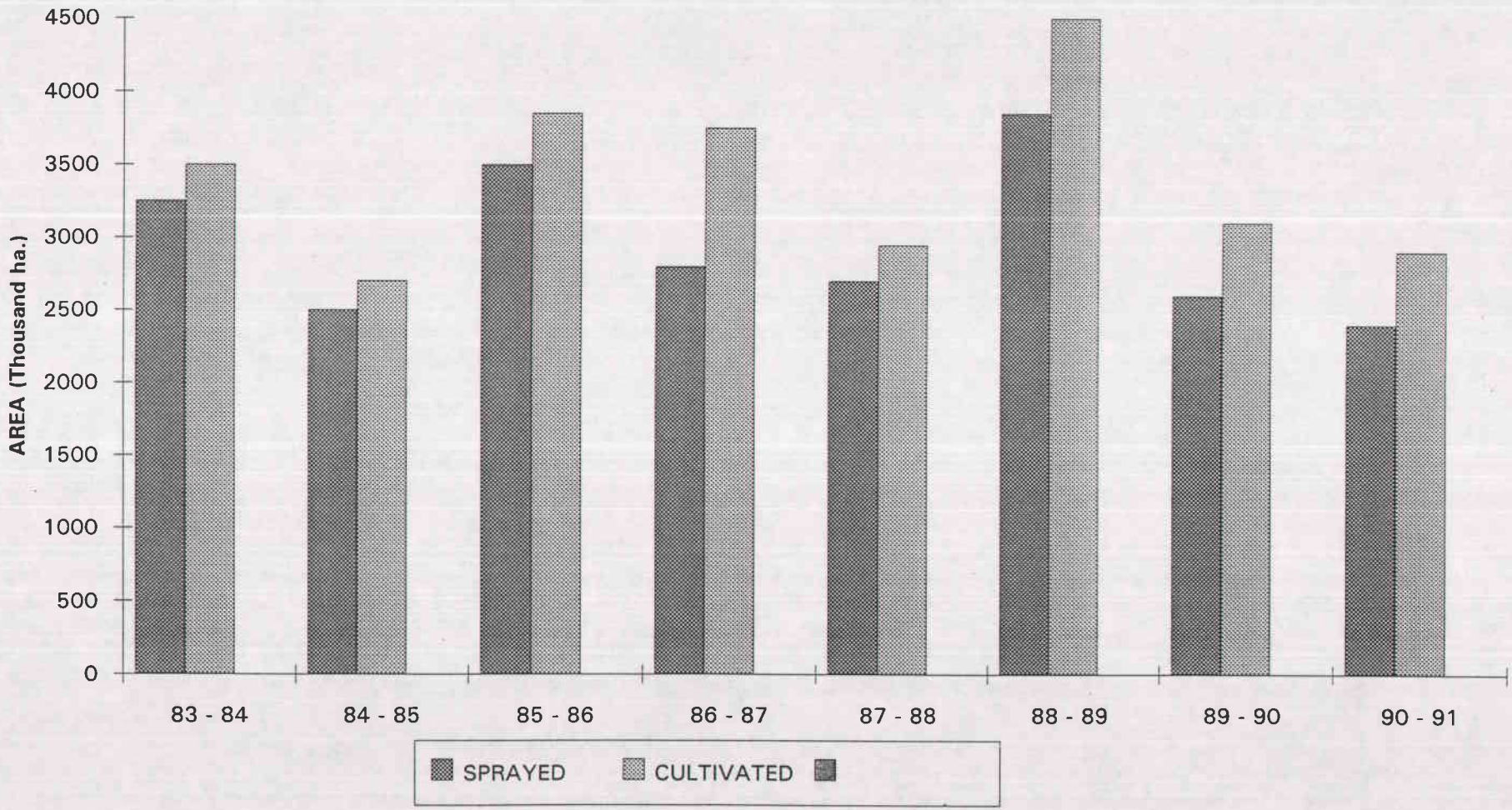
The Cotton General Company supplies the farmers in Tihama with cotton seeds treated with Aldrin, provides white loans (loans without interest) and at the end receives the cotton yield for marketing. the company usually imported Aldrin 40 in barrels 22kg in wt from Shell company in the Netherlands. The last consignment available in their stores was manufactured in 1988. Aldrin 10 is used at the rate of 7.5 g/kg cotton seeds mixed with cotton seed oil for adherence to the seeds.

The Director Mr. Idris Abdulla Alkhirib pointed out that cotton was facing a lot of problems, but when farmers were given these loans in addition to seeds treated with Aldrin and free plants protection services provided by TD and MAWR, (Fig 1), the cotton cultivation was boosted and the acreage of cotton was increasing in the area. The director added that termites are still the biggest problems facing the farmers.. When we discussed the hazards of Aldrin the director mentioned that Aldrin is still the best popular insecticide and unfortunately there are no alternative recombination from AREA, TDA or plant protection Department, MAWR or any other source in Yemen for using another better insecticide. He added that the company received recently sample of chlorpyrifos from a Jordanian pesticide company to be tried for the control of termites in Tihama.

