FOOD AND ENTERPRISE DEVELOPMENT (FED) PROGRAM FOR LIBERIA

COMPONENT 1: INCREASE AGRICULTURAL PRODUCTIVITY AND PROFITABILITY
TRIP REPORT: DISEASE IDENTIFICATION AND MANAGEMENT PRACTICES FOR PERI-URBAN AGRICULTURE

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SECTION I. SUMMARY

The assignment provided an outstanding opportunity to get a robust understanding of many of the vegetable crops that are being grown in and around the Monrovia area, the horticultural challenges associated with these crops, and the diseases that predominated during this time period. Although this time-period was a relatively short snapshot in time, I believe that I had the opportunity to see many of vegetable crops and the associated production constraints. In addition, there also was ample opportunity to visit a number of the vegetable markets to get an accurate assessment of which crops predominated and were a staple in the Liberian diet.

Overall, production of vegetable crops in Liberia faces some major logistical challenges. Available irrigation water is a limiting factor in many locations. Although watering sources appear to be available in the lowland areas of many production locations, getting adequate water to the plants can be problematic. Many of the areas are simply watered by carrying cans of water and hand watering plants. Although this can be adequate, plants at a number of locations were observed that were suffering from severe drought stress (severely stunted root systems, distorted taproots, many fibrous roots systems limited to the top 5-8 cm of soil, etc.) In addition, calcium deficiencies were observed in the form of blossom end-rot likely due to a combination of severe drought stress and calcium deficient soils.

Some very good horticultural practices were observed at some of the farms including the use of contemporary hybrid varieties, the use of raised well-drained shaded nursery beds for raising seedlings, the selection of locally adapted lines, the use of pasteurized soil (used to pack on top of the rubber wood log piles for making charcoal) to put in the planting holes as a way to reduce nematode and pathogen disease pressure. However, even with these practices, nematodes and soilborne disease pressure appeared to be high in most locations. A combination of practices, including biofumigation (the use of mustard or related cover crops) to reduce nematode and soilborne disease pressure. Cover crops could be grown for 4-6 weeks prior to a production crop ad then chopped up and incorporated in to the soil as a green manure. Although plastic is expensive, we purchased some materials to examine the experimental feasibility of enhancing the biofumigation effect by covering the soil with plastic as a way to trap the volatile compounds in addition to passively heating up the soil to solarize the soil to reduce pest pressure.

Liberia has a rainy season from May to October and a dry season from November/December to April. However, both seasons are highly favorable for fungal and bacterial diseases due to the exceptionally high relative humidity even during the “dry” season. This was clearly evident when examining the vegetable crops in April 2013. Many foliar diseases, both fungal and bacterial, were readily observed and many were quite severe causing significant impact on plant vigor and yield. A brief disease report, with accompanying pictures, was assembled for all of the diseases observed during the assignment. In cases were samples were processed (tissue

incubated and observed microscopically), the accompanying fungal pathogens were also identified.

A number of pepper and Solanum fruit, purchased from local markets, were also incubated and observed for potential post harvest fungal pathogens. In all cases, both the peppers and the Solanum fruit appeared to harbor a high incidence of both Aspergillus and Fusarium species. It would be prudent to perform a small subsample of fruit from these markets in Liberia to have them tested for fungal related toxins. Based on the way the fruit are harvest, transported, and marketed, the conditions appear to be favorable for some of these important post harvest fungi to be present on the consumed products.

Disease pressure clearly represents a major production constraint for vegetables in Liberia. Limited fungicides appear to be present in the markets and agricultural depots that were visited. Mancozeb and related products appeared to me the most common fungicide in the distribution stores. Several copper materials also were periodically observed. A full assessment of these materials likely should be a priority along with some mechanism for a program on pesticide safety. Many store-keepers were observed handling the concentrated materials without gloves, without following any safety precautions, and even pouring the concentrated materials into empty unlabeled water bottles for sale.

We also had the opportunity to visit with a number of the CARI (Central Agricultural Research Institute) personnel to discuss rice production and disease problems. A number of major disease problems were recognized including rice blast and sheath blight. However, the observations were limited as only some of the seed increase fields were available for observation as the rice growing season was just getting started.

In addition, we also had the opportunity to visit a few cassava fields and as well as observe some papaya production. Several virus diseases were observed on both of these crops, but a full assessment of them was not possible.

