

FarmServe Africa Trip Report: Ghana Oct. 17 – Nov. 13, 2002

1. Primary Objective(s) of Trip

- a. to diagnose disease and pest problems in tomato crops of the Woraso Progressive Farmers Association
- b. to recommend appropriate control measures, including Integrated Pest Management when possible, in order to reduce pesticide inputs and increase yields
- c. to teach farmers about the safe use of pesticides
- d. to teach farmers how to calibrate a backpack sprayer in order to deliver the correct amount of pesticide
- e. to inform the Ministry of Food and Agriculture about the work accomplished in the Woraso community so they will be able to do followup work in the community



2. Organizations Assisted and Key Contact People

- a. Woraso Progressive Tomato Growers Association (through Opportunities Industrialization Centers International (OICI))

Contact Person:

Mr. I. K. Osei and Mr. Adomako

P.O. Box 10

Kumasi – Woraso

Ashanti Region

Ghana W/A

- b. Ms. Carla Dominique Denizard
Country Representative – OICI-Ghana

P.O. Box BC 137

Burma Camp, Accra

Ghana W/A



- c. Mr. Samuel Arku-Kelly
Agricultural Officer

OIC – Tamale

P.O. Box TL 1183

Tamale, NR

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- d. Mr. Kofi Amankwah
OIC – Kumasi
P.O. Box ANT 2799
Kumasi
Ghana W/A
- e. Dr. O. A. Danquah
Research Plant/Seed Pathologist
Crops Research Institute
P.O. Box 3785
Kumasi, Ghana W/A
- f. Mr. Kwasi Sarkodie
Ministry of Food and Agriculture
Effiduasi
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3. Assistance Provided

- a. One session to deliver questionnaire about current tomato disease and pest control practices used by Woraso farmers (approximately 20 farmers, all male) (See attached questionnaire.)
 - Farmers answered 13 questions about current agricultural practices as a group.
 - Answers to questions were used to determine specific topics to address in pesticide safety sessions and to determine which practices might be contributing to current disease problems in Woraso tomatoes.
- b. One visit to farmers' fields to collect plant samples representing disease problems currently experienced by farmers (approximately 15 farmers, all male, participated)
 - Visited 5 tomato fields and 1 seedling nursery
 - Collected samples of plants showing 6 different symptoms
 - After followup work in CRI laboratory, diagnosed 7 diseases
- c. Three small-group training sessions on pesticide safety and knapsack sprayer calibration
 - Group sizes = 18, 28, 15
 - Number of women = 2



- Topics Covered:
 1. Reasons for sprayer calibration
 2. When it is necessary to calibrate a sprayer
 3. Steps in calibrating a sprayer, including trial calibration by volunteer farmers
 4. Pesticide safety issues, including demonstration of spray residues on skin and clothing with use of fluorescent dye in spray water



- d. Two days spent in seed pathology lab at Crops Research Institute in Kumasi
 - The Crops Research Institute (CRI) primarily assisted me by providing space and the use of microscopes and other equipment to diagnose the diseases I found in Woraso tomatoes. This assistance was vital to correct diagnosis of the diseases I found.
 - I diagnosed 7 diseases in Woraso tomatoes; most farmers experienced all of these diseases (see below).
 - I also provided assistance to the plant pathology researchers at CRI by demonstrating several new techniques for detecting viruses in plant tissue and by providing the researchers with some virus detection kits.
 - I tested field samples of 11 research lines of cassava for Cassava Mosaic Virus for Dr. E. Moses from CRI.
- e. One meeting with researchers and OIC personnel to discuss future work with resistant tomato seed I brought to Ghana
 - 8 researchers from CRI participated, including four virologists (Dr. Joseph Lamptey, Emmanuel Lord Appia, Alan Oppong, and Gyamra Antwi), one mycologist (Dr. O. A. Danquah), one molecular biologist/plant pathologist (Dr. E. Moses), one horticulturist (Adam Harruna), and one sociologist (Florence Ansere)
 - 3 OIC representatives, plus myself, participated
 - Kofi Amankwah
 - Sammy Arku-Kelly
 - Yaw Ejapon (National Service student)

- I provided 1-gram packets of seed of each of four varieties of tomatoes resistant to several diseases, including Bacterial Wilt and Tomato Yellow Leaf Curl (see list below). These diseases were found in Woraso tomatoes and are difficult to control by means other than resistance. Seed was obtained from the Asian Vegetable Research and Development Center (AVRDC) in Taiwan, which provides startup seed packets to countries interested in testing new varieties and increasing the seed on their own.