Wood Stores:

Several wood stores at Hodeidah city were visited (Alsharabey and Alkhamri stores). Wood was imported from different countries, mainly Russia, Sweden and Malaysia. Some stacked old timber were attacked with termites while new stock were in good condition. Soft wood was more attacked than hard wood.

Fig 1. Sprayed & Cultivated Cotton areas



Health Institute:

The health Institute at Alzuhra (Hodeidah) was visited. Some wooden doors, windows, cupboards and electrical wooden framed and fittings were completely damaged by termites. Damage was more concentrated in WCs, bathrooms, offices and the library. The institute was constructed five years ago; and to replace windows, doors and other ruined furniture which I suggest to be replaced by aluminum, it will definitely cost millions of Rials.

I think it is time that the government should think of endorsing recommendations for pre foundation treatment of buildings in high risk areas in Hodeidah and experts or reputable companies should carry out this business in scientific way. Winged species and soldiers of termites were collected and taken to the Lab. for further identification.

Results Of Identification Of Termite Samples Checked In The Laboratory

Identification of termite species was carried out in evenings at the Plant Protection Laboratory in TDA; based on a reference collection for Yemen received previously from Dr. Cowie (NRI-U.K.).

It is clearly shown in table (6) that more than 95% of termite species in the samples collected from different areas in Tihama were identified as *Microterms najdensis* which concludes that almost all damage to crop in Tihama is caused entirely by one species Microtermes najdensis.

Very few samples were identified as *Microcerotermes diversus* which were usually associated with older trees of citrus, papaya and date palm trees.

Damage to building was caused largely by Heterotermes aethipicus and *Psammotermes hybostoma* and in some cases *Microtermes najdensis* was involved.

Samples of predatory ants found predating on termites, collected from different sites in Tihama, were handed to Dr. A. Van Harten, GTZ Yemeni-German Plant Protection Project and some of them were handed to Dr. T. Wood (NTRI-U.K.) for further identification. No results so far have been received by the consultant till the moment of writing this report.

Table (6) Results of Survey of termite damaged crops and buildings and termites species involved, in areas visited by the consultant in Tihama during November -December 1993

No. of Termite Samples taken	Areas covered	host pt./trees/buildings	Extent of infestation	Termite species involved (lab. finding)
15	Wadi Siham			
	Kambaheya	Citrus	+	Microtermes najdensis
		Papaya	++	M. najdensis
		Date Palm	+	Mocrocerotermes diversus
	Abyat Sofla	Cotton	++	M. najdensi
		okra	++	M. najdensis
		Tomato	++	M. najdensis
		Sunflower	++	M. najdensis
		Sesame	< 1%	M. najdensis
				M. najdensis
	Abyat Olya	Cotton	++	M. najdensis
		pepper	+++	M. najdensis
		Groundnut	+	M. najdensis
			+	M. najdensis
	Gumaisha	Cotton	+	M. najdensis
		Pepper	++	M. najdensis
	Dir Zawaya	Groundnut		M. najdensis
		Sunflower		
12	Wadi Rima'a+			M. najdensis
	Wadi Zabeid			M. najdensis
				M. najdensis
	Alhusaineyah	Henna	++	M. najdensis
	Nursery & farm	Conocarpus	+	M. najdensis
		(Damass)		M. najdensis
		Hibiscus	+	M. najdensis
		Guava	+	M. najdensis
		Papaya	++	M. najdensis

Table (6) Results of Survey of termite damaged crops and buildings and termites species involved, in areas visited by the consultant in Tihama during November -December 1993 (Cont.)

No. of Termite Samples taken	Areas covered	host pt./trees/buildings	Extent of infestation	Termite species involved (lab. finding)
15	Al Mahat (shoaibAfasha)	Papaya	++	M. najdensis M. diversus
	Azbeid (Altuhaita)	Cotton	++++	
	Zabeid (Al Ahdal)	Sunflower	++	M. najdensis
	(Abdan)	Groundnut	+	Heterotermes
	TDA stores (Zabeid)	stores (buildings)	++	aethiopicus M. najdensis
		(Al Rawda camp)		M. najdensis
4				M. najdensis
	Wadi Surdud	Groundnut	+	M. najdensis
	Alkadan	Sesame	< 1%	M. najdensis
		Cotton	++	
	(Alsho'abah (shamra)	Tomato	+	M. najdensis
5				
	Wadi Mawr			
4	Almarawghah	Maize	+++	M. najdensis
		Citrus	++	M. najdensis
	Al Rafaei	Okra	+	M. najdensis
	Allujam	Cotton	++++	M. najdensis
	Extension plots (Alzohra)	Cotton	<5%	M. najdensis M. najdensis M. najdensis
4	Al Hudeidah city	wood stores	+	M. najdensis
	kilo 16	stores (buildings)	+	Heterotermes aethiopicus
	Health center	Building	++	Heterotermes Psammotermes hybotoma H. aethiopicus

Evaluation of damage due to termites:
+= 1- 10% , ++ = 11-30% , +++ = 31-50%, ++++ >51% infestation.