SECTION II. SOW SUMMARY & OBJECTIVES

LIBERIA FOOD AND ENTERPRISE DEVELOPMENT PROGRAM (FED)
SCOPE OF WORK

Title: Peri-urban Plant Pathologist

Location: Monrovia, Liberia (with field travel as required)

Period of Performance: Second quarter fiscal year 2013 for a minimum of two weeks. In addition, 5 days in the USA for working on the pest management guide.

LOE Required: Anticipated 2 ½ weeks in Liberia and 1 week in the US

Consultant: Dr. James Correll

BACKGROUND:

USAID Liberia's Food and Enterprise Development (FED) Program is being implemented to achieve the following component objectives:

- Component 1: Increase agricultural productivity and profitability and improve human nutrition;
- Component 2: Stimulate private enterprise growth and investment; and
- Component 3: Build local technical and managerial human resources to sustain and expand accomplishments achieved under objectives one and two.

OBJECTIVES:

The objective of this STTA is to work with Dermot Cassidy, the Peri-Urban Agriculture (PUA) Specialist, in development of a crop protection manual for peri-urban agriculture in Liberia. This STTA is part of a team of STTAs scientists under the direction of the PUA Specialist to develop individual chapters of a pest management guide. The goal is to refine any existing field guides or information developed at the Food and Enterprise Program (FED) aimed at extension workers and farmers and to develop a chapter on plant pathology for inclusion into the Peri-Urban Agriculture Pest Management Guide.

At present, very little if any information and documentation is available for pests of Liberian peri-urban crops. The guides will take full advantage of the Pesticide Evaluation Report and Safer Use Action Plan

(PERSUAP) and the initial surveys made by the FED PUA Specialist. The guides will fill other gaps in Liberia including;

1. The lack of a crop protection framework in Liberia for pesticide registration
2. The lack of a formal list of crop pests and diseases
3. The absence of any knowledge of what natural enemies of endemic pests in Liberia

4. A pest list will facilitate the development formal recommendations on pest management

TASKS:

1. Identify any potential collaborating research and/or educational institution and/or individual interested in plant pathology in Liberia;
2. If possible work with such individual/institution to;
   a. Survey crop species of interest to peri-urban agriculture in Liberia
   b. Catalogue and provisionally identify the broad range of fungal pests on the crops (to species level if possible)
   c. Where possible assist an institution in Liberia to develop basic pathogen identification and remedy recommendation expertise;
3. Take samples of unknown organisms for confirmatory identification at appropriate institutions if necessary.
4. Document the practices being followed in country to manage current disease problems with regard to resistant cultivars, cultural practices, and fungicides.
5. Review and refine guidelines for cultural and other non-chemical methods of disease control in the existing Peri-urban Agriculture (PUA) agronomy guidelines
6. Assist the PUA agronomists, Noorie Dudley and others, to refine guidelines for crop remedies for control of such pathogens within the guidelines set out by the FED PERSUAP
7. Carry out one training exercise at a suitable venue to link up and provide training with/to MOA CARI and University of Liberia scientists.

Deliverables:

1. Submit and present (e.g. power-point presentation) a preliminary trip report with meeting notes, describing activities undertaken, accomplishments and recommendations to the DAI/FED Project Office before departure for the United States.
2. An illustrated chapter (essentially extensive revisions and elaborations to the existing document) for the identified crop diseases in PUA crops including etiology, and cultural control methods for the proposed Liberia crop protection book.
3. Review of, and revisions to, the crop protection guidelines (PERSUAP approved crop protection remedies).
4. A final trip will be submitted within seven days of departure.

Training/Mentorship: The Peri-urban Plant Pathologist will provide mentoring to PUA agronomists and county extension personnel as well as training to FED, University of Liberia, and/or MOA as needed.

Reporting: The Specialist in the field will report to the FED Chief of Party, or his designee, and to the LSU AgCenter PI.

SECTION III. MEETING NOTES

Sunday, March 31, 2013

Arrival at Roberts International Airport at 7:30 am

2:00 pm Arrival meeting with Dermot Cassidy, Peri-Urban Agri-Specialist FED

We discussed the overall assignment and the approach to the logistics of the assignment. We also covered what crops, diseases, and pests we may encounter over the 2.5 week period, the locations we would visit, and the deliverables that would be expected from the assignment. This provided an excellent orientation of the assignment and the challenges that may be encountered.