Determinate Inbred Tomato Lines:

- CLN2318F (80-g size, oblong fruit; resistant to BW, TMV, F-1, F-2, and St)
- CLN2443A (80-g size, pear-shaped fruit; resistant to TYLCV, BW, TMV, F-1, St)
- CLN2443B (75-g size, pear-shaped fruit; resistant to TYLCV, BW, TMV, F-1, St)
- CLN1466EA (150-g size, Dglobe fruit; resistant to BW, TMV, F-1, St)

BW=bacterial wilt; TYLCV=tomato yellow leaf curl virus; F-1=Fusarium wilt race 1; F-2=Fusarium wilt race 2; St=Stemphylium leaf spot

- One visit to agrochemical supply store to determine availability of disease and insect pest control chemicals; three OIC representatives and I met with owner of store.
- One seminar for whole group of Woraso farmers and local MOFA Extension officer (31 farmers in attendance, one of whom was female)
 - Reviewed all diseases found and made detailed recommendations for control
 - Reviewed steps in knapsack sprayer calibration (3 farmers volunteered to demonstrate for others in group)
 - Provided written materials to chairman of Woraso Progressive Tomato Growers Association
 - Summary of diseases and control measures
 - Summary of activities in Woraso (10/23/02-11/5/02)
 - Table for determining length of spray calibration path based on individual's swath width
 - Instructions on steps in sprayer calibration
 - Provided written materials to local Extension officer
 - Summary of diseases and control measures
 - Summary of activities in Woraso (10/23/02-11/5/02)
 - Instructions for conducting knapsack sprayer calibration demonstration with farmers
 - Various photocopied materials on tomato pests, diseases, pest and disease control, and horticulture
- Provided the following materials to the following groups:
 - Woraso Progressive Tomato Growers Association
 - One 4-gallon Field King knapsack sprayer
 - Extra nozzles of four different sizes for obtaining correct sprayer calibration for individual farmers
 - Extra handle parts

- Additional equipment for sprayer calibration
 - 2-liter measuring pitcher
 - 8-m measuring tape
 - 100 ml graduated cylinder
 - small calculator
 - 64 pairs of chemical-resistant nitrile gloves (13" long, 15-mil thickness)
 - crescent wrench for attaching pump handle to sprayer
- Crops Research Institute
 - 1-g packets of four varieties of tomato with resistance to several diseases, including two of the diseases found in Woraso
 - rapid detection kits for the following viruses:
 - all potyviruses
 - Cucumber Mosaic Virus
 - Tobacco Mosaic Virus
 - Tomato Spotted Wilt Virus
 - Membrane testing of 11 research cassava lines for Cassava Mosaic Virus for Dr. E. Moses
 - Information on how to submit plant samples for virus detection to Agdia, Inc.
- OIC
 - One *Tomato Compendium*, published by the American Phytopathological Society
 - One copy of *Tomato and Pepper Production in the Tropics*, published by AVRCD
 - One copy of *Field Guide to Selected Insect Pests of the Tropics*
 - Four copies (for offices in four locations) of CDs of images taken in Ghana will be supplied for use in OIC publications
 - Copies of same printed materials that were provided to Woraso growers and Extension officer

4. Observations and Accomplishments (Please refer to lettering of subtopics in #3.)

Results of Questionnaire

- a. A questionnaire was developed prior to meeting with farmers (see separate file). From this activity, I obtained important information on current agricultural practices that guided me in planning other activities and in providing disease control recommendations. I recommend taking the time to gather this type of baseline information when initiating other projects.

Some of the key things learned from the questionnaire that had implications for disease control were:

- (i) Farmers grow up to three crops of tomatoes per year on the same land and they grow tomatoes year after year on the same land. Repeated cropping of the same species allows pathogens and insect pests to build up to levels that become very difficult to control. This is especially a problem with soil-borne diseases, several of which were present in these farmers' fields. Many of the farmers rent their fields. I encouraged them to try to find fields where tomatoes had not been grown

for at least two years or to plant fields in which tomatoes had been grown to maize, cassava, or some other unrelated crop for at least one year. Farmers indicated that they also grow onions, maize, groundnuts, peppers, garden eggs (eggplant), and cassava in addition to tomatoes. Tomatoes can be rotated with any of these crops except garden eggs or peppers, which are in the same family as tomatoes and are susceptible to many of the same diseases.

- (ii) Farmers apply both fungicides and highly toxic insecticides with much greater frequency than is recommended on the label. They also apply the same pesticides over and over and rarely change the type of pesticide they apply. This drastically increases the likelihood that pest or pathogen populations with resistance to certain pesticides will develop. The risk of development of resistant populations is high for pesticides that have a very specific mode of action. Many of the insecticides the farmers are using fall into this category. In fact, the farmers indicated that the disease, Tomato Yellow Leaf Curl, a viral disease that is transmitted by whiteflies, had increased in frequency and severity in their fields in spite of frequent application of insecticides to control whiteflies. Farmers said they were applying endosulfan (Thionex) at least ten times per crop. Thus, Woraso farmers were apparently applying this insecticide up to 30 times per year. The label for endosulfan in the United States restricts use to a maximum of six applications per year.
- (iii) Farmers grow only three different varieties of tomato and they save their own seed. The germplasm they are using probably has very little resistance to diseases and insects since the farmers are not selecting for resistance. Increasing the genetic diversity of the seed they use by introducing some new varieties with disease-resistance would help reduce some of their disease problems. This is especially important in this community because several diseases are present that have few other control options and because farmers continue to grow tomatoes on the same land. I hope that at least one of the four varieties of disease-resistant tomatoes I delivered to CRI will grow well under Ghanaian conditions. It will be important to assess the viability of any promising new varieties in the marketplace as well as in the field.
- (iv) Farmers select seed by saving seed from the best looking tomato fruit, but do not consider the overall qualities of the plant when selecting seed. Thus, they are not selecting for disease-resistance, yield potential, or overall plant quality. If new varieties are introduced to Woraso, it would be useful to have a horticulturist work with the growers to determine what plant traits they should consider when selecting seed.
- (v) Farmers use either 15-15-15 or 20-20-0 fertilizer. More work could be done to determine the best timing and type of fertilizer to apply to encourage fruit vs. vegetative growth. However, I got the impression that these fertilizers were the only ones available locally, and, in that case, it may be difficult to make many changes in fertilizer practices. It is important not to apply too much nitrogen too early in order to obtain more fruit and less vegetative growth. The horticulturist from CRI or the local MOFA officer may be able to provide more specific information on general fertilization practices that would be recommended for tomatoes grown in Woraso soils.