Meetings and Discussions with D. Gs. and Head Departments at MAWR, AREA , DOSCP TDA and IDAS

Ministry of Agricultural and Water Resources (MAWR)

On 11 November 1993, short discussions were made with dr. Mohammed Yahya Alghishim, Director General Department of Plant Protection (MAWR) and Mr. Fouad Bahakim., Head Dept. of Pest Control Campaigns. The director pointed out the importance of termites in the country and in particular at Tihama and asked us to find out solutions for their control away from using Aldrin and dieldrin. We understood that the Department is going to publish a bulletin on termites showing its importance in the country.

Discussions were made on 11 and 24th November 1993 with Dr. Hasse and Dr. A. Van Harten from GTZ Yemeni-German Plant Protection Project who expressed their assistance to us and agreed to receive the samples of predatory ants to be sent to experts for identification.

Tihama Development Authority (TDA)

Discussions were made with Dr. Abdel Monim Haza'a Director General of TDA on 13 and 17 November 1993. The director was aware of the problem and asked for alternatives to Aldrin as well as recent recommendation from AREA for the control of termites. He is seeking assistance from the World Bank and any other organization for funding a project for the control of termites. He and his staff forwarded us every assistance to make our mission successful. Mr. Wadie Seif, Mr. Aljifri from TDA attended the meetings as well as Dr. Hubaishan and Dr. T. Wood and Dr. C. Martius.

Agriculture Research and Extension Authority (AREA) Development of Oilseed Crops Project (DOSCP) and Innovation Development in the Agricultural Sector (IDAS) Project.

The consultant discussed his final report and recommendations with Dr. Abdulwahid Mukred, Director general of AREA and Dr. M.A. Hubaishan, National Coordinator (DOSCP) who were standing behind this mission and are keen enough to seek solutions and practical

recommendations for the control of termites in Tihama. They agreed to support the consultant's recommendations and has asked us to propose a project that could be presented to the European Economic Community (EEC) for support. Dr. Martin Karnap, GTZ team leader of IDAS encouraged us to do so and attended one of our evening meetings at TDA concerned this proposal.

Discussions were made to develop and submit a research proposal to the EEC, life science and Technologies for Developing countries (STD) on Integrated Pest Management of Termites in the Tihama Coastal area of Yemen. Dr. T. Wood, Dr. M. Hubaishan, Dr. C. Martius, Dr. S. Ba Angood, Mr. Wadie Saief, Mr. Abdelnur Shaher participated in these discussions which are held at the plant protection laboratory at TDA. We finalized the proposal in which Yemen and European Institutions will participate in executing it.

The participants were :

D. M.A. Habaishan (AREA)
Prof. S.A. Ba Angood (Univ. of Aden)
Dr. T. G. Wood (NRI - UK)
Dr. C. Martius (Univ. of Goettingen (FRG
Dr. R.A. Sikora (Univ. of Bonn)FRG
Prof. K.E. Linsenmair (Univ. of Wurzburg)FRG

The proposal was sent to EEC for consideration. Later on, we received bad news that our proposal was not accepted simply because EEC are not, at that time, being interested in funding projects on insecticides or Insect Pest Management (IMP), as we have been told so. In my opinion, this is a good proposal for a good project and AOAD will be grateful if they kindly seek donors or funds for executing such a project. FAO may be approached for a TCP on this aspect.

Discussions And Recommendations

The Tihama Coastal Plain:

1- The Tihama region includes the coastal plain, is 400 km long and 30-60 km wide with an area of 22000 km2. It is a dry region with maximum temperature ranges from 33-42 C. , an average monthly temperature ranges from 24-36 C and relative humidity ranges from 50-70%. Rainfall ranges from 100-400 mm. usually comes twice a year, 70% on May - August and 30% on December- January. The Tihama region is a desert or semidesert, but rapid expansion of irrigated systems and introduction of exotic crops, increasing the annual cultivated area, changed the agro-ecological environment in the region. Tihama region contributes to 30-40% of crop production in Yemen.

Oil Seed Crops in Tihama

2- Cotton and sesame are the most important oilseed crops in Tihama. According to the Agricultural Statistic Year Book published by the General Department of Statistics and Documentation, August 1993, the total cultivated areas of cotton and sesame in 1992 was 12235 ha and 9414 ha, respectively giving a total yield of 11372 tons and 4587 tons for cotton and sesame respectively.

3- Cotton is the most important cash crop in the area. Cotton growers are provided with white loans (no interest) and free Aldrin treated seeds from The General Cotton Company (GCC). TDA and MAWR provide free chemical pest control services. Fig. (1) shows clearly the annual sprayed area related to cultivated area of cotton in Tihama for the years 1983-1984 till 1990-1991 . Farmers should handle the cotton yield to the GCC for marketing.

4- Sunflower and groundnuts are considered exotic crops recently introduced to Tihama and mainly by DOSC Project. The acreage of both crops is not exceeding 100 ha.