Monday, April 1, 2013

8:00 am Arrival at the FED Headquarters and introduction to many of the staff members. Met with Agnes Luz, Deputy Chief of the Party Technical Services and Jonathan Greenham, Chief of Party, Flomo Pewu, Winrock International Vegetable Extension, and Noorie Dudley, Peri-Urban Agri- Specialist among others.

9:00 Staff meeting with group to present progress updates on the various projects. The meeting provided a general overview of the efforts being conducted at FED.

10:00 am – 4:00 pm – Evaluated various reports by Dermot Cassidy and Eric Wailes to get background information on various vegetable crops and rice.

Crops to focus on during assignment include: Velvet or tropical bean (Mucuna pruriens), African okra (Abelmoschus caillei), chili pepper (Capsicum frutescens), African eggplant (Solanum macrocarpon), bitter ball (Solanum torvum), lablab bean (Lablab purpureus), Moringa (Moringa oleifera), groundnut, or peanut (Arachis hypogaea) and corn (Zea maize).

Mucuna pruriens (Velvet Bean, or tropical bean)

Mucuna pruriens is a tropical legume known as velvet bean or cowitch and by other common names (see below), found in Africa, India and the Caribbean. The plant is infamous for the extreme itchiness it produces on contact, particularly with the young foliage and the seed pods. It has value in agricultural and horticultural use and has a range of medicinal properties

Abelmoschus caillei (A. Chev) (African okra)

Abelmoschus caillei, the West African okra, (as opposed to common okra - Abelmoschus esculentus) is a plant species in the family Malvaceae. It occurs in West and Central Africa, where it is used as a vegetable. It originated as an allopolyploid hybrid of Abelmoschus

esculentus and A. manihot. The same hybrid was produced experimentally in Japan where it is known as Abelmoschus glutino-textile.

The most serious fungal diseases of okra in Africa are damping-off (Macrophomina phaseolina, Pythium aphanidermatum, Rhizoctonia solani), vascular wilt (Fusarium oxysporum), Cercospora blight (Cercospora abelmoschi, Cercospora malayensis) and powdery mildew (Erysiphe cichoracearum, Oidium abelmoschi).

Okra mosaic virus (OkMV), transmitted by flea beetles (Podagrica), is widespread in Africa but damage is much less important than that caused by okra leaf curl disease (OLCV), transmitted by whitefly (Bemisia tabaci). Whitefly is also the vector of yellow vein mosaic virus (BYVMV), a major cause of crop failure in Asia. These viruses can only be controlled through control of the vectors. Nematodes of the genus Meloidogyne constitute a major problem. Damage by nematodes is avoided by crop rotation (e.g. with cereals) and by large applications of organic manure.

Important pests are fruit and stem borers (Earias spp. and Heliothis spp., Pectinophora gossypiella), flea beetles (Podagrica spp.) and jassids (Empoasca spp.). Chemical control is hazardous because crop harvesting is frequent. Common okra is in general more seriously affected by diseases and pests than West African okra.

Capsicum frutescens (chili pepper)

Capsicum frutescens is a species of chili pepper that is sometimes considered to be part of the species Capsicum annuum.[1] Pepper cultivars in Capsicum frutescens can be annual or short-lived perennial plants. Flowers are white with a greenish white or greenish yellow corolla, and are either insect or self-pollinated. The plants' berries typically grow erect; ellipsoid-conical to lanceoloid shaped. They are usually very small and pungent, growing 10–20mm long and 3–7mm in diameter.[2] Fruit typically grows a pale yellow and matures to a bright red, but can also be other colors. C. frutescens has a smaller variety of shapes compared to other Capsicum species, likely because of the lack of human selection. More recently, however, C. frutescens has been bred to produce ornamental strains, because of its large quantities of erect peppers growing in colorful ripening patterns.

