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FOOD AND ENTERPRISE DEVELOPMENT (FED) PROGRAM FOR LIBERIA

SUBTITLE: SOIL TESTING

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AUGUST 2012

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Executive summary:

Activities of the Soil Specialist during this trip included: 1) training the staff of a private soil testing laboratory, 2) working with Professor Korvah to assist the University of Liberia in providing electricity and water to the university soil science laboratory and 3) meeting with the leadership of Booker Washington Institute (BWI) and Nimba County Community College (NCCC) to plan out how to use rancid soy flour as a soil amendment. The Soil Specialist trained two technicians at Boimah Engineering Inc. (BEI) on how to test soils using the LaMotte AST-5 soil test kit. This was part of the enterprise development aspect of FED to assist local businesses in the agriculture sector. A small, illustrated booklet was prepared of standard operating procedures for soil testing and used to train the technicians. The training lasted two days and the Soil Specialist directly oversaw the initial two days of testing FED demonstration site soil samples. BEI is looking to expand their market to other NGOs, the Ministry of Agriculture and medium to large-scale plantation farmers. The FED extension agents who submitted the soil samples were gathered to review how to convert the results into fertilizer recommendations. Professor Korvah, from the University of Liberia, drafted a document to propose how FED can work with the university to bring electricity and water to the laboratory. This document clearly states the responsibilities of both parties and was drafted into a Memorandum of Understanding (MOU) for approval by FED and the University of Liberia. Recommendations for the use of soy flour in combination with phosphate and potassium fertilizers were given to BWI and NCCC for twelve different crops. Along with general use, experimental and demonstration plots were planned using soy flour on both campuses. Experimental design using computer generated randomized plot distribution was also explained to representatives at both institutions. This was the third and final trip of the Soil Specialist. The groundwork established in the first two trips enabled the start-up of the first private soil testing lab in Liberia during this last trip. Not only will FED projects benefit from these available soil testing services, but Liberia's agriculture sector as a whole will be able to manage soil resources in an informed way and thereby increase food security.

Soil Testing:

Boimah Engineering Inc. (BEI) Soil Testing Laboratory

FED has been working with BEI for over four months to set up a functioning soil laboratory. BEI was very eager to establish a soil laboratory, but sought technical advice and training from FED. An appropriate soil testing kit was recommended to BEI (see Table 1 for tests and tolerances of each test). The soil kit is produced by LaMotte (AST-5) and uses standard methodology to measure available nutrients. This helps to ensure that there is agreement between the results of the test kit and more advanced methodologies that will be used in the future. As BEI generates revenue from this activity, they plan to expand their laboratory and purchase commercial grade testing equipment. However initially, they want to evaluate the market demand and to determine if this will be a profitable business. FED assisted BEI to find a regional distributor of LaMotte equipment. Sword Scientific, from South Africa, is an official LaMotte dealer and was eager to help BEI order the kit. The kit contains some acids (HCl and H_2SO_4) necessary for the tests and so needed to be specially shipped via a hazardous material shipping company. The kit along with the shipping and customs fees totaled approximately $1300. A memorandum of understanding (MOU) between BEI and FED stated that once BEI had obtained the soil test kit, FED would provide training for the laboratory technicians. The kit arrived in Liberia in early August and the training was completed on August 27 and 28.

Table 1: Soil test parameter and tolerances (LaMotte AST-5)

	Range	Tolerance	Notes
pH	4.5-8	0.5	Estimated to nearest 0.25
Humus	1.5-8%	1 to 2.5%	Tolerance changes with scale
Nitrate	1.25-100ppm*	1.25 to 10ppm	Tolerance changes with scale
Phosphate	7.5-120ppm*	7.5	Melich 1 extraction
Potassium	60ppm, 100ppm	L,M,H	<60ppm=Low, 60>100=Med., >100=High

*Higher concentrations may be determined by dilution.

A small, illustrated booklet (Appendix A) was created by the Soil Specialist to guide the technicians through each soil test. The theory and chemistry of each test was explained to the technicians and the technicians performed multiple practice tests with oversight by the Soil Specialist. A variety of soils were used for practice tests to show the full range of nutrient concentrations in the soils of Liberia. The technicians each assumed responsibility for a particular set of tests. This ensures that any operator error in testing will be consistent between all samples. After the training, the technicians began testing FED soil samples. The Soil Specialist oversaw the testing and observed their work, offering advice and correction when needed. Both BEI technicians take this job very seriously and are aware that they are doing something that is very much needed in Liberia. Mr. Boimah has started communication with Sword Scientific about ordering the next set of test supplies. They have been encouraged to order chemicals 1-2 months ahead of testing so that there will not be a delay in the receipt and testing of samples.

