Integrated Pest Management Training Workshop Report

Scaling up: Training of adult education teachers on general principles of crop husbandry and integrated pest management KARI-Kisii, Kenya

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CIAT- Arusha
P.O. Box 2704
Arusha, Tanzania

KARI - Kisii
Regional Research Centre
P.O. Box 523
Kisii, Kenya

Farmer group activity reports for the DFID Crop Protection Programme (CPP) Bean IPM Promotion Project in eastern and southern Africa

Written and Edited by
E.M. Minja, J. Ogecha, J.K.O. Ampofo and H.A. Mziray

For distribution to Village Information Centres (VICs) in bean growing areas in eastern, central and southern Africa.

Introduction

The common bean is an important food and cash crop in western, central and eastern Kenya. In southwestern Kenya (Kisii and Rachuonyo districts), beans are grown mostly by small-scale farmers. The majority of these farmers are poor rural women. Insect pests, diseases and poor soils are among the major constraints to increased bean production. The two districts cover medium to high altitude slopes (1500-1800 m.a.s.l.) that are densely populated. Farm fields are commonly small (0.2-0.4 ha) and soils are highly leached. Bean farmers in Kisii and Rachuonyo have formed research groups since 1994 to collaborate with the Kenya Agricultural Research Institute (KARI) at Kisii on experimentation and evaluation of management options for crop and livestock production constraints. The major bean pests in the area include bean stem maggots (BSM), aphids, pod borers, bruchids and diseases e.g. root rots.

Farmer groups at Bototo (Kisii) and Otondo (Rachuonyo) have taken lead in experimenting with BSM tolerant genotypes, seed dressing, use of botanicals as sources of insecticide, earthing-up and other cultural practices, use of animal and green manures and mixtures of organic and small quantities of inorganic fertilizers. Farmer groups at Otondo demanded to have extension materials and other relevant information within their reach. To achieve this, they requested the local divisional chief to assist and in response he offered part of his office to be used as a village library (village information centre - VIC).

When the zonal adult education officer for Homa Bay and Rachuonyo learnt of this, he participated in the inauguration (June 2002) of the VIC and joined in as collaborator to furnish part of the premises and use it for adult literacy campaigns.

The Ministry of Health also became a partner shortly later to use the same for HIV/AIDS campaigns in the area. Most of the adult education teachers in the southwestern Kenya are farmers. As the teachers became aware of the purpose of the VICs, they also demanded to be enhanced to disseminate the IPM information to farmers attending the adult education classes.

The Bototo groups admired their Otondo colleagues and organized themselves to build a library in the past one year using their own resources. They have formed partnerships with the Ministry of Health who use the same premises for HIV AIDS campaigns for Bototo area. A one-day workshop for Rachuonyo adult education teachers was organised and hosted by KARI Regional Research Centre at Kisii on 15 May 2003 to address the demand.

Objective

To equip adult education teachers with skills on principles of crop production and integrated pest and soil nutrient management to enhance their capacity in IPM information dissemination to adult education class participants.

Participants

Nine (5 men and 4 women) adult education teachers including the Homa Bay/Rachuonyo zonal officer participated in the workshop. An agronomist and entomologist based at KARI-Kisii were the two resource persons who facilitated the workshop. CIAT entomologist provided backstopping during discussions. Extension officers were also expected to attend but they could not make it because of heavy rains (24 hour non-stop during the week) that inconvenienced some of the participants commuting from their distant locations in Rachuonyo district.

Focus area

The crop production areas covered during the workshop included - Agronomic principles of crop husbandry and General principles of insect pest management. An afternoon session of farmer field visits was cancelled due to heavy rains.

Participants briefly viewed on-station experimental and demonstration plots for different crops. The teachers also developed interest in viewing improved dairy animals (cattle and goats) and forages.

A. Workshop meeting

1. Agronomic principles of crop husbandry

Trainer: Ms Margaret Onyango, Researcher, KARI-Kisii

- **History of cultivated crops:** All cultivated crops were domesticated from their wild species. Most of the crops spread into new areas from their centres of origin (e.g. China, Egypt, South Asia and Tropical America) through migrants and traders.
- **Present position of agriculture in Africa** - Most countries in Africa depend on agricultural crops for food and cash income.
- **Soils and soil fertility** - Soils support plant growth. The ability of the soil to constantly provide the required plant nutrients for high

crop yields is referred to as soil fertility. Soil fertility is affected by the parent rock, soil erosion (soil conservation) and management.