Historical Background of Termites in Yemen with Particular Reference to Tihama

5- Records of termites in Yemen dated back to 1937-38 where a British Museum expedition recorded two species of termites collected from Sana'a and identified as *Microcerotermes diversus* and *Microtermes subhyalinus.(Harris,1959).*

6- Several termite species have been identified afterwards and recently more than 25 termite species have been recorded from Yemen (Harris 1957), Ba-Angood, 1982 , 1983 ; Hubaishan 1992; Cowie 1989; Chhotani, and Bose 1979, 1983, 1985 Wood etal 1986)

7- FAO (1975) and Watt (1975) reported extensive damage to cotton based on four years of observations in Tihama. Watt (1975) mentioned that termite control remained the most difficult problem in cotton, and added that it was not uncommon to find 100% damage in living plants pulled up after harvest from heavily infested fields.

8- Ba-Angood (1982) and Cowie (1987/1988) have reported that termites caused no significant problem to crops in the southern and eastern Governorates of Yemen, which were previously called People's Democratic Republic of Yemen. However, there are some localities e.g. Attariya farm where pepper, groundnut, maize and tomatoes were seriously attacked in addition to coffee trees at Al Dhale'a . Most of the damage was caused by Microcerotermes diversus (Ba-Angood 1993).

9- Termites are a major problem to cotton, maize and pepper grown in Tihama wiliest being a potentially important problem in other oilseed crops namely sunflower and groundnuts.

10- Termite damage to crops and termite control in Tihama have been reported by FAO (1975, 1980) Watt (1975), Awad and Hassan (1977) , ElBashir (1984), El Bashir et al (1981), El Bashir and Amir (1982), Wood (1982, 1993), Bednarzik (1984), Wood et al (1986, 1987) and Kassem and Ahmed (1988a, 1988b.).

11- From the above published and unpublished reports, we can conclude that damage to crops is caused in most cases by Microtermes najdensis and a small amount of damage is caused by M. diversus.

12- *Microterme najdensis* is a subterranean fungus growing termite which is known to be distributed widely throughout deserts of Yemen and Saudi Arabia as far as slightly north of Jeddah (Wood et. al. 1986). In Yemen its distribution is confined to moist regions of the wadis and to irrigated areas of the Tihama and the mountain foothills below 1000 m (Wood et. al 1987). Out of Yemen and Saudi Arabia, the only other known locality of M. najdensis is the Toker Delta of Sudan (Pearce et. al. 1986).

13- There is often a severe and an increasing damage by termites to buildings in Southern and Eastern Governorates of Yemen as well as in Hodeidah (Ba-Angood 1982, 1993, Cowie 1987, Wood 1993). *Psammotermes hybostoma and Heterotermes aethiopicus* are responsible for this damage in Southern and eastern Governorates and in addition these species *M. najdensis* in Tihama.

14- Aldrin and dieldrin are the most widely used and recommended insecticides for the control of termites on crops and in buildings,. However, in the southern and eastern Governorates of Yemen these insecticides were no longer recommended and were replaced by Diazinon (Basudin).

Past and Current Termite Research Activities in Tihama:

15- Surveys published by Wood et. al. (1987) showed that plant mortality without termite control ranged form 2-63% . (average 20-30%) in cotton and maize. pepper, okra and tomato were attacked less severely (average mortality of 10-20%). Tobacco, sorghum, millet and most vegetables suffered little damage (less than 2% stand loss) whereas experimental crops such as groundnuts, wheat and sesame suffered severe losses.

16- Insecticide were evaluated in different methods as seed dressing, side application and soil treatment by Wood et al (1987), Bednarzik (1984) El Bashir and Amir (1982) and Kassem and Ahmed (1988a ,

1988b.). Most of these trials were carried out for the control of termites on cotton and maize. Bednarzik (1984) tried some micro organisms mainly *Metarhizium spp* . ash and kerosine to stop termite progress in fruit trees.

17- Most of the trials conducted by the above authors were carried out for only one agricultural season in Tihama.

18- The most successful and adopted recommendation was the use of Aldrin as seed treatment for cotton. Since then Aldrin and Dieldrin have been widely used in Tihama region. They are the most popular insecticides for the control of termites not only for cotton but also for all crops and other fruit trees in the Tihama region.

19- In my opinion and as everybody knows, Aldrin and other cyclodiene insecticides have been banned in almost all parts of the world. A lot of companies stopped the production of Aldrin due to its hazards and toxic effects to human beings, animals and to the environment. Environment protection in Yemen is gaining more interest and care by the Yemen people. TDA and the GCC should think seriously in stopping the use of Aldrin and other cyclodiens in Tihama and should search, with cooperation of AREA, for other alternative insecticides and other methods for better management of termites in Tihama.

20- Over viewing the research programs of AREA and in particular of the Surdud Agricultural Research Station at Alkadan from 1990-91 on- wards, we found that there were several experiments carried out by Abdel Nur Shaher and Ibrahim Al Mugaba'a evaluating some insecticides with different application methods for the control of termites on cotton maize and pepper. In their trials, still Aldrin was the best, but diazinon with irrigation water gave encouraging results for the control of termites on pepper. It is worth to mention that Wood (1982) was against the use of insecticides with irrigation water for the control of termites.