- (vi) Farmers considered their worst disease problems to be Root Knot Nematodes and Septoria Leaf Spot. Although Septoria can be controlled with fungicides, root knot nematodes are difficult to control, and the farmers will experience more severe problems the longer they grow tomatoes on infested land. Although I did not bring any tomato seed with resistance to root knot nematode to Ghana, varieties with resistance to root knot nematode are available from AVRDC. The AVRDC lines that currently have RKN resistance do not have resistance to Tomato Yellow Leaf Curl Virus, however. I recommend that someone from either OIC or CRI order seed of varieties with resistance to the root knot nematode *Meloidogyne incognita* from AVRDC for field trials in Ghana in the future. The url for the AVRDC website is: <http://www.avrdc.org.tw/>
- (vii) Farmers estimated current yields to be approximately 65-80 large crates of tomatoes per acre. This is an anecdotal baseline yield that can be used for comparison with yields obtained in the future after implementing recommended disease control practices.
- (viii) After harvest, farmers leave the plant debris on the field. This contributes to the buildup of pathogens in the soil. Tomato plant debris should always be removed from the fields after harvest to reduce inoculum for succeeding crops. The debris can be burned or buried in a place where tomatoes will not be grown.
- (ix) While administering the questionnaire, I also examined of the farmers' agrochemicals. Pesticides used by the farmers include:
 - Fungicides
 - Maneb (which they called "Dithane" = mancozeb but which was, in fact, maneb and not mancozeb)
 - Topsin (I assume this is thiophanate methyl, "Topsin M" in the US.)
 - Kocide, Champion (cupric hydroxide)
 - Goldazim (carbendazim)
 - Fungaran-OH (not able to determine the active ingredient of this chemical since it was not on the label and is not used in the US)
 - Ridomil (metalaxyl)
 - Insecticides
 - Karate (lambda cyhalothrin)
 - Polytrin, Cypercal (profenofos + cypermethrine)
 - Thionex (endosulfan)

Most of the fungicides the farmers had were appropriate for controlling the diseases for which they were using them. Many of the insecticides, however, were labeled for use in cotton, a non-edible crop, and did not have tomatoes on the label. Farmers follow the label rates for cotton if they follow the label at all, and these rates may not apply to tomatoes. Upon further checking, I found that these insecticides (e.g. lambda cyhalothrin, endosulfan, cypermethrine) are labeled for use on tomato in the United States, but several of them are restricted-use chemicals or have certain restrictions for their use that were not listed on the Ghanaian label (e.g. no more than 6 applications of endosulfan per year).



Based on my work in Woraso, I believe the farmers are exposing themselves to excessive amounts of highly toxic insecticides. Our visit to the agrochemical supply store indicated that less toxic options are not available to them. Some examples of less toxic insecticides we use in the US include insecticidal soap for control of soft-bodied insects, such as whiteflies and aphids, and Bt, a biological control product used for many caterpillars. If these products were available in Ghana with clear instructions for proper use, farmers could replace at least some applications of highly toxic insecticides with less toxic products. It would be helpful to have an entomologist work further on this problem (see recommendations for future work).

In the meantime, I encouraged the farmers to try using their local soap at a 1-2% rate (5 matchboxfuls to one 15-liter sprayer) to control whiteflies, one of their main insect problems. The main disadvantage to using insecticidal soap to control whiteflies is that applications need to be made every week; however, farmers were already spraying (highly toxic) insecticides every week, so this was not an issue in Woraso. The advantages of soaps for insect control are that they do not induce pesticide-resistance, they are relatively nontoxic to humans, and the sprayer does not need to be calibrated for application (soaps should be sprayed until plants are wet). Care must be taken not to exceed the 2% rate or plants may burn. Soaps will not control hard-bodied insects, such as grasshoppers, which were also a problem in Woraso. However, including soap in the spray program would reduce the need for as many applications of other insecticides.

Results of Field Visit

b. Observed seven different diseases in Woraso tomatoes:

- *Rhizoctonia stem rot* (soil-borne fungal disease)
- *Septoria leaf spot* (fungal disease)
- *Root knot nematodes* (soil-borne nematode disease)
- *Bacterial wilt* (soil-borne bacterial disease)
- *Buckeye fruit rot* (soil-borne fungal disease)
- *Pythium damping-off* (soil-borne fungal seedling disease)
- *Tomato yellow leaf curl* (insect-vectored viral disease)
- Also diagnosed blossom end rot (calcium deficiency disorder) from farmer descriptions (problem was not present while I was there)

Recommended the following control measures, which included several relatively simple cultural controls, such as staking and increasing plant spacing, that should significantly reduce some of the diseases observed without increasing the use of pesticides:

- *Rhizoctonia stem rot*: Avoid mounding soil around the base of plants. (However, farmers should continue growing plants on raised beds to avoid drainage problems.) Stake plants to keep them upright. Specific instructions on how to stake were given to farmers orally and in writing. Infected



plants were putting out new roots above lesions on stems and still produced some tomatoes, so farmers kept these plants. However, the plants were already too crowded, so I recommended that they remove affected plants. The increased spacing will allow healthy plants to produce more fruit, compensating for yield loss due to removed plants.

