Report to the USAID

ICIPE

TOWARDS IMPROVED PEST MANAGEMENT ON EXPORT VEGETABLES IN AFRICA

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Joint Initiative By
The International Centre of Insect Physiology and Ecology (ICIPE)
and
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3. Supportive research on improved pest control options:

3.1. Testing of neem

On station trials were initiated on the efficiency of standardized neem formulations (powder, oil) on some of the target crops. Initial results appear promising for neem sprays in control of flower thrips on French beans. To explore the scope for systemic protection through seed treatment, a range of doses were tested to identify the safe dose limit that would not affect seed germination in French bean and Okra. Farmer-participating testing of neem on bittergourd has also been initiated (at Nguruman).

3.2. Insect Pathogens

An exploratory on-station trial on the potential for the fungus - *Metarrhizium anisopliae* has been found to be promising against thrips on French beans. Follow-up trials are being planned.

3.3. Testing of crop cultivars/genotypes for pest tolerance

Seven genotypes of Okra were compared at Mbita Point Field Station for pest tolerance/yield advantage over the local common cultivar - Pusa Sawani and one of them appeared to be superior to the local. Additional genotypes as they become available will also be tested in due course.

4. Human resource capacity building for national research extension institutions

4.1. Refresher training for National Horticultural Development Authority Technical Officers

For updating the technical field officers of the Horticultural Crops Development Authority (HCDA) of Kenya on improved crop protection, a one-day refresher-training workshop was held. There were 35 participants including from other projects and farmers' organizations. A total of 12 resource persons from ICIPE and other organizations provided the scientific book up. The participants adjudged the course contents and structuring as good to very good.

4.2. Scientific underpinning for African regional vegetable production training course

A regional training course for vegetable production practitioners jointly organized by the Israel Government and University of Nairobi during July/August, 1997 invited the project Coordinator (Dr. S. Sithanantham) for a lecture-cum discussion session for a group of about 24 middle level professionals drawn from 8 countries in the region. This contribution was commended through a

formal letter of appreciation (Annex 10).

4.3. M.Sc/M. Phil Research Training

A M.Phil Project of Moi University (Kenya) on "Non-target effects of neem in export vegetables" commenced in June 1997 and to complete by April 1998 is being supervised by the project Coordinator (Dr. S. Sithanantham).

By special arrangement with the Kenyatta University (Kenya), four MSc research topics were identified as below:

- Bioecology of pests on okra capsicum and eggplant.
- Bioecology of pests on cucurbits vegetables (including bittergourd).
- Evaluation of neem on pests and beneficial insects on okra/pea.
- Potential for insect pathogens in control of caterpillar pests on vegetables.

The students are preparing to initiate the research from April 1998.

5. Linkages and Networking with Partner Institutions/Initiatives

For Kenya, most of the partner institutions concerned with export vegetable production/protection were linked up with the project in different activities. Some of these are as below:

- Horticultural Crops Development Authority (HCDA)
- Fresh Produce Exporters Association of Kenya (FPEAK)
- Kenya Agricultural Research Institute (KARI)
- Kenya Institute Of Organic Farming (KIOF)
- Pesticide Safe Use Project (GIFAP)
- GTZ - IPM Horticulture Project
- Kenya Small Scale Farmers' Association (KESSFA)
- Association for Better Land Husbandry (ABLH)

Invitations for partnership input were also received by ICIPE from Zanzibar (Tanzania) and the Invest for Development of Export Agriculture (IDEA) project from Uganda. (Annexes 11 and 12).

6. Communications/Publications

The project staff participated in the following seminars/workshop

Workshop on Export Horticulture - Protrade/HCDA
National workshop on Horticultural Research and Development of Agriculture and Technology, January 1997.
Horticultural Export Seminar, FPEAK Kenyatta Conference Centre.

The following communications were also prepared for explaining the project goals and activities

- Scientific articles - 2
- Lecture outlines - 2
- TV coverage - 1
- Radio coverage - 1

B. IMPLEMENTATION STATUS

1. Most of the project staff joined in their positions during the first quarter (Oct - Dec '96).
2. Equipment required field/office work have also been procured.
3. Project quarterly reporting (technical/financial) has been kept up.
4. Proposal for continuing the activities into 1999 - 2000 through IFAD co-financing is being pursued.

C. FINANCIAL REPORT

1. Fund utilization status for year 1 is included.
2. Revised estimate for year 2 to be ready in January/February 1998 when USAID - Kenya office would confirm their support.

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activities for which we record our sincere appreciation.

This report is a product of a team effort involving the input of several ICIPE scientists, especially Dr. K. Ampong-Nyarko, Dr. K. V. Seshu Reddy, Dr. G. T. Lako, Dr. A. Varela, Dr. W. A. Overholt, Prof. G. Kiros, Dr. M. Odindo. The support staff in the team especially Ms. Lizzie Chongoti, Mr. Walter Ogutu, Mr. Gideon Jira, Mr. Dickens Nyagol, Ms. Diana Muiruri, Mr. Moses Mbeke, Mr. Bernard Muia, Mr. Romanus Odhiambo, Mr. Joseph Ondijo all deserve appreciation for their spirited input.

Dr. S. Sithanantham
COORDINATOR

1. UNDERSTANDING THE PEST PROBLEMS AND PRIORITY NEEDS OF FARMERS

1.1 Initiative for improved pest management for export vegetables: summary of consultation meeting convened by ICIPE with stakeholders in Kenya, 26 -27 February 1997

1.1.1 Background of the Initiative

During June - August 1996, USAID-Africa Bureau expressed interest in an initiative proposed by ICIPE, for "Improved Pest Management in Export Vegetables in Eastern and Southern Africa" through funding support. The initial phase was visualized to focus on Kenya where ICIPE's experts are presently based, with the provision to initiate network collaboration in research, training and information exchange with other interested partner countries in the region. This was a new initiative involving knowledge/linkages to be developed.

1.1.2. Purpose of the meeting

As a basis for priority setting in the initiative for meeting Kenya's needs, it was considered desirable to consult all stakeholders and potential collaborators, so to:

(i) Assess the existing knowledge on pests and the control options and identify the research gaps.
(ii) Comprehend the ongoing pest management related activities of different institutions/projects.
(iii) Identify the priority target areas of concern in pest management.

In addition, the meeting was to also document the potential interest of researchers, extensionists, and the farming community to collaborate with a full, project to be developed. Accordingly, the consultation meeting was convened by ICIPE at Nairobi during February '97, with representation from a broad range of institutions/stakeholders in Kenya (See Annex 2 for list of invitees). Technical aspects as well as policies relating to improved pest management on the target crops were addressed in different sessions (see Annex 3 for program) using a participatory approach.

1.1.3. Outcome of the meeting

a). Target crops and importance of pests as constraints ascertained

i) Based on their share of the export market, six vegetables were identified as being important in Kenya: French beans *(Phaseolus vulgaris)*, snowpea *(Pisum spp.)*. Okra, eggplant, capsicums (sweet pepper & chilies) and karella (bittergourd) *(Momodica charantia)*.

ii) Pests (including arthropod pests, diseases and weeds) were agreed on as being critical constraints for achieving high production and quality of the crops.

b). Ranking among pest problems achieved

While the available countrywide information on pest spectrum and yield losses due to pests is meager, a 'perceived' prioritization was arrived at among the arthropod pests (and diseases) for the six target crops (Annex 3). It was agreed that this priority is only indicative. In the next two years, the project should undertake surveys/visits of the major growing areas, so as to confirm/revise these rankings based on the quantitative data to be assembled on pest distribution and yield loss

c). Status of research on relevant IPM technology options assessed

For each export vegetable crop and major pest, it was possible to list the potential IPM technology options and classified into two major categories:

i) Those which have adequately been researched and/or demonstrated and efficacy level known

(ii) Those that have shown indications of usefulness but need to be verified or refined prior to being recommended to farmers.

A summary of the relative status of the technology options is furnished in Table 1.1.1. This would form the basis for the selective incorporation of options for applied or adaptive research in the project.

d). Suitable sites (hot spots) for technology verification identified

The identification of 'hot spots' for major pests was another achievement of this meeting. Pest management technologies usually need to be verified under 'high pest challenge' levels and the project could dependably select the 'hot spots' for this activity. These sites will also be ideal for 'benefit demonstration'. A list of the hot spots identified is furnished in Table 1.1.2.

e). Stakeholders' opinions synthesized for priority setting

The opinions of several farmers' representatives (8) and other stakeholders who were participants at this meeting were sought and are suitably reflected in the priority setting of pests and IPM options. The priority setting for aspects based on a questionnaire response is furnished in Table 1.1.3.

f). Policy issues and government regulations clarified

Lead papers were presented from the Kenya Ministry of Agriculture and Livestock Development and Marketing (MOALDM), Kenya Agricultural Research Institute (KARI), and the Horticultural Crops Development Authority (HCDA). These papers provided a comprehensive background for discussing policy issues and government regulations relating to pest management on export

vegetables.

g). Ongoing IPM Projects and their activities understood
Lead papers by two projects the IPM -- Horticulture Regional Project (GTZ) and the Periurban IPM Project (IIBC/ODA/KARI)-- provided insight into regional technical projects with which the Project could collaborate and so avoid duplication while at the same time ensuring complementation. It was also possible to identify activities for which collaborators were likely to be available.

1.1.4. Baseline data assembled
The meeting enabled identifying the priority activities to be addressed during the initial phase, in Kenya (and later extended to other interested partner countries in Eastern and Southern Africa). The relevant baseline information for Kenya on the range of technical as well as policy issues was assembled at this meeting.