21- Some field trials of termite control in groundnut were recently carried out at Surdud Research Station and the Development of

Oilseed Crops Project has introduced some varieties of groundnuts to be tested for their tolerance to termite attack in the area. Barberton showed better results but the trials need to be statistically analyzed to verify that.

22- A bibliography of termites in Yemen has recently been prepared by Hubaishan (1992) and Ba-Angood (1993).

Recent Aspects of Termite Research in the World:

23- If we have to overview the advances and recent aspects of termite research in the world; we will easily find it almost entirely covered by the papers presented in the 1st Regional Workshop on Termite Research and Control, which was recently held in Nairobi, Kenya on 17-19 August 1992.

24- The objectives of this workshop were (1) to review past and present research on termite control and to formulate future control strategies (2) to sensitize the public and private sectors to the economic importance of termites in agriculture , forestry and buildings and (3) to initiate a regional approach for termite control in East and Central Africa.

25- Most of the papers were concentrated on testing and evaluation of new insecticide of new insecticides and plant extracts for the control of termites. The development of IPM strategy, the use of natural enemies with more emphasis on fungal pathogens were covered. Information on the extent of damage caused by termites in agricultural, forestry and building industry were retrieved.

26- The papers presented at the workshop were collectively summarized by Logan (1992) and almost five problem areas were identified: (1) the need for accurate identification of termites; (2) the lack of information on the biology and ecology of termites and how their behavior relates to damage and control (3) the lack of efficient crop loss assessment techniques and the need to asses damage thresholds; (4) high cost of synthetic pesticides and the need for effective alternative methods; (5) concern over the fate of termites and a

desire to achieve reduction of damage without destruction of beneficial termite species.

27- I recommend copies of the proceedings of the above mentioned workshop to be ordered and kept at the libraries of AREA, TDA, and colleges of Agriculture at the Universities of Sana'a and Aden.

28- It is worth to mention that some groundnut varieties were tested at two sites in Burkina Faso for resistance against termites. The varieties NC, AC 2243, RMP 40 and NC, AC 343 were found to be highly resistant at both sites (Dicko et al 1992).

29- In Egypt, Saudi Arabia, Kuwait, India ,Pakistan , Kenya, Zambia, Tanzania, Brazil , Australia, UK and USA, research on termites was almost concentrated on the ecology, biology , and testing IPM programmes for the control of termites in forestry and buildings rather than agricultural crops. However, consultants from institutes in these countries were involved in termites in agricultural crops when sent abroad.

AP roposal for a 5-years Research Programme on Termites in Tihama:

30- As AREA is responsible for making recommendation to farmers, they should be involved with TDA in a research programme of studying the biology, ecology and control of termites in Yemen. Close cooperation and support will be required from TDA , Plant Protection Department at MAWR and the colleges of Agriculture in Yemen. The following research programme is recommended for the coming 5 years :-

Culturing of *Microtermes najdensis*:

31- *M. najdensis* is responsible of about 95% of damage caused to field and tree crops in Tihama. It is a subterranean fungus - growing termite widely distributed in the area and is becoming a key pest in Tihama. No reports, as far as I know, of culturing such a termite in the laboratory. Accordingly, I recommend culturing *M. najdensis* as a prerequisite for various experiment and screening of pathogens.

Laboratory colonies could be established in the first year and biological observations could be completed 2-3 years later.

Evaluation of Insecticides:

32- The DG of TDA and senior plant protection staff made it clear to us that they can not answer the question for an alternative insecticide for the control of termites if Aldrin is banned in Yemen. They are waiting for an advice from AREA. AREA can no give an accurate answer for which insecticide could give the same quality of Aldrin in controlling termites; as most previous trials on the control of termites were just for one growing season and all recommended Aldrin or Dieldrin or heptachlor or chlordane which are no longer recommended. Accordingly, several insecticides should be tried for the control of termites and the consultant recommends testing chlorpyrifos (Dursban), fenvalerate (sumicidin), propoxur, dizainon and plant extracts e.g. neem. Different application methods of such chemicals should be tried.

33- Experimental trials could be backed by demonstration trials of termite control testing 2-3 insecticides and a plant extract (neem) in different regions of Tihama. The consultant recommends chlorpyrifos and fenvalerate to be tried at Zabeid, Gumeisha and Wadi Mawr.

Plant Extracts:

34- Logan et al. (1990) listed numerous plants containing materials toxic to termites. Some of these plants are growing in Yemen. The consultant suggested trying the following plant extracts for the control of termites : Neem (*Azadratica indica*), tobacco (*Nicotina tabacus*), Aushur (Calotropis procera) papaya (*Corcica papaya*) and castor (*Ricinus communis*); in addition to extracts of plants known to be tolerant to termite attack in the area as millet and sorghum.

Studies on the Biology and Ecology of *M. najdensis*:

35- It has been observed that the population of termites and attacked cropping areas are increasing in Tihama. This might be due to increase of irrigated and cultivated areas, introduction of exotic crops in the area and other biological and ecological factors.