Solanum macrocarpon (African Eggplant)

Solanum macrocarpon otherwise known as the African Eggplant or Gboma is a plant of the Solanaceae family. S. macrocarpon is a tropical perennial plant that is closely related to the eggplant.[1] S. macrocarpon originated from West Africa, but is now widely distributed in Central and East Africa. Through an introduction from West Africa, the plant also grows in the Caribbean, South America, and some parts of Southeast Asia.[2] S. macrocarpon is widely cultivated for its use as a food, its medicinal purposes, and as an ornamental plant.[3]

Solanum torvum (bitterball)

Solanum torvum (Turkey Berry), is a bushy, erect and spiny perennial plant used horticulturally as a rootstock for eggplant. Grafted plants are very vigorous and tolerate diseases affecting the root system, thus allowing the crop to continue for a second year.

It is also known as Devil's Fig, Prickly Nightshade, Shoo-shoo Bush, Wild Eggplant, Pea Eggplant, Pea Aubergine, susumba, boo, terongan, tekokak, berenjena cimarrona, berenjena de gallina, berenjena silvestre, tabacón, pendejera, tomatillo, bâtard balengène, zamorette, friega-platos, sundaikkai (Tamil: **சுண்டைக்காய்**), Thibbatu (Sinhala), makhua phuang (Thai: มะเขือพวง), and many other names (Howard 1989, Little and others 1974, Pacific Island Ecosystems at Risk 2001).

Lablab purpureus (Lablab bean)

Lablab purpureus, commonly known as the hyacinth bean, Indian bean, calavance, seim (Guyana and Trinidad and Tobago), Egyptian bean, njahi (in the Kikuyu language of Kenya), bulay (Tagalog), bataw (Bisaya), or đậu ván (Vietnamese), a species of bean in the family Fabaceae, is widespread as a food crop throughout the tropics, especially in Africa, India, Bangladesh, and Indonesia. A traditional food plant in Africa, this little-known vegetable in the West has potential to improve nutrition, boost food security, foster rural development and support sustainable landcare.[2]

Moringa oleifera (Moringa)

Moringa oleifera (synonym: Moringa pterygosperma) is the most widely cultivated species of the genus Moringa, which is the only genus in the family Moringaceae. English common names include moringa, and drumstick tree, from the appearance of the long, slender, triangular seed pods, horseradish tree, from the taste of the roots which resembles horseradish, or ben oil tree, from the oil derived from the seeds. The tree itself is rather slender, with drooping branches that grow to approximately 10m in height. In cultivation, it is often cut back annually to 1–2 meters and allowed to regrow so the pods and leaves remain within arm's reach.[1][2]

Arachis hypogaea (groundnut, peanut)

Zea maize (corn)

<u>Tuesday, April 2, 2013</u>

All day field day – “Money in the Bush” near Wealida, Kakata.

Noorie, Dermot, Ivy

Slash and burn preparation of production fields. Lots of Neurospora found on 1-month old burn tree stumps and limbs. Observe a number of crops and diseases:

Leaf spot – Cercospora on watermelon. Confirmed

Blossom end rot on watermelon – Calcium and drought stress

Choneothora on eggplant – severe

Mustard – Alternaria – confirmed

Fusarium root rot (F. solani, confirmed)

Macuna leaf spot – Cercospora sp., confirmed

Verticillium on eggplant

Wednesday, April 3, 2013

Field day – visited New Generation Woman's Farm. Hiked into the production area. Again, slash and burn practices. 30 acres to be in production. Contours being set up, terraces built for the Vetiver plantings.

Stop at one of the local vegetable markets. The predominant vegetables were the bitter ball, small chili pepper, palm oil.

Worked on background information on crops and diseases in the afternoon.

Spoke with Agnes Luz about the potential to get a student to come to the University of Arkansas for a Master's of Science degree in Plant Pathology and then return to Liberia to assist with plant disease diagnosis and developing management practices. The student likely could get their classes finished in 8-12 months and then return to Liberia to conduct their field research. Some funding options would include an assistantship from the University of Arkansas with perhaps FED looking into covering the travel costs. There is also the possibility of getting a student from the U of A to come over to Liberia for a few months at a time to assist with the disease surveys.

Thursday, April 4, 2013

Morning presentations to the Chevron group for the New Generation Woman's Program for processed cassava production. Dermot provided an overview of what was being done here and the plan to gear up the cassava production for this group.