Table 1.1.1 Ranking of insect pests in Kenya and status of readiness of control options for adoption as perceived at stakeholders meeting (February 1997)

CROP	INSECT PEST AND IMPORTANCE*	STATUS OF CONTROL OPTIONS (*)					
		CHEMICAL CONTROL (PESTICIDES)	BIOLOGICAL CONTROL	USE OF BOTANICALS	USE OF CULTURAL PRACTICES	USE OF TOLERANT CULTIVARS	OTHER METHODS
French beans	Bean flies (1)	B	B	B	B	B	-
	Bean flower thrips (1)	A	C	C	-	-	-
	Spider mites (2)	A	B	-	-	-	-
	Aphids (2)	A	-	C	B	-	-
	Helicoverpa sp. *Maruca* sp. (2)	A	C	C	-	-	-
	Cutworms (2)	A	C	-	B	-	-
Snowpea	Pod borers *Helicoverpa* sp. *Maruca* sp. (1)	A	C	C	-	C	-
	Aphids (2)	A	-	-	B	-	-
	Flower thrips (2)	C	C	C	-	-	-
	Cutworms (2)	A	C	-	B	-	-
Okra	Leaf miners (1)	A	B	B	B	-	-
Okra, Eggplant and Capsicum	Aphids and Whiteflies (1)	A	B	B	B	-	B
	Spider mites (2)	A	B	-	B	B	B
	Thrips (3)	A	B	-	-	B	-
Karella	Fruit fly	A	-	-	B	-	B

	(Melon fly) (1)						

(*) 1= IMPORTANT
2= LESS IMPORTANT
A= Research Completed - Ready for demonstration
B= Research Promising - Needs Verification before demonstration
C= Research Inadequate - Needs Intensification of research and further verification.

Table 1.1.2 List of hot spots identified for specific pest problems on export vegetable s in Kenya

CROP	PEST	DISTRICTS (SITES)
FRENCH BEAN	Thrips	Mwea/ Naivasha
	Whiteflies	Baricho
	Red spider mite	Mwea/ Yatta/ Mbooni
	Root rot	Vihiga/Meru/ Makueni/ Machakos
	Bean rust	Naivasha/ Thika
SNOWPEA	Ascochyta disease	Molo/ Timboroa/Limuru/ Kinangop
	Powdery mildew	Yatta/ Thika/ Embu
OKRA	Aphids	Nguruman/Loitokitok
	Powdery mildew	Nguruman
	Nematodes	Nguruman
EGGPLANT	Leaf miners	Kibwezi
CAPSICUM	Red spider mite (Eggplant)	Nguruman
BITTERGOURD	Nematodes	Kibwezi/ Mtito Andei
	Viral diseases	Kibwezi
	(Capsicums)	Coast
	Bacterial wilt	Coast/Nguruman/ Kibwezi/Mtito Andei
	Nematodes (Eggplant)	Yatta/ Nairobi

Table 1.1.3 Priority rankings assigned by stakeholders in Kenya among issues related to improved pest management for export vegetables (February 1997)

Issues	Priority Ranking*
Enabling farmers to recognize pests and beneficial organisms in the crop.	1
Guidance on deciding the need for pesticide use.	1
Availability of biological control technologies.	1
Advice on cultural practices that reduce pest severity.	1
Advice and availability of less persistent pesticides.	2
Advice on pesticide spray 'waiting period' before harvest.	2
Guidance on safety aspects in handling/ use of pesticides	2
Improved devices or methods for applying pesticides.	2
Availability of natural pest control materials from plants like neem.	3
Advice / availability of pest tolerant varieties.	3

*1 = Most important; 2 = Second in importance; 3 = Third in importance

1.2 On-farm surveys for pest damage

1.2.1 Pest problems and their severity on peas -pilot survey of 20 farms in Molo, Nakuru District, September 1996

A field survey was carried out on 20 farms in Molo, Nakuru district to assess the pest problems on peas (Table 1.2.1). Most of the farmers grew four cultivars- Kagoci, Kikuyu, Grano and Kigondoro. Among the crop production constraints, pest problems were perceived as the major biotic factor while soil, credit, seed supply and infrastructure/policy constraints were mentioned. None of the farmers have used insecticides while a majority (65%) has used fertilizer (diammonium phosphate) as input. All farmers expressed interest and need for technical guidance on pest control.

Table 1.2.1 Pest problems and their severity on peas -pilot survey of 20 farms around Molo, Nakuru District, September 1996.

Pest observed	% Farms in which Found
Aphids	70
Caterpillars	35
Cutworms	25
Pod borer (*Etiella*)	10

1.2.2 Pests and their severity in farmers vegetable crops, coastal Kenya, July -October 1996

The survey was done in coastal Kenya during July- October 1996, and involved 11 farms. Results showed that in eggplant 4 pests were found to be severe namely (Table 1.2.2). Beetle, caterpillars, sucking bugs and grasshoppers. Moderate damage by leafhoppers, leafminers and fruit borers were observed. In capsicum bugs, grasshoppers and caterpillars appeared to be severe while leafminers were moderate. The identity of many of them is being scrutinized and will be reported in due course.

1.3 On-station trials on pest spectrum and yield loss

Decisions on pest management are based on economic effects of pests. The information is particularly important in comparing the relative importance of different pests in order to allocate research, control and extension resources. Crop yield is affected by many factors. These include the distribution of pest in space and time, the response of plants to different climates and soils, and interactions between pests and diseases. The objectives of these studies were to determine the most vulnerable stages of crop growth to insect attack and establish the avoidable yield losses to these pests.

Methods. There were four treatments consisting of:
1. Vegetative stage protection; weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting from 2 weeks after emergence (WAE) up to flowering;
2. Reproductive stage protection, weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting from early flowering up to harvest;
3. Protection at both vegetative and reproductive stage and (weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting from 2 WAE up to harvest.
4. No protection.

1.3.1 Okra

The experiment was planted on 30 October 1996 at MPFS. Plot size was 9 m x 4.5 m with 6 replications using okra variety Pusa sawani. Entomological assessments consisted of visual scoring once in every two weeks for aphids, leaf miners, flower thrips, flea beetles, grasshoppers, leaf caterpillars, and pod bugs.

The experiment was planted again on 22 March 1997 and 16 May 1997 at MPFS. Plot size was 4m x 4m with 6 replications using the same okra variety Pusa sawani. Entomological assessment consisted of visual scoring once in every two weeks for aphids, leaf miners, flower thrips, flea beetles, grasshoppers, leaf caterpillars, and pod bugs.

There was moderate infestation (up to 50%) of the crop by aphids. Application of insecticide at both vegetative and reproductive stages significantly reduced the incidence of aphids in the crop. The incidence of flea beetles was light to moderate and its intensity increased with crop growth. Leaf miner incidence was low. Fifty per cent date of flowering was observed 36 days after emergence. There was no significant differences in yield between protecting at the vegetative stage (4.1%) or reproductive stage (6.5 %) alone (Table 1.3.1). However, maximum protection was obtained by protecting at both the vegetative and reproductive stages (20% yield loss). Further studies will be required to determine the optimum number of sprays at each of these crop growth stages.

The incidence of flea beetles was light to moderate in the 1997 studies (Table 1.3.2). Insecticide application significantly reduced flea beetle numbers. Leaf miner incidence was low. There was

no significant difference in yield between protecting at the vegetative stage or reproductive stage. In 1997, there was no yield advantage between the protected and unprotected treatments in both early and late plantings (Table 1.3.3). However, in protected treatments the numbers of damaged fruits were significantly lower than in untreated plots.

Table 1.3.1. The effect of protecting okra at different growth stages on yields and yield parameters (MPFS, 1996 SR)

Crop growth stage	Fruit (number)	Fruit damage (%)	Yield	Yield loss (%)
Vegetative stage	1843.6 ab	0.60 a	54.453 a	4.1
Reproductive Stage	2063 a	0.358	53.035 a	6.5
Vegetative + reproductive stage	1881 ab	0.473 a	56.757 a	0
No protection	1787 b	0.757 a	45.201 a	20.4
Prob.	0.04	0.07	0.10	

Table 1.3.2. The effect of protecting okra at different growth stages on the incidence of aphids, flea beetles and leaf miners at 6 weeks after emergence (MPFS, 1997 long rains early planting).

Crop growth Stage	Beetle No.	Aphid rating	Leaf Miner	Grasshoppers
Vegetative	6.83 a	1.07 a	1.0 a	1.0 a
Reproductive	2.33bc	1.07 a	1.0 a	1.0 a
Vegetative + reproductive	0.0 c	1.07 a	1.0 a	1.0 a
Untreated Control	11.5	1.13 a	1.0 a	1.0 a
F value	8.29**	0.18ns	ns	Ns

Table 1.3.3. The effect of protecting okra at different growth stages on the fruit yield and damage by *Helicorverpa armigera* and at harvest (MPFS, 1997 long rains early planting).

	Yield kg/plot	Damaged fruits (no.)	Damage by *Helicorverpa*	Damaged fruits (weight g)
Vegetative	7.86ab	47.3a	47.0a	333.0b
Reproductive	8.89a	36.7ab	35.3ab	133.3ab
Veg +Repro	7.41b	21.8b	21.5b	0.0 b
Untreated control	9.19a	37.8ab	52.3a	200.0a
F value	4.62*	3.26*	5.59**	4.79*

Plot size =11.5m^2

1.3.2 French Beans

The experiment was planted on 25 March 1997 at MPFS. Plot size was 4m x 3m with 3 replications using variety Monel. The treatments consisted of:

1. Vegetative stage protection; weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting from 2 weeks after emergence (WAE) up to flowering;
2. Reproductive stage protection, weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting starting from early flowering up to harvest;
3. Protection at both vegetative and reproductive stage and (weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting from 2 WAE up to harvest.
4. No protection

Plant pacing was 30 cm x 15 cm. Entomological assessment consisted of visual scoring once in every two weeks for aphids, leaf miners, flower thrips, grasshoppers, leaf caterpillars, and pod bugs. The experiment was repeated later in the season. The second planting was done on 16 May 1997 with similar treatments.