36- It seems that very little is known about the biology and ecology of *M. najdensis*. Therefore, studies on the distribution and foraging activity of this species for one or two years in relation to the main ecotypes of the Tihama lowlands, irrigation and cropping systems should be carried out.

37- Field baiting could be used to serve two purposes (a) as a monitoring tool for quantifying the foraging activity and (b) a delivery system for toxicants and microbial pathogens (Wood and Thomas 1988).

38- The ecological requirements of *M. najdanesis* , soil parameters e.g. particle size, organic matter, humidity, which might affect termite distribution could be studied to get better understanding of the factors that might affect horizontal and vertical distribution and lead to population increase in cultivated areas.

39- The relationship between termite damage and yield loss assessment should be studied at least for cotton, and sunflower. Studies on economic thresholds, though difficult to do, but could be tried.

40- It has been observed that sorghum and millet in Tihama were almost not attacked by termites, while cotton maize, pepper, groundnut and sunflower were highly susceptible. Feeding preference studies including studying pathogens in the soil ecosystem of Tihama that are associated with the nest component of *M. najdensis* will lead us to gain better understanding of nesting biology as well as natural diet of this species and at the end better management of the pest.

The Use of Biological Control Agents:

41- Termite control with entomopathogenic fungi and bacteria, repellent plant extracts or particle size barriers has been proven successful under laboratory and field conditions in Yemen and other parts of the world, (Bednarzid 1984). Therefore identification of biological control agents e.g. fungi, bacteria, nematode, predatory ants), that are effective for the control of termites could be investigated and some of them e.g. *Metarhizium anisopliae*, and *Beauveria bassiana* could be tried for the control of termites under field conditions in

Tihama. The role of the available predatory ants found attacking termites on fruit trees in some areas in Tihama could also be studied.

Cultural Methods:

42- The effect of sowing date on cotton and other, oil seed crops should be studied. The effect of cultivation or ploughing to disrupt termite galleries as well as the effect of fertilizers to produce strong vigorous plants should also be investigated.

43- During our filed visits, farmers told us that when they increased the number of irrigations, the extent of attack by termites decreased. As far as we know, rain or irrigation would appear to stimulate foraging by M. najdensis in the even drier Tihama, as the onset of foraging in Gumaisha and El Gerba occurred approximately 6 weeds after the first irrigation, late August at El Gerba and mid September at Gumaishs (Wood et al 1987). Therefore the relationship between irrigation (quantity and number of irrigations), date of sowing and the onset of foraging and damage of *M. najdensis* to crops need to be investigated.

Plant Resistance Studies:

44- The oilseed crops project introduced several groundnut varieties from ICRISAT. Some of these showed some tolerance to termite attack. In the Sudan, the consultant has been informed (Personal communication with Prof. Abdelmomin Ahmed, groundnut breeder) that two varieties of groundnut showed some tolerance or resistance to termite attack. The consultant recommends introducing such varieties to be tried in Tihama at Surded Agricultural Research Station together with the resistant varieties tried in Burkina Faso. (mentioned in 28 - Discus,and Recom).

45- During our visits, we noticed that a wild perennial variety of cotton probably *Gassypium herbaceum* was apparently more tolerant to termite attack. Therefor, it is recommended that further studies into the possibility of resistance in cotton against termites should be carried out.

General Recommendations :

46- During our field visits we noticed that most of the crops residues, trash and other leftovers on soil or ground were attacked by termites. Therefore, a strict recommendation should be passed not to leave cotton, not picked for a long time, to clean all crop residues, collect all trash and leftovers in fields; and burn them in order not to be used as a source of further infestation of termites.

47- Due to the excessive use of Aldrin and dieldrin in Tihama as seed treatment for most field and tree crops, dipping pepper seedlings before transplanting to fields; the consultant suggests soil and crop samples should be taken periodically from different areas in Tihama for residual analysis in soil and crops.

48- Damage by termites to buildings is increasing and several buildings in Hodediah were severely attacked. The consultant feels that it is now time that the Governorate authority should think of endorsing some regulations or by- laws for pre-foundation treatment of constructions using standard techniques to prevent or limit the damage of termites to buildings. Experts or professional operators in reputable companies would have to be allowed to do such work.

49- When we visited AREA and TDA, we found that basic literature is badly needed. It was very difficult to get even copies of the previous reports on termites in Tihama. A small number of books and journals would be of great help to researchers at AREA and plant protection and extension staff at TDA. The consultant recommends the following books and journals to be provided, one copy of each , for AREA and for TDA.

- Haris, W.V. (1971) Termites, Their Recognition and Control. Longman, London.
- Krishna, K . and F. M. Wessner (1969-1970). Biology of Termites Volumes 1 and 2 Academic Press., London . New York.
- Edwards, Rand A.E. Mill (1986). Termite in Buildings. Retnokil, East Grinstead.