Red Light Market. Spent the day surveying vegetables at the large, highly active, Red Light Market outside the city of Monrovia. Many vegetables were observed but the predominant ones were the small, locally grown hot chili, C. frutescens, bitter ball, eggplant, water green, sweet potato leaves, ground cassava leaves, cassava tubers, okra. Samples were collected for post-harvest evaluations.

Dr. Rhoads (Soil scientist) gave a presentation on the curriculum. Most soils in the area are very acidic. Not clear if there are sources of lime or sources of other fertilizers that contain calcium. They definitely are needed.

Other potential crops for consideration:

Cowpea (Vigna unguiculata)

Tomato – hot-set types (flowers get fertilized at higher night time temperatures)

Phaseolus vulgaris – try new types

Spinach – try longstanding heat tolerant lines.

They are growing lettuce under shade awnings – ask Ryan Hayes about heat tolerant OP lettuces.

Lettuce production under shade.

The late afternoon and evening were spent examining the plant disease samples collected on Tuesday. Many pictures and disease confirmations were completed.

For the Diseases of Vegetable Crops in Liberia Compendium the organization for the compendium will follow the APS format:

Overall disease name

Symptoms

Causal Organism

Disease Cycle and Epidemiology

Control

Selected References

Diseases observed and documented in Compendium of Diseases in Liberia

Black leaf spot of mustard – Alternaria brassicae
Cercospora leaf spot of watermelon – Cercospora ?
Fusarium root rot of pepper – Fusarium solani
Verticillium wilt of eggplant – Verticillium dahliae
Choanephora rot of okra, blossom or fruit blight –Choanephora cucurbitarum
Young fruit and blossoms (flower petals) are colonized by the fungus which gives them a "whiskery" appearance as the mycelium grows and the organism sporulates producing sporangiospores in a black head on the ends of the sporangiophores.
The disease development is favored by warm humid weather. Control is difficult. Physically
removing the flower petals as the fruit is initiated may help as the fungus needs a food source
to colonize prior to infecting the actual fruit. Some compost "teas" may also have some efficacy. Spraying with an approved fungicide could reduce losses.

Friday, April 5, 2013

Morning presentation to the FED group about potential graduate student opportunities at the University of Arkansas.
Ken Hasson, Ag. Development Officer, USAID
Surendra Bhatta, Senior Ag Business Advisor

Field work at Crozierville

Choneothora on Okra
Fusarium root rot of pepper
Rhizoctonia root rot of mustard

Saturday, April 6, 2013
Worked on pictures, diary, and report

Sunday, April 7, 2013
FED Group Lunch

Monday, April 8, 2013
9:00 am Staff Meeting
Worked on Compendium
Information from Eric Wailes on rice
    Josephine Francis – well-connected rice producer
    Arjay Farms
    David – field manager

CARI Personnel Central Agricultural Research Institute
    Eric Tokpah – 0880556423
    In charge of increasing foundation seed and getting it to seed companies
        Popular rice varieties – Lac23, Sukoko8. Tolerant to rice toxicity
        Nerica lines 2,4,5,6,7. Nerica 14. Nerica 19 seems popular.

Tuesday, April 9, 2013
Wednesday, April 10, 2013
Thursday, April 11, 2013
Friday, April 12, 2013

Bill Talbot – Progressive vegetable grower
Lots of vegetables and many new diseases
Diseases confirmed:
Leaf Spot of lettuce (*Cercospora lactucae*)
Cercospora leaf spot on pepper (*C. capsici*)
Downy mildew of cucumber (*Pseudoperonospora cubensis*)
Cercospora leaf spot on watermelon (C. citrullina)
Bacterial leaf spot of bitter ball (causal bacterium – unknown)
Fusarium root rot of pepper (F. solani)

Saturday, April 13, 2013
Sample evaluations and microscopy work for disease identification

Sunday, April 14, 2013
Monday, April 15, 2013

Met with Dave and Cristin (Winrock)
9:00 am Staff meeting for the week
Seminar, EOA report, and picture preparations
Presentation at 2:00 pm

Tuesday, April 16, 2013

6:00 am Depart for Roberts Airport and the U.S.

SECTION IV: SUMMARY OF RECOMMENDATIONS (FROM SEMINAR)

Over-arching agricultural practices

Irrigation and fertility (Calcium, micronutrients)

Continued evaluation of germplasm

Existing crops and novel crops (cowpea, tomato, spinach)

Diseases present (2 week snapshot)

Bacterial and viral diseases

Pesticide usage

More detailed study on availability, usage, safety

Post harvest concerns – mycotoxins

Short-term (U.S. student to aid with disease ID)

Long-term (Liberian/Regional student to the U.S.