- **Cropping systems** - Shifting cultivation, continuous cropping, crop rotation, sole cropping (monoculture), intercropping, relay cropping, strip cropping, mixed cropping (growing different crops in different mixtures especially when land is scarce).
- **Common bean (field beans - *Phaseolus vulgaris*) cultivation** - Most important food grain legume grown in the tropic and sub tropic-regions.

Agronomic practices for common (field) beans cultivation

The common beans are the best known and most widely cultivated species of *Phaseolus*. They are grown for their dry grain, immature pods, shelled green bean, leaves used as spinach and haulm used for fodder. Beans are probably native to

tropical South America but they are grown throughout the cooler tropics (Latin America, Brazil, China, Mexico and USA, India, and Africa). In Africa, common beans are grown in Kenya, Uganda, Rwanda, Tanzania, Ethiopia, Malawi, Burundi, DR Congo, Zambia, Cameroon, Madagascar, Mozambique and Sudan.

- **Cultivation:** Beans are seldom grown as a sole crop under smallholder production systems. The crop is usually intercropped with maize, bananas, sweet potato, cotton and coffee. Rotation with other annual crops (maize, wheat, sorghum, Irish potatoes and vegetables) is also common. As a legume, beans are able to fix atmospheric nitrogen into the soil to help improve soil nutrient levels for the following crop. Continuous cultivation of beans on the same piece of land is not advisable because of the build up of diseases and insect pests.

- **Land preparation:** Deep ploughing early in the season is most appropriate. Incorporate crop residues into the soil to improve soil fertility. Harrow the field a few days before planting.

- **Planting:** Planting should be done when the soil is sufficiently moist and at the appropriate time during the season to avoid peak periods of insect pests and diseases. Sow 2-3 seeds per hole at 50-75 x 10-15 cm spacing. The seed rate is about 60 kg/ha but his may vary due to seed size.

- **Moisture requirements:** Adequate moisture is essential during germination to flowering and pod filling stage. Water stress results in stunted growth, flower and pod shedding that leads low yields.

- **Disease and pest management:** Plants should be inspected regularly from

germination and appropriate plant protection actions implemented accordingly.

- **Harvesting and storage:** When bean pods loose the green colour, the bean seeds are mature. If cultivars are non-shattering, they can be harvested when the moisture content of the seed is between 10-12%. Allow pods to dry for 1 week if harvesting is done early. Pods should be threshed and grain winnowed. The seed should then be dried further to 10% moisture content. Store seed/grain under hygienic conditions.

- **Yields:** Average yields under smallholder production are low (200-600 kg/ha). Improved cultivars grown under improved management practices including insect pest and disease control can yield 1000-1500 kg/ha.

2. General principles of insect pest management

Trainer: Mr John Ogecha, Researcher, KARI Kisii

Definition of pest:

It is an organism (plant or animal) that is troublesome to man and his interest or an organism whose presence is not required. Regarding insects, they are defined as pests when their numbers have increased in the field to a level of causing economic damage or losses on crops.

Factors that lead to pest problems:

- Modern farming that has replaced the balanced mixed cropping system with large hectares of monocultures

- Improved high yielding crop varieties that are highly susceptible to pest attacks
- Abundant food supplies that have stimulated pests to multiply fast leading to outbreaks
- Wide scale use of synthetic pesticides and fertilizers that have accelerated the development of resistance/tolerance to pesticides among some of the pests
- Pests have evolved to synchronise their reproductive cycles with the availability of food, i.e. biological clock
- Weather (temperature, rainfall and humidity) patterns that affect pest incidences and population growth and hence determine the damage.

Types of damage:

- **Direct damage**
  - Destruction of the assimilative plant parts

- Damage to roots and stems that causes disruption in the transportation of nutrients in the plants
- Sucking of plant sap (juices) that contain nutrients and hormones for the plants causing stunting and wilting of plants
- Damage to seed embryo that leads to loss in seed viability (quality) and quantity
- Damage to flowers and fruits that leads to abortion and reduces crop yields.

- **Indirect damage**
  - Disease transmission - some insect pests are vectors of various plant diseases including Leafhoppers that transmit maize streak viruses, Whiteflies that transmit several types of viruses to crops and Aphids that transmit the bean common mosaic virus (BCMV) and the groundnut

rosette viruses (GRV)

- Loss of crop quality - damaged bean seeds (storage bruchids), damaged cabbage leaves and bored tomatoes where crops do not fetch the right market price or they totally loose their market value.