- *Septoria leaf spot*: Staking will also help control this disease. The farmers said they were spraying every 3 days to control this disease, yet plants had severe leaf spot. I believe poor control is due to: (a) poor coverage of leaves with the spray due to crowding of plants and lack of staking and (b) farmers may not be applying enough fungicide since they have not been calibrating their sprayers. With proper calibration, they should be able to extend the spray interval to 5-7 days during rainy weather and 7-10 days during drier weather. Farmers were using the correct fungicides for control of this disease.



- *Root knot nematodes*:
 - Avoid repeated cropping of tomatoes in same field.
 - Try planting marigolds in infested fields for one or more cropping periods and then tilling marigolds into the soil. Marigolds are reported to be toxic to nematodes and should reduce populations.
 - Avoid moving soil from infested areas to uninfested areas. Work in infested areas last.
 - Soil solarization should work for nematode control in Ghana. The area to be solarized should be level and be free of debris or large clods of soil. The soil should be moistened until it is damp but not saturated. Then clear plastic should be placed over the soil surface and the edges of the plastic buried in a foot-deep trench. Clear construction grade plastic that varies in thickness from 1 to 6 mils can be used. The thinner plastic (1-2 mils) allows better soil heating since it reflects less solar energy. The plastic should be left in place for 4-6 weeks during a period of the year when solar radiation is high.
 - Tomato varieties with resistance to root knot nematode (*Meloidogyne incognita*) can also be obtained from AVRDC and tested in field trials.
- *Bacterial wilt*: There are no good controls for this disease, other than to plant resistant varieties. Several of the varieties I brought to Ghana have resistance to this disease. Tomatoes should not be cropped repeatedly on the same land and plant debris should be removed at the end of the season.
- *Buckeye fruit rot* – The main way to control this disease is to prevent fruit contact with the soil by staking or mulching. Fungicides can be used for control, but did not appear to be necessary in Woraso tomatoes if farmers will stake their plants.

- *Pythium damping-off* – Farmers were using the correct fungicide, Ridomil, for control of this disease; however, they will get better control if they apply Ridomil as a soil drench directly after seeding rather than waiting until the disease appears.
- *Tomato yellow leaf curl virus* –
 - Try using local soap at a 1-2% rate weekly for control of whiteflies. Plants should be sprayed until wet. (The sprayer need not be calibrated.) If the local soap will control whiteflies without burning the plants, the growers can reduce the number of sprays of endosulfan and other highly toxic insecticides they currently apply.
 - Two of the varieties of tomato seed I brought to Ghana have resistance to TYLCV. However, these may or may not show resistance to the virus in Ghana in field trials. Resistance to this disease is very strain-specific, so if the Ghanaian strain of the virus is different from the one the plants were bred for, the plants will not show resistance.
- *Blossom end rot* – This disorder is related to drought, which makes calcium less available to the developing fruit. Farmers said it only occurred during the dry season. Mulching during the dry season to help preserve soil moisture may help reduce the incidence of this disorder.



Small Group Sprayer Demonstrations

- c. We spent 2-3 hours at each sprayer demonstration, which included not only practice with sprayer calibration, but also a discussion of pesticide safety issues. Much was accomplished in these sessions. The translator, Yaw Ejapon, and I, made an effort to phrase much of the discussion in the form of questions for the farmers to answer, and then added our own observations. The farmers became very involved in the discussion, had many comments, ideas and questions, and seemed actively concerned about pesticide safety issues once they learned of some of the real dangers of improper pesticide use. The farmers seemed willing to use proper protective clothing and techniques if they were available and affordable, and were interested in learning to calibrate their sprayers in order to deliver the proper amount of pesticide.

Pesticide Safety

Farmers demonstrated that they had some prior knowledge of pesticide safety issues. Many of the things the farmers already knew about pesticide safety they had learned from their local MOFA Extension officer. This spoke well of the programs that had been conducted by the Extension officer in this community. Examples of things they had already learned and implemented were: (a) to spray early in the morning when pests are most active and when the applicator will not perspire as much in protective clothing, (b) to avoid eating immediately after spraying without washing hands. The fact that the farmers were trying to practice these suggestions indicated to me that they

would also try to follow some of my recommendations. This was very encouraging. In general, the farmers seemed eager to learn new things.