The pest incidence was generally low in both plantings (Table 1.3.4). Insecticide application significantly reduced flea beetle numbers. Leaf miner incidence was low. There was no significant difference in yield between protecting at the vegetative stage or reproductive stage. In protected treatments, the number of damaged pods was lower than in untreated plots though the difference was not significant.

Table 1.3.4. The effect of protecting French bean at different growth stages on yield and insect pests at 6 weeks after emergence (MPFS, 1997 long rains early planting)

Crop growth Stage	Yield kg /plot	Leaf caterpillars	Grasshoppers	Damaged pods (No.*)
Vegetative	9.263a	2.00b	1.07a	34.6a
Reproductive	8.283 a	1.67b	1.06a	32.3a
Vegetative + reproductive	8.61 a	1.53a	1.06a	31.3a
Untreated Control	7.943a	2.13a	1.13a	46.0a
F value	3.70	19.3**	Ns	2.43

Plot size =11.5m^2, * out of 250/pods

1.3.3 Snowpea

The experiment was planted at Mbita Point Field Station in the first cropping season of 1997. There were four treatments consisting of:

1. Vegetative stage protection; weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting from 2 weeks after emergence (WAE) up to flowering;
2. Reproductive stage protection, weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting starting from early flowering up to harvest;
3. Protection at both vegetative and reproductive stage and (weekly application of a mixture of 140 g ai/ha of dimethoate and endosulfan at 145 g ai/ha starting from 2 WAE up to harvest.
4. No protection

The pest incidence was generally, low therefore there was no difference between treatments on insects (leaf miners, leaf caterpillars, beetles, grasshoppers, thrips and *H. armigera*). There was no significant difference in yield between protecting at the vegetative stage or reproductive stage. However, maximum yield of 4480 kg/ha was obtained with protection at both reproductive and vegetative stage, compared with 3666 kg/ha at vegetative stage, 4309 at reproductive and in protected treatments and 4190 for the unprotected.

1.4 Understanding farmers' perceptions and constraints: Thika farmers' group consultations

A rapid rural appraisal was undertaken on 6 August 1997 on vegetable farmers group at Ngoliba sublocation, Gatuanyaga location, Thika District. This was carried out to enable us to understand their problems, priorities and needs for pest control on export vegetables. The survey was conducted jointly by ICIPE and Ministry of Agriculture (Thika) officials on a group consisting of 20 farmers including 7 women farmers. They are smallholder farmers and grow export vegetables as outgrowers for different exporters operating in the area.

Some important points relating to pest management based or rapid rural appraisal are summarized below:

1. Major crops grown: Capsicum, Eggplant, Bittergourd, French bean

2. Major pest problems: Aphids, Thrips, Whiteflies, Mites, and Caterpillars

3. Major methods adopted for pest control:
   Applying insecticides e.g. Dimethoate, Karate

4. Perceived problems in pest control:
   i) Pest control becomes less effective when pesticides are repeatedly used
   ii) We do not know how to select pesticides
   iii) We do not know what better methods can be tried for pest control

5. Request for information/assistance for improved pest control:
   i) Information on how to identify pests by damage/ in lifestages
   ii) Information on the good (beneficial) insects and how to conserve them
   iii) How to select and safely use chemical pesticides without bad effects on crop produce
   iv) What are the alternative to chemical pesticides and how to test/ use them?

The survey clarified their lack of knowledge on alternatives to pesticides and their eagerness to be involved in learning about rational pesticide use as well as alternatives to pesticides on their crops.

Understanding farmers' constraints: USAID consultant Dr. Walter Knausenberger discussing pest problems with a farmer.

2 FARMERS KNOWLEDGE/AWARENESS BUILDING THROUGH GROUP LEARNING MODELS (MODIFIED FROM FARMERS' FIELD SCHOOL SYSTEM)

2.1. Highlights of Nguruman community consultation -24 May 1997 for ICIPE assistance in improved pest management for sustainable export vegetable production

Highlights of the Nguruman community meeting held on 24 May 1997 are given below.
1. Participants: Representatives of export vegetables farmers groups, community elders, ministry of agriculture officers, HCDA, Exporters, ICIPE scientists (Annex 4).

2. Requests to ICIPE:

- To assist in reducing the cost of pest control in export vegetables
- To help in methods which can reduce the bad effects of pesticides
- To guide in testing/ using neem and any other good methods for pest control

3. Response from ICIPE:
- ICIPE is very willing to assist, but it should be possible to do so step-wise, because we need to just clearly know which pests are important on each crop in which part of the season they are more severe, how much loss they cause and then test the methods which we expect to be of use, besides training in identifying the bad and good insects in the crop/ field
- For this year, we could try to understand the locally occurring pests and their seasonality
- We should then prioritize 2-3 pests of each crop (okra, eggplant, capsicum, karella)
- We need to clarify the economic loss due to each of the major pests
- We should then locally test the new methods like use of neem, other locally available materials etc.
- We need to also test/ demonstrate the usefulness of biological control agents
- We should then train local farmers and extentionists in all the improved pest control methods
- We should also try to develop training materials to help in further local training activities

4. Partnership for action:
- ICIPE to assist as a partner both in developing a suitable project proposal and in exploring for funding support along with the community, Ministry of Agriculture, HCDA and any other stakeholders
- ICIPE to assist the extensionists in conducting a systematic awareness building training on pest ecology for frontline staff and farmers' leaders through a modified farmers' field school model as soon as possible.

Farmers knowledge and awareness building through group learning: Nguruman community consulting with ICIPE scientists on reducing pest problems in export vegetable crops

3 DEVELOPMENT AND TESTING OF INTEGRATED PEST MANAGEMENT COMPONENTS

3.1 Effect of neem sprays on the infestation by insect pests and other crop components in French bean (*Phaseolus vulgaris*)

ICIPE has been building awareness on the potential of neem, *Azadirachta indica* A. Juss. (Family Meliaceae), as a source of natural pesticides. Neem can be used in a variety of applications. However, its efficacy against many pests in East Africa has remained largely untested. The objective of this activity was to test various formulations and doses of neem against the common pests of French bean.

3.1.1 French bean study at Machakos

Method

The crop was planted on 18 April 1997 at Machakos. Plot size was 2m x 2m with 4 replications using the variety Monel with an inter-row spacing of 60 cm and within row spacing of 15 cm. The experimental design was a split plot with 6 main treatments namely:

Neem powder 25g/l- 0.5%
Neem powder 50g/l- 0.5%
Neem oil EC 15ml/l- 0.003%
Neem oil EC 30ml/l- 0.003%
Karate EC-3.25ml/l
Non-protected control

There were 2 subtreatments (spray regimes):

Weekly sprays (3) -Dates: 5/6/97, 12/6/97, 19/6/97
Fortnightly sprays (2) -Dates: 5/6/97, 19/6/97

Observations

Crop: i) Days to flower/maturity
ii) Dates of harvest
iii) Yield of green pods
iv) Scores for smell/taste
v) Damage and severity of green pods at harvest

Pests: i) Thrips-Sample of 10 flowers-4 periods (30/5/97- Pre treatment, 9/6/97,16/6/97,23/9/97)
ii) Aphids-Visual score (1-5)- 4 periods (30/5/97-Pretreatment, 9/6/97, 19/6/97,23/6/97)

iii) All pests-Visual score -weekly.

Scores: Aphids/Plant

1	< 10 (Little/ no infestation)	4	201-500 (Severe infestation)
2	11-50 (Light infestation)	5	> 500 (Very severe infestation)
3	51-200(Moderate infestation)		

Data on thrips counts was subjected to log transformation while that on aphid scores was subjected to square root transformation

Results

Up to 6 weeks after planting, the incidence of pests very low. Very light infestation was later observed of leaf miners, whitefly, red spider mites, leaf eating caterpillars and beetles, stem maggots and pod sucking bugs such as *Clavigralla* and *Nezara* (Table 1.3.1a).

It can be concluded that thrips control by neem appears to be satisfactory (significantly less insects than in unsprayed plots). However, aphid infestation did not appear to be satisfactorily controlled by neem sprays.

Conclusions

1. Due to the high aphid infestation, yield increase due to neem was not significant.
2. The number of sprays of neem did not differ significantly in effect on yield
3. Neem sprays did not seem to affect the taste of fresh pods.
4. Neem sprays did seem to affect the smell of fresh produce in some cases.

Table 3.1.1a Effect of neem sprays on the infestation by thrips and aphids on French bean, Machakos, 1997 long rainy season

Treatment	No. of Sprays	Week 1	Week 2	Week 3	Week 1	Week 2	Week 3
Neem powder 0.5%-25g/L	3	10.00cd	4.50b	11.50bc	3.50ab	3.00ab	3.25a
Neem powder 0.5%-25g/l	2	14.75abc	4.75b	13.50abc	3.25ab	3.50a	3.25a
Neem powder 0.5%-50g/L	3	6.75 ed	5.00b	9.75 c	3.25ab	3.50a	2.00c
Neem powder 0.5%-50g/	2	6.75 cde	4.50b	13.50abc	2.50bc	3.00ab	2.50bc
Neem Oil 0.003%-15ml/L	3	15.25bcd	4.00b	16.00abc	3.00ab	3.00ab	2.25c
Neem Oil 0.003%-15ml/L	2	17.50abc	4.00b	13.75abc	3.25ab	3.00ab	2.50bc
Neem Oil 0.003%-30ml/L	3	11.50bcd	8.25b	12.25bc	3.25ab	2.75ab	3.25ab
Neem Oil 0.003%-30ml/L	2	17.00abc	3.50b	11.00c	2.50bc	2.50b	2.50bc
Karate-3.25ml/L	3	4.00 ed	0.75c	0.00 d	1.75cd	1.50c	1.00d
Karate-3.25ml/L	2	3.25 e	7.75b	0.75 d	1.50d	1.25c	1.00d
Non-Protected (Control)	3	23.75ab	16.25a	26.50a	3.75a	3.50a	3.50a
Non-Protected (Control)	2	27.25a	8.00b	23.00ab	3.25ab	3.25ab	3.75a
	MEAN	13.15	5.94	12.63	2.90	2.81	2.56
	CV%	25.5	27.1	26.5	11.6	9.8	9.9
	LSD	10.3	5.3	11.3	1.0	0.7	0.8
Pr > F*	TRTS	.0001***	0.0051**	.0001***	.0001***	.0001***	.0001***
Pr > F	SPRAY	0.219NS	0.938NS	0.790NS	0.046*	0.356NS	0.735NS
Pr > F	SPRAY * TRT	0.868NS	.0001***	0.740NS	0.720NS	0.606NS	0.278NS