Pests of crops

a. Cereal crops (maize, sorghum, rice, millets)

- African armyworm (*Spodoptera exempta*) - These green and/or black-stripped larvae appear in large masses and feed only on plants in the grass family (pasture and cereal crops). The larvae pupate in the soil and adult moths fly at night. The moths are attracted to light and as such light traps have been used to monitor their incidence but more recently the pheromone traps have been adopted

- Stalk/stem borers (*Busseola fusca*, *Chilo partellus*, *Sesamia calamistis*, *Eldana saccharina*) - Damage is caused by the larva (borer) when they feed in the leaf whorls in the early stages of the crop and later feed within the stem or stalks where they make tunnels

- Sorghum shoot fly (*Antherigona soccata*) - The larvae (maggots) attack sorghum seedlings where they destroy the growing point, causing dead hearts

- Sorghum midge [*Stenodiplosis* (=*Cantarinia*) *sorghicola*) - The larvae (maggots) attack the flowers and feed on the developing embryo thereby preventing seed formation in sorghum heads (the result is empty or chaffy heads)

- Plant sucking bugs (various species including aphids) - Using their piercing and

mouth parts, the bugs' nymphs and adults suck sap from developing seeds on sorghum heads and transmit diseases that lead to loss in quality and quantity.

- Aphids and leafhoppers - aphids suck plant sap from leaves and developing seeds. Leafhoppers also transmit diseases including the maize streak virus.

- Root pests (cutworms, grubs, etc.) - These are the larval stages of moths and beetles respectively, that live in the soil and feed on roots and seedlings.

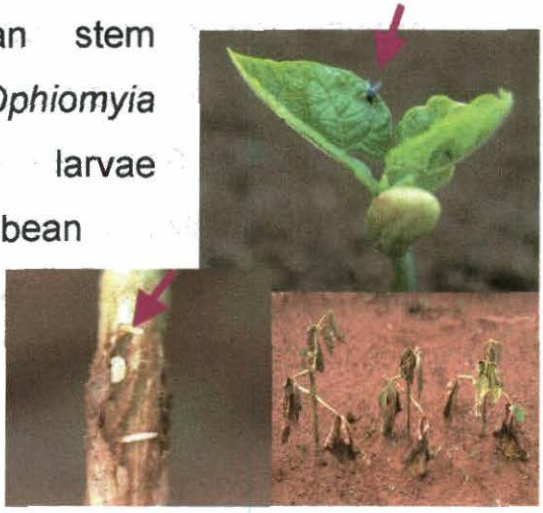
- **Storage pests:**
  - Grain weevils - the larvae live in the seed and feed by tunnelling through the grains
  - Grain beetles - e.g. the larger grain borer that has recently become the most serious pest of maize. Both larvae and adults feed on the grain and

other materials including wooden structures

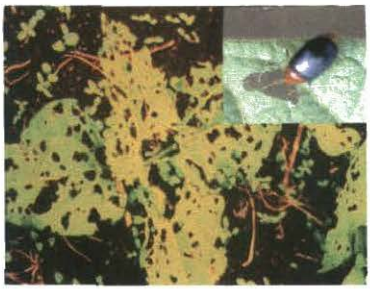
- Grain moths - e.g. the tropical warehouse moth (*Sitotroga cereallela*). The small dark moths fly around the stores. The larvae feed on the grains while making webs between seeds.

b. Grain legume crops (beans, cowpea, pigeonpea, green gram, *Dolichos*)

- Bean fly (Bean stem maggot - BSM, *Ophiomyia* spp.) - the larvae (maggots) attach bean and cowpea seedling leaves and stems



- Bean foliage beetle - BFB (*Ootheca* spp.) - Larvae feed on roots in the soil and adults feed on leaves especially at seedling stage immediately after germination



- Aphids - they suck plant sap causing stunted growth and transmit diseases including the bean common mosaic virus
- Defoliators - Semi-looper (*Plusia orichalcea*) and cotton bollworm defoliate bean leaves. The cotton bollworm causes leaf damage in the absence of flower buds, flowers and pods
- Pod borers (Cotton bollworm - *Helicoverpa armigera*, cowpea pod borer - *Maruca vitrata*). Larvae (caterpillars) feed on developing flowers, pods and seeds