One demonstration I conducted involved dissolving a fluorescent dye in the water we used to calibrate the sprayer. This was a very effective exercise in demonstrating that invisible substances end up in places where you don't expect them. The dye was invisible to the farmers but wherever the dye had contacted clothing or skin, it could be detected with a hand-held blacklight in a dark room. After we completed the calibration exercise, we went into a dark room and examined everyone's clothing and exposed skin for fluorescence to see how careful the farmers had been during mixing and spraying. The feet of one farmer who was not wearing enclosed shoes glowed very brightly! This made a big impression on the farmers. They began talking about how much they had exposed themselves to pesticides in the past and worried about whether various health problems they had experienced were due to pesticides. They also learned that pesticides end up on clothing and that it is important to wash clothing used during application after spraying and to wash it separately from other clothing. Although we had good discussions with the farmers about pesticide exposure, I think this exercise was more effective in teaching the farmers about pesticide exposure than any of our discussions. They could really see the results!

After our discussions about pesticide safety, the farmers were more interested in wearing protective clothing. I told them that their greatest exposure to pesticide was through their hands. I gave them chemical-resistant gloves to wear while mixing and spraying. The farmers seemed very willing to use the gloves, so I have purchased more gloves to send to them so that each farmer will have his/her own pair. If pesticide safety training becomes a part of OIC projects in other communities, I think the cost of chemical-resistant gloves should be written into the grant to get the farmers off to a good start. If farmers are simply told about the gloves, I don't think they will purchase and use them. But if farmers are initially provided with the right kind of gloves, they will be more apt to use them and more likely to spend their own money on gloves when their first pair of gloves wears out. The farmers also seemed willing to follow my other recommendations for protective clothing: a long-sleeved shirt (with gloves tucked inside the sleeves), long pants, socks and enclosed shoes or boots.

We discussed potential acute (short-term) and chronic (long-term) effects of pesticide exposure. I told the farmers about another village in which many of the men became impotent from chronic effects of pesticide exposure. The Woraso farmers took this very seriously! Several farmers related anecdotes from their personal experience, e.g. one farmer said he felt dizzy one morning after spraying and fell asleep for a long time. I explained this was probably the result of acute inhalation exposure.

Sprayer Calibration

Teaching the farmers how to calibrate a sprayer was the most challenging part of this project because it is impossible to calibrate a sprayer without knowing some basic math. However, some of the farmers clearly had some basic math skills and were able to follow the logic of the exercise. In general, I think the sprayer demonstration/

calibration exercise was helpful to the farmers. Some of the farmers really seemed to catch on and will probably explain what they have learned to other farmers. If I had the project to do over again, however, I would insist on spending some time in the village with the farmers when they are actually getting ready to go to the field to spray. It would have been helpful to spend one or two nights in the village for this purpose.

The farmers seemed to understand that it was important to spray enough pesticide to control the disease, but they learned that for reasons of safety and expense, it is not a good idea to spray more pesticide than needed. I introduced the farmers to the issue of pesticide-resistance and how overapplication can lead to pests and pathogens that no longer respond to the pesticide.

We discussed when it is and when it isn't necessary to calibrate a sprayer (i.e. if the label says to deliver a certain volume per area, then the sprayer needs to be calibrated; if the label says "spray to runoff" or "spray to wet," it does not need to be calibrated.) We then went through the steps in sprayer calibration with two different volunteer farmers in each session. Volunteers sprayed a 20-square-meter area and we determined whether they had sprayed more or less than the specific label required. If the volunteer sprayed less than he should have, he repeated the exercise with a larger nozzle; if the volunteer sprayed more than he should have, he repeated the exercise with a smaller nozzle. The farmers were able to see clearly the relationship of nozzle size, walking speed, and pumping speed to the volume of liquid delivered from the sprayer; however, I was skeptical about whether they would actually be able to calibrate the sprayer themselves after I left. It was encouraging that three of the farmers were able to demonstrate the steps in sprayer calibration at my final seminar in the village.

In order to be able to calibrate a sprayer, farmers need to be able to:

- measure distance
- use the swath width chart I provided them with to determine, from their own swath width, the distance they need to walk to cover 20 sq m
- use a watch to time someone to the number of seconds
- divide the label rate in liters/hectare by 500 to determine how much volume to deliver on 20 sq m

Some of the problems with this exercise that made me skeptical about how well the farmers would be able to calibrate a sprayer independently are listed below:

- We did not have time to calibrate the sprayer for each individual, so only a few farmers actually got to try the exercise. It would have been more effective to have conducted additional small-group sessions to allow more farmers to try the exercise, but farmers were reluctant to spend time away from their field activities.
- Several of the pesticide labels the farmers used did not have enough information for the farmers to know how much they should deliver over a given area. Some of the pesticides had been repackaged into plastic bags and had no label information at all.

- Pesticide labels are not standard. Rate per area was expressed in different ways on different labels, so it was difficult to give the farmers one standard way to interpret the labels.
- I tried to explain that **each individual** needs to calibrate the sprayer for **each chemical** used. Once the individual knows which nozzle gives him or her the right amount per area for a given chemical, he/she need not recalibrate for that chemical. I'm not sure the farmers understood this point.
- The farmers indicated that they routinely mix different pesticides, e.g. fungicides and insecticides, when they spray. It is important for them to understand that labels that have different rates of application should not be mixed. If they are mixed, the farmers will not be delivering the correct amount of each chemical. **I neglected to stress this point to them. This is something the local Extension officer should explain to them.** It would be helpful if someone could be present with the farmers on a day when they actually spray to see what issues crop up in an actual situation and to help them to interpret specific labels.
- I supplied the farmers with all the tools they need to be able to calibrate the sprayer I gave them except a watch and a bucket, which they had themselves. The knapsack sprayer they already had in the community can also be calibrated, but I do not know if they have different nozzle sizes for that sprayer. **They would need to obtain larger and smaller nozzles for this sprayer in order to be able to calibrate it.**

Labwork at CRI

- d. I am grateful the researchers at CRI, who were very helpful in allowing me to use their facilities. Without their microscopes I would not have been able to diagnose several of the diseases I found in Woraso. The plant pathologists at the CRI were aware of most of the diseases I found in the tomatoes and would be a useful resource for OIC in future projects involving plant diseases.