Table 3.1.1b : Effect of neem sprays on quality and quantity of green pods produced

Treatment	No. of Sprays	Mean damaged pods/10 pods	Mean damaged pods/10 pods (Combined spray)	Yield (Kg)/ 4^m
Neem powder 0.5%-25g/L	3	8.75	8.75 ab	0.91
Neem powder 0.5%-25g/L	2	8.75	-	0.80
Neem powder 0.5%-50g/L	3	10	9.375 ab	1.14
Neem powder 0.5%-50g/L	2	8.75	-	0.98
Neem Oil 0.003%-15ml/L	3	10	10.00 a	0.56
Neem Oil 0.003%-15ml/L	2	10	-	0.99
Neem Oil 0.003%-30ml/L	3	9.5	9.75 ab	0.99
Neem Oil 0.003%-30ml/L	2	10	-	0.79
Karate-3.25ml/L	3	5.75	6.75 c	1.68
Karate-3.25ml/l	2	7.75	-	1.26
Non-Protected control	3	9	8.25 bc	1.08
Non-Protected control	2	7.5	-	1.03
	MEAN	8.81	8.81	1.01
	CV%	10.51	10.51	7.48
	Pr > F	0.02	0.02	0.66

3.1.2 French bean neem foliar spray study at Mbita Point

Methods. There were six treatments consisting of 1. Neem seed kernel 25g/l 2. Neem seed kernel 50g/l 3. Neem oil EC 1ml/l, 4. Neem oil EC 2ml/l 5. Two-weekly application of a mixture of 140 g ai/ha of dimethoate and thiodan at 170 g ai/ha throughout crop growth; and 6. Non protected control. The experiment was planted on 12 November 1996 at MPFS. Plot size was 5m x 5.5m with 4 replications using the variety Monel with an inter-row spacing of 50 cm and within row spacing of 20 cm.

Results: There was no incidence of leaf miners, aphids, and grasshoppers up to 8 weeks after planting. Very light infestation was later observed on leaf thrips. There were no significant differences between the neem and the untreated control on the number of flower thrips. The differences between the neem and the insecticide mixture of dimethoate and thiodan on flower thrips were not significant (Table 3.1.2). Though there was no difference between the yield of French bean between the insecticide treatment and the neem formulations as much as 38.9% yield loss was observed with the neem oil 1ml/l formulation (Table 3.1.2).

Table 3.1.2. The effect of different neem formulations on the number of flower thrips and yield of French beans (MPFS, 1996 SR)

TREATMENT	Flower thrips 39 DAE	Flower Thrips 46 DAE	Flower Thrips 57 DAE	Yield Kg/ha	Yield loss (%)
Neem seed kernel 25g/l	46.5 ab	98 a	340.5a	5871 a	15.5
Neem seed kernel 50g/l	54 a	94 ab	310 ab	5672 a	18.3
Neem oil 1m/l	34 ab	72 ab	254.3 ab	4242 a	38.9
Neem oil 2ml/l	40.5 ab	73.5 ab	251.3 ab	5179 a	25.4
Dimethoate + thiodan	14 b	33.5 b	112.2 b	6944 a	0
Untreated control	63.5 a	129.8 a	440.0 a	4293 a	38.2

3.1 3 Neem foliar spray on okra

Methods. There were six treatments consisting of 1. Neem seed kernel 25g/l; 2. Neem seed kernel 50g/l; 3. Neem oil EC 1ml/l, 4. Neem oil EC 2ml/l; 5. Two weekly application of a mixture of 140 g ai/ha of dimethoate and thiodan at 170 g ai/ha throughout crop growth; and 6. Non protected control. The experiment was planted on 1 November 1996 at MPFS. Plot size was 5.25m x 4m with 4 replications using the variety Pusa Sawani.

The incidence of leaf miners was low so treatment differences could be discerned. There were significant differences between the neem and the insecticide mixture of dimethoate and thiodan on the flea beetle. However, there was no difference between the yield of okra between the insecticide treatment and the neem formulations as much as 36% yield loss was observed with the neem seed kernel formulation (Table 3.1.3). Neem seed oil at 2 ml appears to be the best formulation.

Table 3.1.3. The effect of different neem formulations on the yield of okra (MPFS, 1996 SR)

TREATMENT	Yield kg/plot	% Yield loss
Neem seed kernel 25g/l	19.65 ab	26.1
Neem seed kernel 50g/l	17.07 ab	35.8
Neem oil 1m/l	20.975 ab	21.1
Neem oil 2ml/l	21.625 ab	18.7
Dimethoate + thiodan	26.60 a	0
Untreated control	15.85 b	40.4

3.1.4 Snowpea neem foliar spray

There were six treatments consisting of 1. Neem seed kernel 25g/l; 2. Neem seed kernel 50g/l; 3. Neem oil EC 1ml/l, 4. Neem oil EC 2ml/l; 5. Two weekly application of a mixture of 140 g ai/ha of dimethoate and thiodan at 170 g ai/ha throughout crop growth; and 6. Non protected control. The experiment was planted on 8 November and germinated on 18 November 1996. Plot size was 5m x 5m with 4 replications using the variety Cascadia with an inter-row spacing of 50 cm and within row spacing of 20 cm.

Leaf caterpillars rating damage was light in all treatments at all sampling times. There was also a low incidence of *Helicoverpa armigera* in the study. The maximum recorded was 5 larvae in 40 plants in the untreated control 9WAE (Table 3.1.4a). There was no cut worm incidence when the crop was sampled at 3 and 5 WAE. However, during the sampling at 7 WAE the highest cut worm density of 24 larvae was recorded from 40 plants in the neem oil 2m/l treatment, whilst the insecticide mixture of diamethoate and thiodan had only 3. There was no incidence of aphids throughout the study. Light leaf miner damage was recorded in all treatments at all sampling times. There was no difference between the yield of snowpeas. However, the highest yield was obtained with the neem oil 2 ml/l formulation. A maximum yield loss of 33.8 % was observed (Table 14). The application of neem did not reduce the amount of seed damage (Table 3.1.4b).

Table 3.1.4a. The effect of different neem formulations on the number of *Helicoverpa armigera* per 10 plants at different sampling times in snowpea (MPFS, 1996 SR)

TREATMENT	3WAE	5WAE	7WAE	9WAE
Neem seed kernel 25g/l	0.5	0.25 a	0.75 a	0.50 a
Neem seed kernel 50g/l	0 a	0 a	0.75a	0 a
Neem oil 1m/l	0 a	0 a	0.5 a	0 a
Neem oil 2m/l	0 a	0 a	0.75 a	0 a
Dimethoate + thiodan	0 a	0.25 a	0 a	0 a
Untreated control	0 a	0 a	1.25 a	1.25 a

Table 3.1.4b. The effect of different neem formulations on the yield of snowpea (MPFS, 1996 SR)

TREATMENT	Yield/plot kg	Yield loss %	Seed damage
Neem seed kernel 25g/l	3.255 a	33.8	10 bc
Neem seed kernel 50g/l	3.742 a	23.9	12.25 bc
Neem oil 1m/l	4.102 a	16.7	16.0 abc
Neem oil 2ml/l	4.923 a	0	22.75 a
Dimethoate + thiodan	4.765 a	3.2	8.0 c
Untreated control	4.222 a	14.2	19.5 ab

3.2 Biocontrol options

In the 1997 long rains, two experiments were initiated on the use of biocontrol agents. The first trial at Jomo Kenyatta University was on the use of Metharizium ansopliae on flower thrips in French beans. This was repeated at Mbita Point Field Station. The second experiment comprised the use of Bt to control lepidopterous pests in snowpea. A list of natural enemies has been compiled for major pests in export vegetable crops (Annexes 9).

3.3 Evaluation of cultivars for pest tolerance and adaptation

3.3.1 Okra varietal trial

A study to establish the yield loss caused by insect pests in okra was conducted in the second cropping season of 1996 at the Mbita Point Field Station. The experiment was sown in a four-replicate trial in a randomized complete block design. The treatments were 8x2 factorial (8 okra cultivars and 2 insect protection levels). The eight cultivars were Parbhani, Abhay, Dwarf Green, Aminike, Kangwani, Louisiana velvet, Pusa sawani and Spineless clemson. The protection treatments were achieved by two-weekly applications of a mixture of 140 g ai/ha of dimethoate and thiodan at 170 g ai/ha throughout crop growth. Plot size was 5.25 m x 3 m. The okra spacing was 75 cm in the inter- row and 30 cm within the row. Entomological assessments during crop growth was conducted both visually and destructively at two weekly interval starting from 4 WAE (weeks after emergence). Scoring plants damaged on a 1-5 scale carried out visual assessment. At harvest, dissecting 10 fruits per plot did destructive sampling of fruits. The fruit weight was determined at harvest. Data for each parameter were subjected to analysis of variance. To stabilize variance, the data on insect larval and pupal density, were transformed to logarithms (x + 1) before analysis. Arcsine transformation was used for percent plants damaged. Mean separation was obtained using Ryan-Einot-Gabriel-Welsch Multiple Range Test.

The study was repeated in the first cropping season of 1997 at the Mbita Point Field Station. The experiment was sown in a four-replicate trial in a randomized complete block design on 10 April 1997.