- Plant sucking bugs - These pierce and suck sap from tender growing plant parts including stems, flower buds and flowers, pods and developing seeds. This leads to premature drying and dropping of affected parts. It also exposes the plants to fungal infection

- Flower beetles - These are brightly coloured beetles (in yellow, orange and red bands on black wing covers) that feed on flowers of various plants including legumes. The larvae live in the soil feeding on other soil pests

- Thrips - Nymphs and adults of these very small insects have rasping and sucking mouthparts. They feed on flower filaments, pollen, petals, soft stems and leaves. Heavy infestations cause flower drops and stem/leaf wilting

- Soil pests - Cutworms, wireworms (click beetle larvae) and grubs. Larvae live in the soil and feed on plant roots and stems. Cutworms come to the surface to feed on seedlings at night and burrow into the soil before daybreak

- Storage bruchids - Serious pests of stored grain. Some of the species (*Acanthoscelides obtectus*) infest the crop in the field before harvest and is carried to the store with the grain while *Zabrotes subfasciatus* infests the crop only during storage.

c. Pests of vegetables and horticultural crops (cabbage, onion, pumpkin, tomatoes, other leaf vegetables, bananas, oranges, avocado, guava, etc.)

- **Foliage feeders**
  - Diamondback moth larvae on cabbage and other Brasiccae
  - Cabbage saw fly on cabbage family
  - Cotton bollworm on tomatoes and other crops
  - Thrips on onions
  - Mites
  - Looper caterpillars
  - Cucumber beetles
  - Flea beetles on onions and spider weed
- **Sucking pests**
  - Plant bugs
  - Leaf hoppers, aphids, white flies that also transmit diseases

- **Flower/fruit pests**
  - Cotton bollworm
  - Plant bugs
  - Fruit flies (attack tomato, pumpkin, oranges, avocado, guava, etc.)
- **Pests of stems**
  - Banana weevil - larvae tunnel the stems
  - Onion maggots
- **Soil pests**
  - Cutworms, Chafer (white) grubs, crickets, etc. - These feed on the roots and other underground plant parts.

d. Pests of oil crops (groundnuts, simsim, sunflower, soybean)

- Cotton bollworm - attacks sunflower heads and defoliates groundnut
- Aphids - feed on groundnut and transmits groundnut rosette viruses

- Simsim flea beetle - feeds by puncturing holes on seedling leaves causing intensive and extensive defoliation soon after germination
- Simsim (=sesame) webworm - larvae web simsim leaves and capsules and feed on them
- Simsim gall midge - larvae (maggots) feed on developing seeds causing the capsules to develop into solid galls
- Semi-looper (*Plusia* sp.) - defoliates soybean leaves
- Plant bugs, e.g. the green stink bug (*Nezara virdula)* suck plant sap
- Hairy caterpillars - various types feed on leaves reducing the photosynthetic area.

e. Pests of root and tuber crops (cassava, sweet potato, Irish potato)

- Cassava green mite - causes chlorosis of cassava leaves, leaf bunching and stunted growth
- Sweet potato weevils - Larvae tunnel stems and tubers
- Sweet potato butterfly - Larvae attack the leaves and stems
- Wireworms - damage Irish potato tubers
- Potato tuber moth - Larvae attack Irish potato tubers in storage by feeding through tunnelling.

Principles of pest management

- It is not possible to eliminate pests and therefore the basic principle is to manage them through understanding the factors that govern their populations to reach economic

threshold level and cause losses

Economic threshold level is the lowest pest population density that will cause economic damage and hence loss. This level varies from crop to crop

- Control methods to prevent economic damage have to start early and this requires regular and frequent field visits (scouting) keeping records of observations to be able to select suitable options

- A farmer's objective is to minimize risks and maximize profit, therefore the control options should be within farmers' capability

- When selecting pest control options, consideration should be made on the outcome of the effect, e.g. some of the insecticides are harmful to man, beneficial organisms and the environment (water systems, food chain, etc.)