- NRI Termite Abstracts -ODA_ NRI (U.K).International Journal of Pest Management - Taylor and Francis U.K

50- Small informative bulletins or extension leaflets should be published including nice colored photos of termites, showing their damage, how to estimate crop losses and different methods of control. The pamphlets should show the dangers expected from the miss- use of toxic pesticides. ARE, TDA , DOSP and Department of Plant Protection at MAWR could cooperate in this field. These leaflets should be widely distributed and at the access of farmers and extension officers.

Academic and Technical Training :

51- Termite is a big problem in Tihama region and will continue to be a big problem for several years to come, simply because the major species of termites in Tihama have subterranean nests that can not be easily exterminated. Therefore scientists,, extension and plant protection workers and farmers must accept the presence of termites in the area and must work together to minimize or prevent damage to crops and buildings. Training is very important at all levels of personnel involved in termite control in Tihama.

52- Most of the plant protection staff working at Surdud Research Station on particular in Entomology are B.Sc. holders. The consultant recommends AREA to send them for postgraduate studies leading to Msc. and Ph.D. degrees. They are hard workers but their research capabilities need to be strengthened in order to implement the recommended 5 year research plan for termites. At the time being the consultant recommends AREA to make use of the services of an experienced entomologists to come to Surdud for 3-4 weeks to help researches. The first week is allocated to plant the research program, one to two weeks to design and plant trials in the field and the last week to help in statistical analysis. He can come at the middle of the season for a few days to see how far the trials are progressing and to make necessary observations. Such expert can either be transferred from any of AREA research stations or from either of the colleges of Agriculture in Yemen or from abroad; but

he should be an expert in termite research and knows something about termites in Tihama.

53- The following academic and technical training is recommended:

(a) A research entomologist working on termites (AREA) and another senior plant protection officer at TDA, may go for termite training for a period 3-4 months in a reputable institute. NRI (UK) is the recommended place for training.

(b) Two M.Sc. in crop protection, one from ARE and another one from TDA doing their thesis on any aspect of termite management. They can be registered either in Aden or Sana'a Universities or be sent abroad, if funds are available.

(c) Two Ph. D. on Termite Pest Management one from AREA and one from TDA. They can register for Ph D. degree abroad; but it is recommended that they do their research in Tihama with local co-supervision.

(d) Short training courses or workshops should be initiated as early as possible to train field and laboratory technicians, extension and plant protection workers separately from TDA and AREA staff on the biology ecology and IPM of termites.

(e) A one-day field program could be made for farmers and farm leaders to train them how to estimate damage and losses of termites to crops; and how to implement control measures. AOAD may help in such training programs.

Farmers Involvement :

54- A panel discussion including farmers research extension and plant protection staff from AREA, TDA and MAWR for only one day could be initiated in different areas in Tihama with the objective of seeking past knowledge and experience that farmers have got from their grandfathers and passed through generations, for the control or management of termites in their fields. A questionnaire could also

be distributed to get such information. I suggest AREA to contact IDAS to participate in such panel discussions. The consultant is ready to participate in preparing or formulating the questionnaire as ready to participate in preparing or formulating the questionnaire as well as participating in the panel discussion if he is asked to do so from the concerned authorities. The farmers should be notified about this meeting several weeks before, in order to prepare for this discussion and to seek and ask for more information from their relatives and colleagues.

AOAD Involvement :

55- AOAD could help in training and workshops, by providing experts for training or seeking funds for training programs.

56- Termites are causing big problems in some Arab Organization for Agricultural Development countries and other Middle East neighbouring countries (AOAD 1976- 1977). The consultant recommends the establishment of a regional termite Research Center. As Tihama is one of the hot spots of termites that can attack crops and buildings, I suggest to be the right place for this center. AOAD may approach UNDP or FAO or World Bank or any other donors for funds to establish such center in Yemen. The whole region will make use of the research findings.

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المخلص

1- تم النزول الميداني لمناطق زراعية في وادي سهام ووادي رماع ، وادي زبيد ، وادي مور ، ووادي سردود الواقعة في اقليم تهامة باليمن ، وذلك لغرض اجراء المسح الميداني للاضرار التي تسببها حشرات النمل الابيض (الأرضة) للمحاصيل الزراعية وخاصة محاصيل الحبوب الزيتية . كما شمل المسح ايضاً بعض المباني .كما تمت زيارة كل من الادارة العامة للقطن والمحطة الاقليمية للابحاث الزراعية في سردود والادارة العامة لهيئة تطوير تهامة والادارة العامة لوقاية المزروعات بوزارة الزراعة والموارد المائية .

2- بعد فحص عينات النمل الابيض التي أُخذت من مختلف الحقول الى المختبر لغرض التصنيف ، اتضح أن الارضة المسماه " ارضة نجد "
Microtermes najdensis تشكل 95٪ من العينات ، وبالتالي فإن معظم الضرر الناتج من النمل الابيض للمحاصيل الحقلية واشجار الفاكهة يسببه هذا النوع من الارضة ، غير أن هناك نسبة ضئيلة من الضرر يسببه نوع أخر هو Microcerotermes diversus والمتواجد على بعض اشجارالفاكهة كالباباي والحمضيات والمانجو والنخيل .