Results There was a light infestation by flea beetles followed by grass hoppers and leaf caterpillars during the first 4 WAE. From the 6 WAE, aphids and leaf miners have increased from none to light infestation. There were significant differences between number of fruit damaged with the highest number reaching 4% in Kangwami. There were significant differences between yields of cultivars ($P< 0.0001$) and protection ($P<0.02$). There was no interaction between cultivar and protection ($P< 0.86$). The yield of Pusa sawani was significantly greater than all the other

cultivars (Table 3.3.1a). Abhay was the second highest yielding variety. There were differences in susceptibility of the 8 varieties tested. This is indicated by the differences in level of yield losses observed (Table 3.3.1a). Parbhani and abhay were identified as resistant and the least resistant variety being spineless clemson with 18 % yield loss. Pusa sawani was moderately resistant with a yield loss of about 8%. The resistance observed in these two cultivars are interesting. They should be further tested under high insect pressure.

There was light infestation of flea beetles, grasshoppers and leaf caterpillars during the study the 1997 study. There was no significant difference between the cultivars in their reaction to these pests (Table 3.3.1b). However, there were significant differences between number of fruit damaged by *H. armigera* at harvest with Parbhani having the least number of damaged fruits. There were significant differences between yields of cultivars ($P < 0.001$) with Spineless clemson giving the highest yield and Loiusiana velvet the least

Table 3.3.1a Effect of different cultivars on the yield loss in okra (MPFS, 1996 SR).

Cultivar	Yield Protected kg/15.75m^2	Yield Unprotected kg/15.75m^2	Yield Loss (%)
Parbhani	12.09	12.62	+0.04
Abhay	13.56	13.23	0.22
Dwarf Green	10.82	9.19	15.06
Aminike	13.67	11.75	14.04
Kangwani	9.31	8.24	11.49
Louisiana velvet	9.53	8.55	10.28
Pusa Sawani	17.29	15.93	7.86
Spineless Clemson	12.92	10.53	18.49

Table 3.3.1b Yield and yield parameters of different okra cultivars (MPFS 1997LR)

Treatment	Yield kg/15.75m^2	Healthy fruits (No.)	Number of fruits damaged by *H. armigera*
Parbhani	9.292bc	386.67	9.8c
Abhay	8.868bc	443.3a	17.3abc
Dwarf Green	8.175bc	388.8a	12.3c
Anamike	9.190bc	519.7a	22.3ab
Kangwani	10.108ab	509.7a	20.3ab
Louisiana velvet	7.648c	440.5a	22.7a
Pusa Sawani	9.990ab	472.2a	17.7abc
Spinesless Clemson	11.535a	439.3a	17.5abc
F value	6.58**	2.02	4.05*

3.3.2 Snowpea varietal trial

Five varieties were evaluated at MPFS for adaptability and pest resistance. The varieties tested were Cascadia, Green Feast, Sugar snap, Oregon II, and Prussian Blue. The varieties except for Cascadia appeared to be un adapted to the lake Basin environment and failed to produce any yields. They were also affected by powdery mildew. *Helicorverpa Armigera* and aphids were predominant in the season but there no varietal differences observed.

3.4 Other potential pest control options

3.4.1 French bean fertilizer/tillage studies

A study to confirm the beneficial effects of common cultural practices in reducing the infestation of stem maggots in French beans was conducted in the second cropping season of 1996 at the Mbita Point Field Station. The experiment was sown in a four-replicate trial in a randomized complete block design. The treatments were 3x2x2 factorial (3 levels of nitrogen 0, 45, 90 kg/ha; 2 levels of phosphorous 0 and 45 kg /ha; and two types of land cultivation: planting on the flat and planting on ridges). Plot size was 4 m x 5 m. The spacing was 65 cm in the inter-row and 15 cm within the row. The crop was planted on 13 November 1996.

The study was repeated in the first cropping season of 1997 at the Mbita Point Field Station. The experiment was sown in a four-replicate trial in a randomized complete block design. The treatments were 4x2 factorial (4 levels/sources of nitrogen and phosphorous (0kg, farm yard manure at 20.8 tons/ha, 46 kg P with 18 kg N/ha, 0, 45, 90 kg/ha; 92 kg P with 36 N kg/ha) and two types of land cultivation: planting on the flat and planting on ridges). Plot size was 6 m x 4 m. The spacing was 30 cm in the inter-row and 15 cm within the row. The crop was planted on 27 March 1997.

Results

There were no significant differences between treatments and the number of bean fly maggots. A trend was observed where the number of stem maggots was on average 19.8% lower in the crops planted on the flat than those on the ridges (Table 3.4.1a). Though there was no significant differences in yield between treatments, the highest yield was obtained with 45 kg phosphorous plus 45 kg nitrogen per ha treatment (Table 3.4.1b).

In the second study due to low incidence of bean fly, there were no significant differences between treatments and the number of bean fly maggots. Again, a trend was observed where the number of stem maggot damaged plants was about 6% higher in the crops planted on the ridges than those on flat. Though there was no significant differences in yield between treatments, the ridging treatment gave 11% higher yield than planting on the flat.

Table 3.4.1a. The effect of fertilizer and cultivation on number of larvae and pupae of stem maggots in French beans, mean of 3 sampling times (MPFS, 1996 SR)

Fertilizer kg/ha Nitrogen	Phosphorous	Ridge	Flat
0	0	3.75 a	2.5
45	0	4	2.83
90	0	3.417	2.58
0	45	4.08	3.75
45	45	4.334	3.833
90	45	3.58	3.083

Table 3.4.1b. The effect of fertilizer and cultivation on the yield of French beans (MPFS, 1996 SR)

Fertilizer kg/ha Nitrogen	Phosphorous	Number of pods	Yield kg/ha	Yield loss (%)
0	0	3.75 a	5871 a	15.5
45	0	2.5 a	5672 a	18.3
90	0	2.25 a	4242 a	38.9
0	45	2.5 a	5179 a	25.4
45	45	1.25 a	6944 a	0
90	45	3.5 a	4293 a	38.2

Farmers' concern: Over dependence on pesticides highlights the need for alternatives

4. CAPACITY BUILDING FOR NATIONAL TECHNICAL PERSONNEL

4.1. Kenya Horticultural Development Authority technical officers' training

For updating the technical field officers of the Horticultural Crops Development Authority (HCDA) of Kenya on improved crop protection, one-day refresher training workshop was held. There were 35 participants including from other projects and farmers' organizations. A total of 12 resource persons from ICIPE and other organizations provided the scientific book up. The participants adjudged the course contents and structuring as good to very good (Annexes 5-7). Course contents included the following: Causes of vegetable diseases and control, insect pests of tropical vegetables, potential for biological control, biocontrol using bacterial pathogens, use of botanicals, pesticide residues and pre-harvest interval, safe use of pesticides and resistance management, cultural practices in vegetable farming, weed control in vegetable crops

4.2. African Regional Vegetable Production Training Courses

A regional training course for vegetable production practitioners jointly organized by the Israel Government and University of Nairobi during July/August, 1997 invited the project Coordinator (Dr. S. Sithanantham) for a lecture-cum discussion session for a group of about 24 middle level professionals drawn from 8 countries in the region. This contribution was commended through a formal letter of appreciation.

4.3. M.Sc./M. Phil. Research Training

A M.Phil Project of Moi University (Kenya) on "Non target effects of neem in export vegetables" commenced in June 1997 and to complete by April 1998. This is being supervised by the project Coordinator (Dr. S. Sithanantham).

By special arrangement with the Kenyatta University (Kenya), four MSc research topics were identified as below:

- Bioecology of pests on okra capsicum and eggplant.
- Bioecology of pests on cucurbits, vegetables (including bittergourd).
- Evaluation of neem on pests and beneficial insects on okra/pea.
- Potential for insect pathogens in control of caterpillar pests on vegetables.

The students are preparing to initiate the research from April 1998.

5. NETWORKING WITH REGIONAL/NATIONAL INITIATIVES ON THEMES

5.1. For Kenya, most of the partner institutions concerned with export vegetable production/protection were linked up with the project in different activities. Some of these are as below:

- Horticultural Crops Development Authority (HCDA)
- Fresh Produce Exporters Association of Kenya (FPEAK)
- Kenya Agricultural Research Institute (KARI)
- Kenya Institute Of Organic Farming (KIOF)
- Pesticide Safe Use Project (GIFAP)
- GTZ - IPM Horticulture Project
- Kenya Small Scale Farmers' Association (KESSFA)
- Association for Better Land Husbandry (ABLH)

5.2. Invitations for partnership input were also received by ICIPE from Zanzibar (Tanzania) and the Invest for Development of Export Agriculture (IDEA) project from Uganda (Annex 10 and 11).