Tools for pest management

Farmers, researchers and extension agents have through efforts and experiences, gained substantial background knowledge and varied experiences in pest control and have developed a framework within which pest management options can be applied. The available techniques for controlling individual pests can be grouped into the following categories:

i) Cultural methods or use of agronomic practices

- **Adjustment of planting time to avoid periods of high pest population peaks**
  - Early planting may result in less pest attacks
  - Delayed planting may favour less pest damage

- Early harvested crops are less exposed to storage pest infestation when pest attacks originate from the fields
- Use of resistant/tolerant plant genotypes e.g. EXL 52, G 8047, CNF 5513, KK 8 (SCAM 80 CM/15), KK 22 (RWR 719) for bean stem maggots
- Crop rotation - in the case of bean pests, this is useful in situations where bean stem maggot and root rot occur together
- Post harvest tillage and deep tillage (ploughing) to expose soil pests to desiccation and natural enemies
- Ridging or earthing up soil around the plants - useful for bean stem maggots, bean root rot and sweet potato weevil control
- Destruction of crop residues - useful in cereal stem borer and bean stem maggot control

- Mulching - helps to conserve moisture and minimises stress to affected plants
- Use of manures (animal and green manures) - to improve soil nutrients and conserve moisture for strong plant vigour
- Intercropping - helps to form barriers during pest movement across non-host plants and smells from other plants may repel some pests (e.g. smells from tomatoes intercropped with cabbage repel diamond back moth). Some intercrops also provide shelter for natural enemies to some pests. Other plants such as elephant grass, attract stem borers of maize and sorghum but these pests do not survive well on the grass.

ii) Physical methods

All these methods help in the control of storage pests:

- Humidity regulation
- Temperature regulation e.g. sunning
- Air regulation e.g. airtight storage

iii) Biological methods

We are all encouraged to protect naturally occurring pest control agents and even artificially increase their numbers.

- Insect pests have other insects that feed on them (predators) and help in regulating pest population e.g. ladybird beetles on aphids and other insects. Other predatory organisms include birds, lizards, chameleon, frogs, bats, spiders and man. Other organisms feed within the body of

insect pests (parasitoids) and they include the larvae of various wasps and nematodes.

- Insects are affected by diseases caused by fungi (*Metarhizium* sp.), bacteria (*Bacilus thuringiensis* - B.T. or Dipel), and

viruses (Nucleopolyhedrosis virus - NPV).

iv) Chemical methods

The use of insecticides has been the most common chemical method for insect pest control. Botanical (plant materials) and conventional (synthetic) insecticides are frequently used by farmers.

- Botanical plants used as sources of insecticides include Pyrethrum flower extract contains (Pyrethrin), Neem tree (*Azadirachta indica*, *Melia* sp.), Pepper

(*Capsicum* spp.), Wild onion (*Allium sativum*), Tobacco (Nicotine), *Tephrosia* spp., *Tithonia diversifolia*, *Datura stramonium*, *Vernonia* spp., etc.

- Synthetic insecticides - Conventional insecticides are widely used for pest control. They are effective against the major insect species and some have broad-spectrum activity. These insecticides are however, highly poisonous and should be handled with most care. They also contaminate the environment and frequent use leads to resistance development among some pests.

Types of synthetic insecticides

- Organochlorines - these were the first generation of synthetic insecticides that have long residual properties (hard

pesticides). These include Aldrin, Chlordane, DDT, Dieldrin, Gamma BHC (Lindane), etc. Because of their persistence in the environment and hence their detrimental effects to human and other organisms, most of them have been banned from use except a few that have remained on the market under restricted use (e.g. Lindane).

- Organophosphates - These have a broad-spectrum activity against insects, mites and ticks. Although some of them are highly toxic and dangerous to apply (e.g. Parathion), they have short residual properties to the environment. Some of them have systemic action (transported through the food chain in the plants). Examples of organophosphate insecticides include Malathion (used in field crops, vegetables and storage pests), Diazinon

Dylox vapona, Disyston, Dimethoate (Rogor), Systox and Thimet.

- Carbamates - These are broad spectrum pesticides used against insects, mites and nematodes. Some of them have systemic action. Examples include Baygon, Sevin (Carbaryl), Furadan (Carbofuran) and Temik.

- Synthetic pyrethroids - These are broad-spectrum insecticides that have quick knock down effect and last for a very short period in the environment. Examples include Karate, Ripcord, Ambush, Baythroid, etc. They should be used with care because they kill most natural enemies in the environment and common insect pests including the cotton bollworm (*Helicoverpa armigera*) have developed resistance against this group of insecticides.

Mode of action for different insecticides

- Stomach poison - effective when ingested by the pest e.g. chewing insects
- Contact poison - effective by entry through the exoskeleton or skin
- Nerve poison - affects the nervous system causing paralysis
- Fumigants - effective through the respiratory system.