The researchers were very interested in the techniques I showed them for virus detection, especially because they are affordable and essentially do not require refrigeration. The techniques they currently use for virus detection require continuous refrigeration, which is not reliable at CRI. I was also able to test some research samples of cassava that Dr. Moses wanted to test for a whitefly-transmitted virus. Since returning home, I have gotten results indicating that his cassava lines are free of Cassava Mosaic Virus.

OIC/CRI Meeting about Disease-Resistant Tomato Seed

- e. The meeting between OIC representatives and CRI personnel about how to handle the resistant tomato seed I brought to Ghana was productive. Agreements were made as outlined below. CRI stressed the importance of variety testing at a research facility prior to distributing seed to communities. They cited examples of varieties of several crops that had been imported in the past and distributed directly to farming communities. Many of these varieties failed to exhibit disease resistance or other

reported traits under Ghanaian conditions and probably should not have been brought directly to the farmers.

It will be important for OIC to follow up on the progress of field testing of the seed at CRI so that any varieties that look promising are eventually tested in Woraso. Woraso farmers were very interested in growing these new varieties. They also expressed skepticism about whether any work done at CRI, which in their minds they associated with government, would ever actually benefit them. We stressed to the farmers that OIC would follow up on CRI's activities and make sure that any seed that shows promise is eventually brought to Woraso.

- CRI researchers agreed to
 - begin trials with the resistant seed to see if the varieties represented are adapted to Ghanaian conditions
 - determine whether the varieties actually do exhibit resistance to the diseases to which they are reported to be resistant under Ghanaian conditions
 - increase the seed of varieties that look promising for Ghana
- OIC representatives agreed to follow up on work done by CRI and ensure that seed from any promising varieties would be delivered to Woraso and used in demonstration plots there.

Visit to Agrochemical Supply Store

- f. The visit to the agrochemical store was not very fruitful. I had hoped to find other available pesticides with lower toxicity, but it appeared that the farmers already had all the available pesticides and that few others were available. The owner of the agrochemical store did not seem very interested in trying to obtain new pesticides from his supplier. In order to increase interest and demand for additional pesticides (especially ones that are less toxic), it might be useful to introduce these pesticides through future volunteer projects (e.g. volunteer could bring and demonstrate these products in demonstration plots). If these pesticides can be shown to be effective for pest control, the agrochemical suppliers might be more interested in trying to import them.

Final Seminar

- g. The farmers who attended the seminar were very attentive and demonstrated that they remembered many of the things we had talked about during the small group sessions. The main purpose of the seminar was to tell them the results of my diagnoses and to recommend relevant control measures. The local MOFA Extension officer was present



and seemed very interested in following up on the work I had done in the community. It will be important to have continued contact with him in order to make this work sustainable. My only disappointment with the seminar was that only half the group was in attendance. I am not sure why attendance was not higher. It would be helpful to interview the farmers about this in order to increase attendance at future gatherings.

Materials Provided

- h. For future pesticide-safety work in other communities, I recommend farmers be provided with protective chemical-resistant (nitrile) gloves (one pair per farmer), goggles and respirators (several pairs per community), either a new backpack sprayer with extra replacement parts or, at the very least, extra nozzles of various sizes for the sprayer the farmers do have, and measuring devices to enable the farmers to calibrate their sprayer. It was very helpful to have good, working equipment while conducting the calibration demonstrations. Providing the farmers with the initial equipment also gave them incentive to follow the procedures I recommended.

It was very helpful to have access to a computer and the Internet in the Kumasi office to prepare printed materials. Initially I did not intend to provide the Woraso farmers with printed materials since I did not think they would be able to read English. However, these farmers seemed very resourceful, so I did give them written information on what I had taught them and they were grateful for it. I encourage future volunteers to provide communities with helpful written materials. The farmers will find a way to have the materials translated if they can not read it themselves.