6. COMMUNICATIONS/PUBLICATIONS

The project staff participated in the following seminars/workshop
- Workshop on Export Horticulture - Protrade/HCDA (14-15 April 1997) at KARI headquarters
- National workshop on Horticultural Research and Development of Agriculture and Technology, January 30-31, 1997, Panafric hotel
- Horticultural Export Seminar, FPEAK Kenyatta Conference Centre, 13-15 March 1997

The following communications were also prepared for explaining the project goals and activities.
- Scientific articles - 2
- Lecture outlines - 2
- TV coverage - 1
- Radio coverage - 1

Annex I

ICIPE staff and collaborators

SCIENTISTS	Project (P) Core (C)	Time Allocation (MY)
1. Dr. S. Sithanantham, Coordinator	P	0.4
2. Dr. K. Ampong-Nyarko, Agroecologist	P	0.2
3. Dr. B. Overholt, Biocontrol Specialist	C	0.1
4. Dr. M. Odindo, Mass Rearing Specialist	C	0.1
5. Dr. G. T. Lako, Social Scientist	C	0.1
6. Dr. Ana Varela, Training Materials Specialist	Cs	0.1
7. Dr. K. V. Seshu Reddy, Applied Ecologist	C	0.1
SUPPORT STAFF		
1. Ms. Lizzie Chongoti, Research Assistant	P	1.0
2. Mr. Walter Ogutu, Research Assistant	C	0.2
3. Mr. Moses Mbeke, Technical Assistant	P	1.0
4. Mr. Gideon Jira, Technical Assistant	C	0.2
5. Ms. Diana Muiruri, Documentalist (Temporary)	P	1.0
6. Site Technicians (4) (Temporary)	P	4.0

P = Project Support (USAID) C= Core (ICIPE) Contribution
Cs = Consultancy

Other collaborators/ resource persons assisting in the project

Anyango J.J, KARI
Dr. Mburu D, KARI
N., Ngatia J, KARI
Chris Mukindia FPEAK -
Walter Knausenberger, USAID -
Dennis Weller, USAID -
Dennis McCarthy USAID -
Maria Kulei USAID -
Njau George, KIOF
Dr. John Aston, Safe use project -
Zeev Carmi, Israel Embassy/UON
Dr Agong Stephen G JKUAT

Annex 2

List of stakeholders participating in priority setting meeting in Kenya, 26-27 February 1997

Name:	Title/ Institution/ Department
MINISTRY OF AGRICULTURE, LIVESTOCK DEVELOPMENT AND MARKETING	
1. Antony Bainito Atonya (Mr.)	Divisional Agricultural Extension Officer, Magadi
2. Muriuki Susan (Mrs)	Assistant Director of Agriculture (Horticulture), Nairobi
3. Smollo David (Mr.)	District Horticultural Crops Marketing Officer, Kajiado
4. Gateri Anthony M. (Mr.)	District Crops Officer, Thika,
5. Waithaka Mercy (Ms)	District Horticultural Officer, Thika
KENYA AGRICULTURAL RESEARCH INSTITUTE	
6. Webule Mary (Mrs)	Assistant Director (Horticulture), KARI Hq, Nairobi.
7. Ikitoo Edwin Caleb (Mr.)	Principal Research Officer, (KARI Hq), Nairobi
8. Kambo Caesar M. (Mr.)	Research Officer, (Entomologist), NHRC- Thika
9. Kedera Chagema John (Dr.)	Head, Plant Quarantine Station, Muguga
10. Kega Vincent M. (Mr.)	Centre Director, Matuga Regional Research Sub-Centre
11. Kibata Gilbert N. (Mr.)	Crop Protection Co-ordinator, NARL, Kabete
12. Maranga Charles Ton'gi (Mr.)	Research Officer, National Pyrethrum R. Centre-Molo
13. Ondieki D. Nyamongo (Mr.)	Research Officer, National Genebank of Kenya-Muguga
UNIVERSITIES	
14. Agong Stephen G. (Dr.)	Chairman, Department of Horticulture, JKUAT, Juja
15. Ambogo Enos (Mr.)	Lecturer JKUAT, Juja
16. Mbuvi, Joseph Peter (Prof.)	Lecturer IDRDUniversity of Nairobi, Kabete
17. Olubayo Florence M. (Dr.)	Lecturer University of Nairobi, Kabete
18. Wagithi Elizabeth Wanja (Ms.)	Lecturer Department of Zoology, JKUAT, Juja
FARMERS GROUPS/ ORGANISATIONS:	
19. Lese-iio Musa Parirong (Mr.)	Chairman, Osupuko Self Help Group-Nguruman
20. Pukare Stephen (Mr.)	Vice - Chairman, Nguruman Farmers Group Ranch
21. Kuira Susan M. M. (Ms)	Technical Officer, Horticultural Crops Development Authority (HCDA), Nairobi
22. Mukindia Chris (Mr.)	Field Technical Manager, FPEAK
23. Ouko Jotham Ooko (Mr.)	Chief Horticultural Inspector, HCDA
REGIONAL HORTICULTURAL PROJECTS	
24. A. A. Seif (Dr.)	Pathologist GTZ-IPM Horticulture Project
25. Bernhard Lo'hr (Dr.)	Project Co-ordinator, GTZ-IPM Horticulture Project

26. Brigiette Nyambo (Dr.) IPM Specialist, CAB Institute of Biological Control, Kenya

27. Suzzane Michalik (Ms.) Ph. D Student, GTZ-IPM Horticulture Project

ICIPE

28 Dr. Hans R. Herren
29 Dr. A. Hassanali
30. Dr. S. Sithanantham
31. Dr. K. Ampong-Nyarko
33. Dr. B. Overholt
34. Dr. M. Odindo
35. Dr. G. T. Lako,
37. Dr. Ana Varela
38. Dr. K. V. Seshu Reddy
39. Ms. Lizzie Chongoti
40. Walter Ogutu

Annex 3

PROGRAMME OF STAKEHOLDERS CONSULTATION MEETING FOR IMPROVEMENT OF PEST MANAGEMENT ON EXPORT VEGETABLES IN KENYA

Wednesday 26 February 1997:

08.00 - 09.00 Registration
09.00 - 10.30 Inaugural Session
09.00 - 09.10 Welcome and introduction: Dr. S. Sithanantham, Project Coordinator, ICIPE
09.10 - 09.20 Inaugural address: Dr. Hans R. Herren, Director General, ICIPE
09.20 - 09.35 Policy and priority issues affecting pesticide use in export vegetables-Mrs. Susan Muriuki -Directorate of Horticulture, MOALM
09.35 - 09.50 Export horticulture and pest management-interdependence-Mr. J.O. Ouko, HCDA
09.50 - 10.05 Research priorities and pest management concerns in export vegetables-Mrs. Wabule-Asst. Director, KARI
10.05 - 10.20 Regional research and training in improved pest management in export vegetables- Dr. Bernard Lohr, GTZ-IPM Horticulture
10.20 -10.30 Farmers' concerns in vegetable pest management-A representative

10.30-11.00 Group photo and tea break

Concurrent working group sessions:

11.00 - 12.30 Session A: Needs and priorities for exporters/farmers
Chair: Mrs. Susan Muriuki, MOALM
Co-chair: Mr J.O. Ouko, HCDA
Rapporteur: Dr. K.Ampong-Nyarko, ICIPE

Session B: Needs and priorities for research/extension
Chair: Mr. G. Kibata, KARI- NARL
Co-chair: Prof. J. P. Mbuvi, UON
Rapporteur: Dr. M. O. Odindo, ICIPE

12.30 - 14.00 Lunch Break

14.00 - 15.30 Joint Session (for discussing sessions A and B)
Chair: Dr. B. Lohr, GTZ-IPM Horticulture Project
Co-chair: Dr. C. Karuiki, KARI, Muguga
Rapporteurs: Drs Ampong-Nyarko/Odindo, ICIPE

15.30 - 16.00 Tea Break

16.00 - 17.30 Concurrent Sessions:

Session C: Technology options for French beans and Snowpea.
Chair: Dr. J.K.O Ampofo, CIAT, Arusha
Co-chair: Dr. Brigitte Nyambo, IIBC/CAB International
Rapporteur: Ms. Susane Michalik, GTZ-IPm Horticulture Project

Session D: Technology options for Okra, Eggplant, Karella, and Capsicum
Chair: Dr. A. M. Varela - Entomologist/Consultant, ICIPE
Co-chair: Mr. G.M Kibata, KARI-NARL
Rapporteur: Dr. S.Sithanantham, ICIPE

Thursday 27 February 97:

08.30 - 10.00 Joint Session (for discussing sessions C and D)
Chair: Dr. F.A Olubayo - UON Department of Crop Sciences
Co-Chair: Mr. Vincent Kega, KARI, Matuga
Rapporteurs: Ms. Susane/Dr. S. Sithanantham

10.00 - 10.30 Tea Break

10.30 - 12.30 Session E: Farmer-participatory strategies for IPM development
Chair: Prof. F. Kiros, ICIPE
Co-chair: Mr. A. B. Atonya , MOALD&M, Nguruman
Rapporteur: Mr. Vincent Kega, KARI, Matuga
Lead paper, Dr. Brigitte Nyambo, IIBC

DISCUSSION/RECOMMENDATIONS

12.30 - 14.00 Lunch Break

14.00 - 16.00 Session F: Progress and plans for 1996-97

Chair: Dr. S. Agong-JKUAT
Co-chair: Dr. S. Sithanantham, ICIPE
Rapporteur: Dr. K.Ampong-Nyarko, ICIPE

16.00 - 16.30 Tea Break

16.30 - 17.30 Concluding Session
Chairperson: Mr. G. M. Kibata, KARI, NARL
Highlights of the work groups sessions, Sithanantham, ICIPE
Brief remarks by USAID representative, Mr. Dennis McCarthy
Chairperson's remarks
Closing remarks- Prof. A. Hassanali- Deputy Director General, ICIPE
Vote of thanks- Dr. K. Ampong-Nyarko, ICIPE

Annex 4

SPECIAL TOPICS RELATING TO RATIONAL PESTICIDE USE AND ALTERNATIVE METHODS FOR IPM IN EXPORT VEGETABLES COVERED IN GROUP LEARNING MEETINGS AT NGURUMAN

Topics	Resource Person	Institution
1. Identifying diseases problems	Dr. A.A. Seif	KARI/ GTZ IPM Hort **(12 Aug. 1997)**
2. Identifying nematode problems	Mr. Zeev Carmi	Israel Embassy/ UON **(12 Aug. 1997)**
3. Safe use of pesticides and pesticide resistance management	Dr. John Aston	Safe Use Project **(22 Aug. '97)**
4. Insect pest pathogens (e.g *B.t*)	Mrs. Matilda Oketch	ICIPE **(24 Oct. 1997)**
5. Beneficial insects	Mr. J. J. Anyango	KARI **(7 Nov. 1997)**
6. Pesticide residues in produce	Mr. Joseph Ngatia	KARI **(19 Sept. 1997)**
7. Waiting periods for pesticides	Mr. Chris Mukindia	FPEAK **(19 Sept. 1997)**
8. Weed control in vegetables	Dr. D.N Mburu	KARI **(3 Oct. 1997)**
9. Organic farming	Mr. George Njau	KIOF **(13 Oct. 1997)**
10. Cultural practices in veg. prod.	Dr. K. Ampong-Nyarko	ICIPE **(7 Nov. 1997)**
11. Use of botanicals (neem)	Dr. A. M. Varela	ICIPE**(17 Oct. 1997)**