Pesticide application techniques

- Spraying - chemicals formulated as emulsifiable liquid concentrates (e.c.) or wettable powders (w.p.)
- Dusting/drilling - chemicals formulated as dusts or granules.

Pesticide handling

- Pesticides are toxic poisons that kill humans and other organisms

- All pesticides need to be locked up before and after use away from children and other people. They should be stored in a cool dry place
- Read the label carefully when purchasing and follow instructions during application
- Don't handle pesticides when you have injuries on the skin
- Don't eat or smoke while handling pesticides
- Use protective gear when handling pesticides (overall, gum boots, hand gloves, face masks, etc.)
- Wash hands, body and application gear (clothes, sprayer, buckets, etc) with soap and water soon after application
- In case of poisoning - provide the patient with first aid (wash the whole body with a lot of water) and then take the person quickly to the nearest clinic/hospital.

What are the "Principles of Integrated Pest Management"?

Integrated pest management entails the judicious use of cultural, biological, physical and botanical/synthetic pesticide options to maintain pest levels below the economic damage level. It involves a stepwise use of a wide range of technologies that suit the specific crop, pest problem, environment and farmer's economic ability.

B. On-station field tour of different crop demonstrations and livestock breeding section

Participants had only half an hour to tour field crop demonstrations before the afternoon heavy rains started. The crops in demonstration plots were beans, groundnut, maize, indigenous vegetables (including *Cleome* spp., *Solanum* sp. and *Amaranthus* sp.), sweet potatoes, sorghum, finger millet, cabbage, onion, bananas, and cucurbits. The group acquired knowledge about appropriate agronomic practices, pest incidences and some management options. Participants viewed the livestock in the sheds after the field tour.

Beans: Participants were able to learn about bean genotypes that are tolerant (XL 52, G8047) and susceptible (local cultivar) to the bean stem maggot (BSM). Plants in the susceptible plot were yellow and wilted despite the abundant rains and their stems were swollen at soil surface level with cracks where fly puparia were visible. Tolerant plants in adjacent plots were dark green and healthy. The group were also shown bean plants with aphid colonies and natural enemies (different species of lady bird beetles). Each group member was very happy to learn about the pests and their natural enemies.

Sweet potato: The group observed the damage and management of sweet potato weevil (*Alcidodes* sp.) and viewed different potato varieties.

Spider flower (*Cleome* sp.): The group were exited about the promotion of indigenous vegetables by research and extension authorities

and gained knowledge on establishment, harvesting and sale on the local market. The young crop was highly infested by flea beetles.

C. Expectations of workshop trainers and trainees

- Wider dissemination of IPM technologies through adult education teachers and trainers
- Adult education teachers and trainers to assist in the translation of extension materials into local languages.

List of Participants

No.	Name	Title	Address
1.	Mr. Joseph Okemwa	District Adult Education Officer	P.O. Box 501 Oyugis
2.	Mr. Philip O. Oyucho	Adult Education Supervisor	P.O. Box 501 Oyugis
3.	Ms. Macolata Oloo	Adult Education Teacher	P.O. Box 37 Oyugis
4.	Mr. Jared N.A. Nyakworo	Adult Education Supervisor	P.O. Box 501 Oyugis

List of Participants (Cont'd.)

No.	Name	Title	Address
5.	Ms. Phoebe Migun	Adult Education Teacher	P.O. Box 501 Oyugis
6.	Mr. Jaram Midamba	Adult Education Supervisor	P.O. Box 501 Oyugis
7.	Ms. Ruth Auma Okoth	Adult Education Teacher	P.O. Box 41 Rakwaro, Kendu
8.	Mr. Jael A. Ouma	Adult Education Teacher	P.O. Box 39 Kadongo
9.	Ms. Jane A. See	Adult Education Teacher	P.O. Box 179 Kadongo
10.	Mr. John Owuor	Technical Assistant	KARI-Kisii P.O. Box 523 Kisii, Kenya
11.	Mr. Daniel Miruka	Technical Assistant	KARI-Kisii P.O. Box 523 Kisii, Kenya
12.	Ms Margaret Onyango	Agronomist	KARI-Kisii P.O. Box 523 Kisii, Kenya
13.	Mr. John Ogecha	Entomologist	KARI-Kisii P.O. Box 523 Kisii, Kenya
14.	Dr. E.M. Minja	Entomologist	CIAT-Arusha P.O. Box 2704 Arusha, Tanzania

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