3- إن اكثر المحاصيل اصابة بالارضة هو القطن ، الذرة الشامية ، الفلفل الاخضر(البسباس) والفول السوداني وعباد الشمس وهناك اصابة متوسطة على الطماطم والبصل والبامية واشجار الفاكهة وخاصة الباباي .

4- إن مبيدي ألدرين ودايلدرين من المبيدات الشائعة الاستخدام في اقليم تهامة لمكافحة النمل الابيض ، اذ تقوم الادارة العامة للقطن بمعاملة بذور القطن رسمياً بمبيد ألدرين وتوزيعها علي المزارعين . كما يقوم المزارعون بتغطيس شتلات الفلفل الاخضر في محلول الالدرين عند نقلها الى الارض المستديمة . ويباع الالدرين في السوق السوداء بحوالي 3000-4000 ريال/كغ . وغالباً ما يوجد مغشوشاً أي مخلوطاً بمواد اخرى . لذلك فإن المستشار ينصح بشدة بالتوقف الفوري لاستخدام هذين المبيدين لانهما محرمان دولياً في كثير من دول العالم ولما لهذه المجموعة من المبيدات من آثار سامة تؤثر على الانسان والبيئة . كما يمكن تجربة بدائل لهذه المبيدات ، منها كلوربيريفوس وبعض المبيدات البيروثرويدية ومستخلصات بعض النباتات كالنيم .

5- في هذا التقرير تم استعراض الخلفية التارخية للنمل الابيض في تهامة ، والبرامج والانشطة

البحثية السابقة والحالية للنمل الابيض في تهامة والاتجاهات الحديثة في ابحاث النمل الابيض في العالم . كما تم اعداد مشروع خطة بحثية (خمسية) على مدى خمس سنوات لبرامج بحثية في مجال النمل الابيض وقد تطرق البرنامج البحثي الى :-

- زراعة مستعمرات لأرضة نجد M. najdensis وقد يستغرق هذا العمل 2-3 سنوات
- تقويم ودراسة واختبار بعض المبيدات كبدائل للادرين ومجموعته
- دراسات حيوية وبيئية لأرضة نجد M. najdensis
- استخدام الاعداء الحيوية بما فيها الكائنات الدقيقة
- أثر الطرق الزراعية
- البدء في دراسات حول اصناف من القطن والفول السوداني مقاومة للنمل الابيض

6- إن معظم المخلفات الموجودة في حقول المزارعين مصابة بشدة بالنمل الابيض لذا يجب أن تكون هنالك توصية قوية تقضي على جميع مخلفات المحاصيل وحرقها لكي لا تكون مصدر اصابة مستقبلية للمحاصيل الاخرى.

7- ان انواع النمل الابيض المسببة للاضرار في المستودعات والمباني بشكل رئيسي هي:

Psammotermes hybostoma

Heterotermes aethiopicus

وتشترك معها احياناً أرضة نجد . وعند زيارتنا لبعض المستودعات والمباني الحديثة (المعهد الصحي بالحديدة (وجدنا أن بعضها يعاني من اصابات فادحة للنمل الابيض وان اعادة ما هدمه النمل الابيض للمعهد الصحي على سبيل المثال ربما يكلف بعض الملايين من الريالات .

8- لذلك يشعرالمستشار أن الوقت قد حان لحث الحكومة بالقيام بسن بعض التشريعات القاضية بمعاملة اساسات المباني وبطريقة عملية قبل البدء في البناء والتشييد وذلك لحمايتها مستقبلاً من الاصابة بالنمل الابيض . مثل هذا العمل لا يمكن السماح بالقيام به الا لاخصائيين في مكافحة النمل الابيض ويمكن الاستعانة ببعض الشركات ذات السمعة الجيدة في هذا المجال .

9- وضع المستشار مشروع خطة لتدريب وتأهيل الكادرالموجود في هيئة البحوث والارشاد الزراعي وهيئة تطوير تهامة العاملين في مجال مكافحة النمل الابيض ، ويرى المستشار ضرورة اشراك

المزارعين في ورشات العمل الخاصة بالنمل الابيض لمعرفة الخبرات القديمة المتراكمة لديهم عن اجدادهم حول مكافحة هذه الحشرة في حقولهم .

10- ان نتائج وتوصيات هذا التقرير قد نوقشت باستفاضة مع الدكتور عبد الواحد عثمان مكرد / المدير العام للهيئة العامة للبحوث والارشاد الزراعي ، والدكتور محمد علي حبيشان / المنسق الوطني لمشروع تطوير محاصيل البذور الزيتية ، والذي يود المستشارأن يشكرهم بالاضافة الى مدير عام المنظمة العربية للتنمية الزراعية الدكتور يحيى بكور ، والمنسق الاقليمي لمشروع تطوير محاصيل البذور الزيتية بروفسيرمحمد بدر احمدسليم ، على اتاحتهم الفرصة له للقيام بهذه الاستشارة المتمثلة في هذا العمل العلمي والذي وجده ممتعاً .