Overall Observations and Comments:

- One of the problems we had in completing the project was that the farmers did not want to take much time away from their field activities to participate in the various sessions. We never did get the whole group of 64 together for any of the sessions. The farmers wanted us to get to the village early in the morning, but this was difficult since it took 1½ hours to get to the village by car from Kumasi. Although it was important to spend most of my evenings in Kumasi so that I had access to a computer and the Internet for preparation, **it would have been helpful to spend some time in the village and to go to the field with the farmers when they intended to spray.** I feel that I could have offered them some more specific advice or clarified additional things that didn't come up during the discussion sessions or sprayer demonstrations, which were not conducted in the field. It would also be helpful to **conduct future similar projects at a time of year when the farmers are not so busy in the field.**
- It was unfortunate that we did not involve the local MOFA Extension officer in the activities of the project earlier. The Extension officer was very knowledgeable and seemed very interested in following up on our work in Woraso. It would have been helpful to him and to the sustainability of the project if he had been present for the sprayer calibration exercise. I was not aware of the role the Extension officer would play in the community after my departure or I would have tried to make sure he could be present for one of the sprayer

demonstrations. **I recommend for future similar projects that the Extension officer be one of the first people to be contacted rather than one of the last people.**

- I was very lucky to have an excellent translator for the sessions conducted in Woraso, as few of the farmers could speak English. Yaw Ejapon, the National Service student with OIC, translated for me for the entire project. Although he had no formal background in agriculture, he was very bright and quickly learned the concepts I was trying to teach. It was critical to have someone who could both find the right words in Twi and understand the agricultural concepts. Yaw was also a careful translator. He often repeated back to me what he had said to make sure he had understood the concepts correctly. I think it will be **important to the success of future projects to identify someone with these same qualities for the job of translation and to have the same translator participate throughout entire project.** Yaw was an asset to this project and should be considered for any followup work done on this project in Woraso. He ended up being the one person who really knew the details of what we had accomplished in this community.

5. Changes Resulting from Volunteer Activities

Since no volunteers had previously worked in this village, I was unable to observe any changes resulting from visits by previous volunteers. However, farmers demonstrated that they were already implementing some of my suggestions before I left. One farmer mentioned at my final seminar that he had sprayed his tomatoes with a solution of the local soap instead of endosulfan for whitefly control that morning and that he had used gloves when spraying. Three farmers were willing (and enthusiastic!) about demonstrating the steps in sprayer calibration at the final seminar.

6. Future Volunteer Assignments

- Because many more diseases than insect problems were evident in Woraso tomatoes in fall of 2002, it was appropriate that the project began with diagnosis of the diseases in the crop. However, part of the reason few insects were evident was probably because the farmers are using frequent applications of some very toxic insecticides. This represents an insidious problem, which I think needs to be more fully addressed in this community. Repeated use of pesticides that have a very specific mode of action often leads to development of populations of pesticide-resistant pests. Most of the insecticides the farmers were using have a specific mode of action. The fact that the disease, Tomato Yellow Leaf Curl (TYLC), a whitefly-transmitted virus disease, was present and, according to the farmers, was becoming more widespread, may indicate that resistance is already present in the whitefly population in Woraso. TYLC has the potential to cause 100% yield loss and, therefore, it has the potential to eliminate tomato production in Woraso.

I would recommend that an entomologist with experience in IPM and alternative insect control methods be brought in to work with the farmers on control of specific insect problems that are identified in Woraso tomatoes. It would be helpful to have a volunteer identify the major insect problems, determine which alternative insect controls would be most effective, determine the best timing for implementing controls for maximum benefit,

and set up demonstration plots in conjunction with the local MOFA Extension officer. Work with poor farmers in Central America has shown that when tubes of protective netting were established over row crops to prevent insect feeding (while still allowing rain penetration), yields were increased and pesticide use was decreased dramatically. This method was successful in areas where insecticide control of whiteflies was no longer effective due to whitefly-resistance to insecticides. Netting row crop covers, reflective mulches, use of yellow sticky cards, and biocontrol (e.g. use of Bt or other biocontrol products) are all options that have potential for reducing the use of expensive, toxic insecticides in Woraso and increasing farmers' incomes. Followup work to determine the effectiveness of the local soap for control of whiteflies would also be useful. Farmers now have a better understanding of pesticide safety issues and are poised to adopt new strategies for insect control.

- An entomologist volunteer might also be able to bring samples of less toxic insect control chemicals for use in demonstration plots in Ghana. If any of these products are determined to be effective, reporting results to some of the agrochemical suppliers might encourage them to try to import these products.
- Help with horticultural issues, such as determination of the best fertilizer practices for maximum yield, variety selection, etc., would also be useful in this community; however, I feel the most pressing need, both from the standpoint of food and applicator safety and farmer income, is further work on the implementation of IPM practices to reduce insecticide inputs.
- From what I have seen in Woraso, I assume that misuse of pesticides due to lack of knowledge about pesticides is a common problem among small farmers in Ghana. I think many other communities would benefit from similar training and that educating more farmers in other areas about the proper use of pesticides would be a valuable project for OICI and OIC Ghana. This work also has implications for the export market since tomatoes (or other produce) with high pesticide residues will not be accepted by European or North American nations. Woraso farmers were very receptive to learning about the power and dangers associated with the use of pesticides, and I think other communities would also be receptive to similar training. I would be happy to participate in or contribute whatever I can toward any future similar projects in other communities.
- If other community projects are initiated, it would be interesting to invite one or two of the farmers from Woraso to participate in the training. The Woraso farmers could attest to the changes they have made that either worked well or have not worked for them. This would lend more credibility to the whole exercise and might result in more farmers adopting recommended practices.

7. Recommendations for Future Volunteers

- My recommendation to future volunteers who have never been to Africa before is to come prepared, but then RELAX on your way to Ghana! The people at OIC, the village farmers, and just about everyone you meet are friendly and welcoming and you will have a wonderful experience!