- M.S. in Plant Pathology
- Clinic – soil testing, Plant Disease ID and Management

SECTION V. DRAFT COVER PAGE FOR DISEASES OF VEGETABLE CROPS COMPENDIUM

DISEASES OF VEGETABLE CROPS IN LIBERIA

SECTION VI. DISEASES TO BE INCLUDED IN THE DISEASES OF VEGETABLE CROPS IN LIBERIA COMPENDIUM

Alternaria Leaf Spot of Mustard

Alternaria Leaf Spot of Watermelon

Bacterial Spot of Tomato

Blossom End Rot of Watermelon

Cassava Mosaic Virus

Cercospora Leaf Blight of Mucuna

Cercospora Leaf Spot of Lettuce

Cercospora Leaf Spot of Tobacco

Choanephora Fruit and Blossom Blight of Okra

Downy Mildew of Cucumber

Neurospora on Burnt Wood

Postharvest Diseases

Rootknot Nematode on Okra

Severe Drought Stress in Okra

Verticillium Wilt of Eggplant

Virus of Okra

Virus of Pepper

SECTION VII. VEGETABLE DISEASE DRAFT EXAMPLE FOR THE COMPENDIUM

Choanephora Fruit and Blossom Blight of Okra

Choanephora fruit and blossom blight, or wet rot, is a fungal disease that infects the blossoms and eventually the fruit of okra causing the fruit to completely rot. The disease can cause quite severe damage to okra fruit under warm, wet, and humid conditions. The disease was observed in all okra fields observed and losses were up to 50% at some locations.

Symptoms

Symptoms of Choanephora fruit and blossom blight initially appear as grey-white mycelium of the fungus growing on the flower petals attached to the young immature fruit (**Figs. 1 and 2**). Under conditions of high humidity, the mycelium appears fluffy and can envelop the young fruit. As the organism grows from the attached flower petals into the immature fruit, the fruit turn black and develop a severe soft rot.

Fig. 1. Sporulation of *Choanephora cucurbitarum* on okra fruit.

Causal organism

Choanephora fruit and blossom blight is caused by the fungus *Choanephora cucurbitarum*. This is a "mucor" type fungus closely related to the common bread mold fungus Rhizopus. The fungus is fast growing colonizing the flower petals and fruit within 1-2 days.

Young fruit and blossoms (flower petals) are colonized by the fungus which gives them a "whiskery" appearance as the mycelium grows and the organism sporulates producing sporangiospores in a black head on the ends of the sporangiophores. The fungus is not very aggressive and typically needs to colonize another food source, such as the flower petals, before invading fruit and causing the wet rot (**Fig. 3**).

Fig. 2. Infection of flower petals prior to fruit infection.

Disease Cycle and Epidemiology

Fig. 3. Wet rot symptoms developing on okra.

The disease development is favored by warm, wet, and humid weather which basically means every day of the year in Liberia. The fungus produces a large number of spores that are readily airborne and can cause new infections (**Fig. 1 and 2**). The fungus has a broad host range causing a similar type disease on cucurbits and peppers. Thus, it is likely that inoculum, or spores are present all year long. The fungus is also known to produce dormant spores which can survive in the soil. Also, the fungus was found colonizing and sporulating on leaf lesions (**Fig. 4**). It was not known if the fungus was causing the lesions or simply sporulating on tissue that had become necrotic from nutrient deficiency or another leaf spot pathogen.

Management

Management of this disease is difficult under environmental conditions that favor disease development. Physically removing the flower petals as the fruit begins to develop likely would help as the fungus needs a food source to colonize prior to infecting the actual fruit (**Fig. 5**). Some compost "teas" may also have some efficacy. Spraying with an approved fungicide could reduce losses. There is some indication that selection of some okra lines have been made whereby the flowers fall from young fruit and do not adhere to the fruit. Observations have indicated that these lines develop less disease.

Fig. 4. Sporulation of *Choanephora cucurbitarum* on infected leave tissue.

Fig. 5. Removal of flower corolla (petals) as a management practice.