Benefits To Farmers

1. Empowerment with knowledge on pest ecology and capacity for scouting.

2. Awareness on pesticide residue problems and need for their rational use.

3. Opportunity to participate in testing improved technologies.

Annex 5

KENYA HORTICULTURAL DEVELOPMENT TECHNICAL OFFICERS TRAINING WORKSHOP

PROGRAMME

08.00 - 08.20 Registration
08.20 - 08.30 Welcome speech: Dr. Hans Herren, Director General, ICIPE
08.30 - 08.45 Introductory remarks: USAID-Representative (Dr. Dennis Weller)
08.45 - 09.00 Inaugural speech: Mr. S.B. Rotich, Chairman, HCDA
09.00 - 09.30 GTZ IPM Horticulture Project - Achievements for the last 3 years: Dr. B. Lohr, Leader, GTZ-IPM Horticulture Project
09.30-10.00 KARI Research on Pest Management in Vegetables and role of IPM: Mr. G. Kibata, KARI-NARL

10.00 - 10.30 Tea/Coffee break

10.30 - 11.00 Disease problems in vegetable crops: Dr. A. A. Seif, KARI/GTZ Hort
11.00 - 11.30 Insect pests in vegetable crops - Dr. S. Sithanantham, ICIPE
11.30 - 12.00 Biocontrol with beneficial insects vegetable crops: Dr. W. A. Overholt, ICIPE
12.00 - 12.30 Safe use of pesticides and managing pesticide resitance: Dr. J. Aston, SUP-GIFAP

12.30 - 13.30 Lunch break

13.30 - 14.00 Pesticide residues and waiting periods to use pesticides, Mr. Ngatia, KARI
14.00 - 14.30 Biocontrol with insect pathogens in vegetables: Ms. Matilda Oketch, ICIPE
14.30 - 15.00 Use of botanicals (neem): Dr. A.M. Varela, IICPE
15.00 - 15.30 Cultural practices in vegetable farming: Dr. K. Ampong-Nyarko, ICIPE
15.30 - 16.00 Weed control in vegetable production: Dr. D. N. Mburu, KARI

16.00 - 1630 Coffee break

16.30 - 17.15 Open Group discussion (led by: Mr. J. O. Ouko HCDA; Drs. G. T. Lako and S. Sithanantham, ICIPE)
(a) Participant Evaluation and Assessment of the Workshop
(b) HCDA-ICIPE Collaboration in Pest Management in vegetables

17.15 - 17.25 Concluding Remarks: Dr. Akke J. van der Zijpp, Deputy Director General, Research, ICIPE
17.25 - 1730 Vote of thanks: Dr. S. Sithanantham, Project Coordinator, ICIPE

Annex 6

SUMMARY OF PARTICIPANTS' APPRAISAL OF THE TRAINING WORKSHOP

ASPECT/TOPIC	SCORE	CATEGORY
1.PLANNING AND COORDINATION		
1.1. Course Structure	1.7	Very good
1.2. Time Regulation	2.2	"
1.3. Audio Visual Facilities	2.2	"
1.4. Documentation notes	1.9	"
1.5. Tea/ Food arrangements	1.9	"
OVERALL	**2.0**	**Very Good**
2.INDIVIDUAL THEMES/TOPICS COVERED		
2.1. GTZ-IPM Highlights	2.2	Very good
2.2. KARI-IPM Highlights	2.6	Good
2.3. Diseases of Vegetable Crops	2.6	Good
2.4. Pests of Vegetable Crops	2.2	Very good
2.5. Biological Control Parasitoids	2.6	Good
2.6. Biological Control Pathogens	2.6	Good
2.7. Safe Use of Pesticides	2.2	Very good
2.8. Pesticide Residues	3.1	Good
2.9. Neem Use	2.6	Good
2.10. Cultural Practices	2.5	Good
2.11. Weed Control	2.7	Good
OVERALL	**2.5**	**GOOD**

SCORES: 1= Exellent 2= Very good 3= Good 4= Satisfactory 5= Poor

Annex 7

FOLLOW-UP ACTIVITIES REQUESTED BY PARTICIPANTS FOR ICIPE ASSISTANCE

	TOPICS OF INTEREST						
REQUESTING TRAINEE	GTZ-IPM	KARI-IPM	Diseases	Pests	Bio-Control (Parasitoids)	Bio-Control (Pathogens)	Safe use of pesticides
MUNUANG'O A.	B	-	C	C	-	B	-
KUIRA SUSAN	-	-	-	-	A	A	-
KIPTOON I.	A	-	-	-	B	B	-
NG'OSOSEI	-	-	A	A	-	-	C
YAKO W.	-	-	A	A,C	B	-	-
KAMAU F.	-	-	-	-	-	B	C
KITHUSI GRACE	-	-	A,C	A,C	A,C	A,C	A,C
KENDUIWA	-	-	A,C	A,C	A,B,C	-	A,C
JELAGAT F.	A,C	A	A	A	-	-	-
NGEKA N.	-	-	-	A	-	-	A
SAGINI RUTH	-	-	-	B,C	-	-	-
LUTA A.	-	-	A	A	A,B	A,B	A,C
WAMWEA J.W.	-	-	A	A	A,B,C,	-	-

A= training, B = trial, C= Demonstration

Annex 8

LIST OF INSECT PESTS FOUND ASSOCIATED WITH EXPORT VEGETABLE CROPS IN KENYA, 1996-97

CROP	ORDER	FAMILY	SCIENTIFIC NAME	COLLECTED /REARED[1]
Frenchbean	Coleoptera	Curculionidae	*Sphrigodes subdemudatus* Hust.	Collected
Frenchbean	Coleoptera	Chrysomelidae	*Luperodes quaternus* Frm.	Collected
Snowpea	Coleoptera	Tenebrionidae	*Gonocephalum simplex* F.	Collected
Snowpea	Lepidoptera	Noctuidae	*Plusia circumflexa* L.	Reared
Snowpea	Lepidoptera	Noctuidae	*Diacrisia investigatorum* Karsch	Reared
Snowpea	Coleoptera	Chrysomelidae	*Epilachna hirta* Thunbg.	Collected
Snowpea	Coleoptera	Cantharidae	*Silidius* sp.	Collected
Snowpea	Heteroptera	Cicadidae	*Platypleura divisa* Germ.	Collected
Snowpea	Heteroptera	Coreidae	*Plectrocnemia bicolor* Hag.	Collected
Snowpea	Heteroptera	Pyrocorrhidae	*Dysdercus cardinalis* Gerst.	Collected
Snowpea	Lepidoptera	Pieridae	*Pontia helice* L.	Reared
Snowpea	Lepidoptera	Lycaenidae	*Lampides boeticus* L.	Reared
Snowpea	Lepidoptera	Noctuidae	*Helicorvepa armigera*(Hubn)	Reared
Snowpea	Orthoptera	Acrididae	*Phymateus viridipes* Stal.	Collected
Snowpea	Coleoptera	Chrysomelidae	*Monolepta lence* Olivier	Collected

Brinjals	Coleoptera	Chrysomelidae	*Epilachna hirta* Thunbg.	Collected
Brinjals	Coleoptera	Chrysomelidae	*Epilachna fulvosignata* Sic	Collected
Brinjals	Coleoptera	Curculionidae	*Nematocerus* sp	Collected
Brinjals	Coleoptera	Meloidae	*Epicanta albovittata* Gerst .	Collected
Brinjals	Coleoptera	Meloidae	*Coryna apicicornis* (Guer)	Collected
Capsicum	Coleoptera	Curculionidae	*Systates sauberichi* Fst.	Collected
Capsicum	Heteroptera	Lygaeidae	*Lygaeus festivus* Thumb.	Collected
Okra	Coleoptera	Anthicidae	*Motoxus jeanneli* Pic.	Collected
Okra	Heteroptera	Pyrrocorhidae	*Dysdercus cardinalis* Gerst.	Collected
Okra	Heteroptera	Pyrrocorhidae	*Dysdercus nigrofasciatus* Stal.	Collected
Okra	Heteroptera	Lygaeidae	*Oxycaremus hyalinipennis*Costa.	Collected
Okra	Lepidoptera	Pyralidae	*Acylolomia* sp.	Reared
Okra	Lepidoptera	Noctuidae	*Earias biplaga* Wlk.	Reared
Okra	Lepidoptera	Noctuidae	*Earias insulana* Boisd.	Reared
Okra	Lepidoptera	Papilionidae	*Papilio demodocus* Esper	Collected
Bittergourd	Coleoptera	Chrysomelidae	*Copa delata* Er.	Collected
Bittergourd	Hemiptera	Coreidae	*Leptoglossus membranaceus* F.	Collected
Bittergourd	Hemiptera	Coreidae	*Anoplocnemis curvipes* F.	Collected

[1]**COLLECTED: Found on the plant; REARED: Completed its development on the plant**