- I would also recommend that future volunteers contact previous volunteers while preparing for their trip. I over-prepared for my trip and brought many things I didn't really need. Although there was no previous volunteer for me to contact before my trip, I did receive advice from colleagues who had done similar work in Africa. In particular, one colleague provided me with her packing list, which was invaluable to me, mainly because it included many helpful little things I never

would have thought to bring. I would be happy to share my own packing list with others.

- Try to get a clear idea from OIC about whether you will be staying in the villages or not; this will help you to determine what you need to bring.
- Make sure you drink plenty of (bottled) water. I suffered from dehydration, not to mention traveler's diarrhea on this trip, and felt much better when I drank a lot of water (and oral rehydration salts, which are readily available at the local pharmacies).
- Bring ballpoint pens to give people as gifts—Ghanaians love American ballpoint pens—and bring small candies or treats for the children in the villages.
- If you have the opportunity to spend the night in Europe on your way to Ghana, do it. Not only will you arrive in Africa in better shape, but you will also get to see the Sahara Desert from the air, which you will not be able to if you leave Europe in the afternoon.

8. *Personal Comments*

I was smitten with Ghana on this trip! I had never been to Africa before and did not really know what to expect, beyond the Internet's report that Ghanaians are very friendly and that the temperatures are very high. It was amazing to see Africa for the first time—to fly over the Sahara Desert, to see crops I had eaten but never seen growing before, to see all the beautiful shapes and colors of a tropical environment—but the thing that made the trip most wonderful was, by far,



the people. "Friendly" is an understatement for the way Ghanaians are. They are a very warm, sincere, and generous people. "Obruni, how are you?" is their constant refrain. Sammy and Carla made me feel welcome from the moment I got off the plane, and just about everyone I met after that made me feel the same way. It made me wonder about how Americans make Ghanaian travelers feel when they come to this country. I suspect we have much to learn from the Ghanaians.

I made more friends on this trip than I have made since I was in graduate school. I especially want to thank Sammy, Kofi, Carla, Isaac, Yaw, Siibu, Ben, Dr. and Alice Azu, Rosalyn, Justice, Ann, Mr. Gyan,

Bordoh, and Seth and his wife for their companionship and friendship during my stay. I thank Dansu and Ben for being so kind as to attend to many personal details for me, and I thank Kofi, Isaac's wife, Seth's wife, and Alice Azu for all the delicious meals they made for me. I also want to thank the drivers, Siibu, Ben, and Samuel Otu, for being so patient about pulling over in the vehicles (on some difficult roads!) for my incessant picture-taking. The Ghanaian landscape and roadsides are so colorful and exotic that I wanted to take pictures every few seconds as we were driving! The reason I have so many nice pictures to put in my report is because of these drivers.

I want to thank everyone, but especially Sammy, Siibu, Kofi, Isaac, Yaw, Ben, Carla, Dr. Azu and the village farmers for teaching me so much about Ghana. I had endless questions and was happy to find that Ghanaians are very open and willing to talk about Ghana. My Ghanaian friends were often amused by my questions ("Doesn't anything ever fall off a Ghanaian woman's head?"), but they never considered any of my questions too stupid to answer. As a result, I feel like less of an outsider to Ghanaian culture, and I enjoy telling all the things I learned to my friends at home.



I thank Sammy, Carla, Kofi and Yaw, who were the main people involved in helping me with the project, and Dr. Danquah and Boku from CRI, who made lab space available to me. I also thank Mr. Gyan and Alvin for making computers with Internet access available to me during my stay in Kumasi. It turned out that I needed to look up a lot of information on the Internet and be able to communicate with colleagues back home in order to provide the farmers with correct information. Although the Internet connection was slow compared to the connection at home, it worked and was very useful. I also want to thank Nina Hopkins, Shannon Hill, and Elizabeth Bush, who took care of everything in my lab in Virginia while I was away, and my husband, who took care of our son and everything else at home. They made it possible for me to go on this trip.

One of my fears before I left the US was that I would feel unsafe as a woman travelling alone in Ghana. Ironically, I felt safer in Ghana than I sometimes do at home. Although I inevitably felt very conspicuous when I walked around alone in Kumasi, I never felt unsafe. Ghanaian men seemed to me to be very respectful of women.

I was surprised at the effort the OIC staff made for me to be able to experience as much of Ghana as possible. I did not really expect to see much more of Ghana than Kumasi and the village I worked in. OIC made sure that I had interesting things to do on the weekends, while still allowing me plenty of private time, and they made it possible for me to visit some of the tourist attractions in Ghana. Working with OIC and the farmers in the village was an incredible experience in itself, but it was wonderful to get to visit the crocodile pond and Mole National Park. One of my most enjoyable evening activities was sitting on the porch talking to Isaac and



Yaw, and my favorite weekend activity was attending church with Kofi. The service was very lively, most unlike church services in the United States!

I also want to mention that the introduction to OIC history and projects I received from Carla, Sammy and others shortly after I arrived in Ghana was very helpful and well organized. The orientation helped me to put my project in

perspective with OIC's mission and to plan my activities.



I could go on and on about my wonderful experiences in Ghana, but suffice it to say that, after my recent experience, I would love to go back!