Annex 9

NATURAL ENEMIES ON PESTS OF EXPORT VEGETABLE CROPS

CROP	PEST ORDER	FAMILY	GENUS/ SPECIES	PREDATOR PARASITE
Brinjals	Coleoptera	Coccinellidae	*Cheilomenes lunata* F.	Predator
Brinjals	Hymenoptera	Formicidae	*Camponotus rufoglaucus* St.zulu Em.	Predator
Capsicum	Heteroptera	Reduviidae	*Harpactor albopilolus.*	Predator
Chillies	Hymenoptera	Eurytomidae	*Eurytoma* sp.	Parasitoid
Chillies	Heteroptera	Reduviidae	*Harpactor tibialis* Stal.	Predator
Cucumber	Heteroptera	Nabidae	*Nabis capsiformis* Germ.	Predator
Cucumber	Hymenoptera	Eulophidae	*Cirrospilus ambiguus*	Parasitoid
Cucumber	Hymenoptera	Eulophidae	*Hemiptarsenus varicornis*	Parasitoid
Cucumber	Hymenoptera	Formicidae	*Camponotus rufoglaucus* St. zulu Em.	Predator
Okra	Coleoptera	Coccinellidae	*Exochomus ventralis* Gerst.	Predator
Okra	Coleoptera	Coccinellidae	*Cheilomenes lunata* F.	Predator
Okra	Coleoptera	Coccinellidae	*Platynapsis capicola* Crotch.	Predator
Okra	Heteroptera	Reduviidae	*Phonoctonus grandis* Sign.	Predator
Okra	Heteroptera	Reduviidae	*Harpactor pandorus* Scop.	Predator
Okra	Hymenoptera	Sphecidae	*Notogonia* sp.	Predator

Snowpea	Coleoptera	Coccinelidae	*Cheilomenes lunata* F.	Predator
Snowpea	Coleoptera	Coccinelidae	*Chnootriba manderi* F.	Predator
Snowpea	Coleoptera	Coccinelidae	*Cryptolaemus vicina* Muls.	Predator
Snowpea	Coleoptera	Coccinelidae	*Hippodamia variegata* Goeze	Predator
Snowpea	Diptera	Syrphidae	*Syrphus cognatus*	Predator
Snowpea	Hymenoptera	Eulophidae	*Oomyzus sokolowskii*	Parasitoid
Snowpea	Hymenoptera	Eulophidae	*Meruana liriomyzae* Boucek	Parasitoid
Snowpea	Hymenoptera	Braconidae	*Diaeretiella rapae*(McIntosh)	Parasitoid

Annex 10

Agribusiness Development Centre (ADC)
Uganda's Investment in Developing Export Agriculture (IDEA) Project
Tel: (256) 41 255 482/3 & 41 255 468/9
Fax: (256) 41 250 360

October 31, 1997

Dr. S. Sithanantham
International Centre of Insect Physiology and Ecology
P.O. Box 30772
Nairobi, Kenya

Dear Dr. Sithanantham,

RE: PEST MANAGEMENT ON VEGETABLES

Thank you for your letter dated October 29, 1997.

The ADC is working closely with export vegetable growers in Uganda, who have doubled the value of their exports over the past two years. They urgently need training in pest and disease control techniques which are acceptable to their customers in Europe. In effect, this means IPM methods, since European consumers and EU food safety legislation allow only minimal use of chemicals.

Further to our discussion, and after reviewing the reports which you provided, we would be interested in specific collaboration in the following areas:-

- A meeting of export growers and other stakeholders, to assess and prioritize needs
- Training of IDEA Field Officers and other extension workers so that they can transfer IPM techniques to export growers
- Group training of farmers in the main vegetable production areas of Kampala, Kabale and Kasese
- Supportive research on target crops (passion fruit, french beans, capsicum, okra, and apple banana)

We welcome your initiative and wish to be considered as a stakeholder in your project.

Yours sincerely,
ADC IDEA PROJECT

S.W. New

Dr. Steve New
HORTICULTURAL ADVISOR

Address:
Plot 18 Prince Charles Drive
Kololo

Mail:
P.O. Box 7007
Kampala, Uganda

Annex 11

Plant Protection Division of Zanzibar
Ministry of Agriculture, Livestock and Natural Resources
P.O. Box 1062, Zanzibar, TANZANIA
Tel/Fax: (255) 054-32110 E-mail: PPDZNZ@twiga.com

REF NO. PPD 4/5/1/97

17 September 1997

To the Director General
P.O.Box 30772
ICIPE, Nairobi, Kenya.

Dear Sir,

Sub: **VEGETABLE CROP - PROBLEMS OF PESTICIDES AND NEED FOR IPM AS AN ALTERNATIVE -**

Please this letter refers to the above subject.

The development and implementation for sustainable ecologically compatible methods under Integrated Pest Management (IPM) is our national policy and priority since the beginning of 1994. In Zanzibar vegetable crop constitute an important source of dietary supplementation, besides generation of regular income for a large number of small holder farm families. There is an urgent need to locally evaluate and demonstrate environment friendly methods of pest management, since presently they mostly depend upon pesticides.

Therefore the Ministry of Agriculture and Department of Plant Protection in Zanzibar are strongly recommending ICIPE to lead in this priority sector of our Agriculture and assist in sustaining and even enhancing the income generation potential of small holder farmers growing vegetable crop. Our Agroecosystem, valuable biodiversity and fragile environment of the Isles need to be well protected from dangers of degradation by misuse or over use of pesticides.

Please we would highly appreciate if you include us as partners in any of ICIPE future networking initiatives for information exchange research collaboration and training in capacity building for helping us in developing and implementing of improved pest management options towards sustainable vegetable production in Zanzibar.

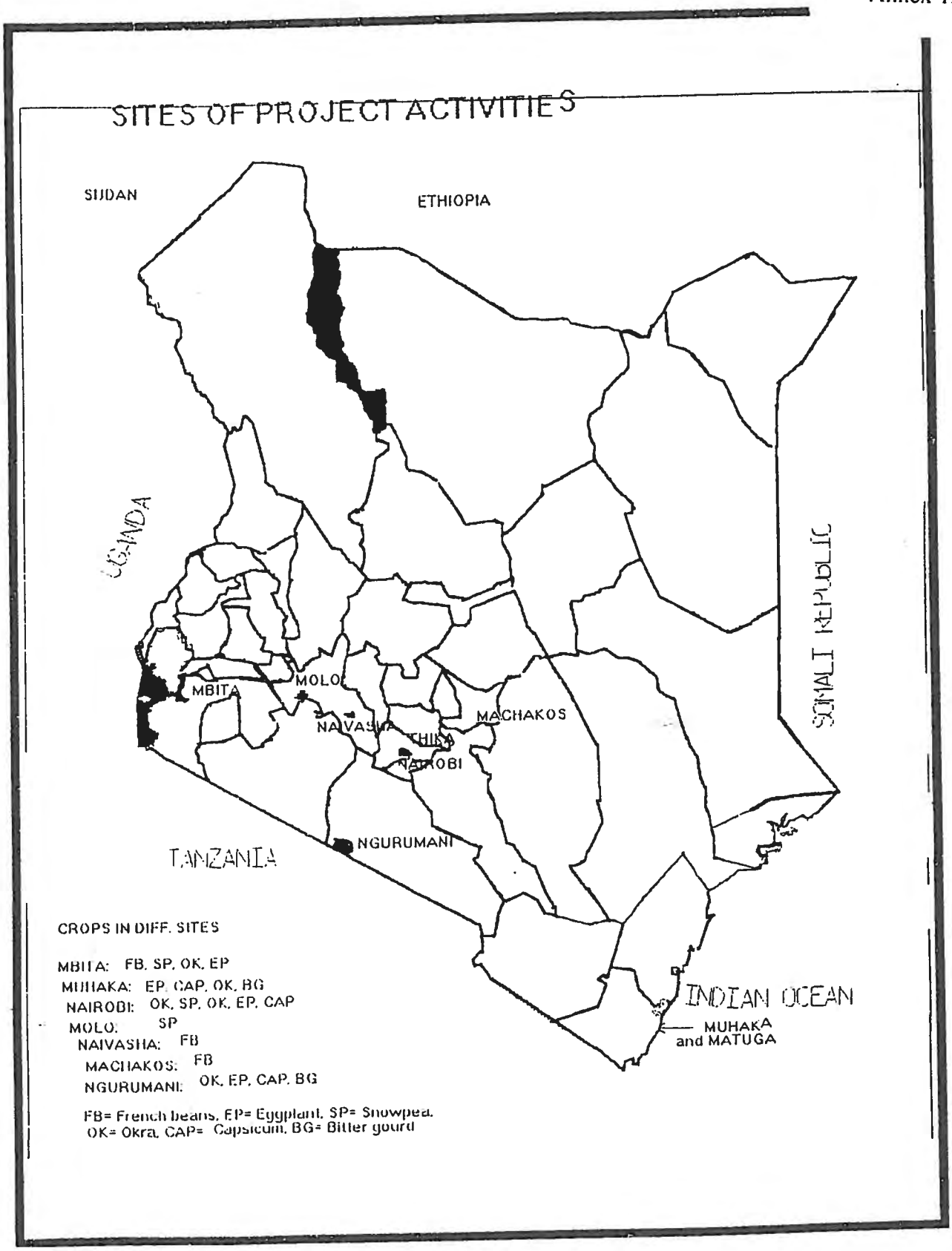
We look forward for the best of your response.

Thank you in Advance.

Yours Sincerely,

Mberik R. Said
Head of Plant Protection Division
Zanzibar.

Annex 12


SITES OF PROJECT ACTIVITIES
SUDAN
ETHIOPIA
UGANDA
SOMALI REPUBLIC
MBITA
MOLO
NAIVASHA
MACHAKOS
NAIROBI
NGURUMANI
TANZANIA
INDIAN OCEAN
MUHAKA
and MATUGA
CROPS IN DIFF. SITES
MBITA: FB, SP, OK, EP
MUHAKA: EP, CAP, OK, BG
NAIROBI: OK, SP, OK, EP, CAP
MOLO: SP
NAIVASHA: FB
MACHAKOS: FB
NGURUMANI: OK, EP, CAP, BG
FB= French beans, EP= Eggplant, SP= Snowpea,
OK= Okra, CAP= Capsicum, BG= Bitter gourd