Forms for both receiving soil samples and reporting soil test results were provided to BEI to help them function in an organized and professional way. These forms can be found in Appendix A as the last two pages of the booklet.


Technicians (Joshua and Henry) during the training.


Color change used to measure soil phosphate with the LaMotte kit.


Technician testing FED soil sample.

FED Soil Samples

During the previous trip (June 19-July 20), the Soil Specialist trained the FED extension agents on how to take soil samples and use the results of the soil test to make fertilizer recommendations. In mid-August, the extension agents were instructed to take soil samples from the demonstration areas in preparation for analysis at BEI. For some unclear reasons, this was not completed in a timely way and most of the samples were collected and shipped to Monrovia wet, shortly after the arrival of the Soil Specialist. The agents were instructed in the training to dry the samples before shipping so that nitrate in the soil would not be lost via denitrification. This aspect of sample collection and submission for testing was reiterated when the specialist met with the agents to review how to calculate fertilizer recommendations. BEI will charge a fee to dry and sieve soil samples that are submitted, so it is very important that agents perform this task before they send the samples to the lab.

An extension agent in the Monrovia office (Flomo Pewu) was identified as someone that will collect soil samples that are sent in from the counties and submit them to the lab for testing. Flomo will be the FED contact person for the technicians from BEI. The BEI specialists will ask Flomo monthly about FED's soil testing needs so that they can order chemical supplies in a timely way. Each time a new demonstration site or farmer's field is identified to be used in the FED project, a soil sample should be collected so that appropriate fertilizer recommendations can be made. The chain of communication at the FED office to gather soil testing needs will be as follows:


Flomo Pewu preparing FED samples for testing.

Inquiry of soil testing needs-

Flomo → Ed → Noorie, Boima (Dennis and Albert, for any soil testing needs of the educational institutions) → County managers → Extension agents → Soil samples are sent to Monrovia and collected by Flomo

Flomo will receive the soil test results and email them to the county managers, who will then give the results to the extension agents. A binder in the agriculture office at FED (Monrovia) will hold all the sample collection data sheets and soil test results. This will serve as a back-up hard copy in case the electronic information is lost. Once the information is sent to the county offices, it will be the responsibility of the county managers to make it available to the extension agents. It will then be the agents' responsibility to use these results to make fertilizer recommendations for each site sampled. This information can be placed in the notes collected for each location. It is the responsibility of the extension agent to make a plan that will specify when and how much fertilizer (mineral or organic) needs to be applied.

Further training for extension agents

During the previous trip (June 19-July 20), the Soil Specialist traveled to each county and conducted a seminar for extension agents on soil fertility and how to make fertilizer recommendations based on soil tests. This concept was new to the extension agents and was not fully understood by most agents. For this reason, it was determined that a follow up training needed to be carried out. Soil test results were used to walk the agents through the process of making fertilizer recommendations. The training was carried out at the Bong County Field Office and was attended by an extension agent from the offices in Nimba, Lofa and Gran Bassa. The agents from Margibi and Monserrado Counties were trained at the Monrovia Office. An updated fertilizer calculation sheet (Appendix B) and simplified tables were given to the agents. Because making soil-test-based fertilizer recommendations is such a new concept in Liberia, it is best to make the process simple to calculate until the extension agents become more familiar with the testing process. The agents left the training with fertilizer recommendations based on soil tests and an application plan for each of their demonstration sites.

Activity with the soil lab at the University of Liberia

In July, the Soil Specialist, along with Albert Bass, asked Professor Korvah, the representative at the University of Liberia, to provide a plan on how to bring water and electricity to the soil lab on the Fendal Campus. Professor Korvah was asked to submit a plan to FED by August 1, which outlined what activities needed to be completed and the division of labor between FED and the university. Professor Korvah provided a plan by the agreed upon date, however the plan was much more extensive than just providing water and electricity. Another meeting was set up during this trip with Professor Korvah and a draft plan (Appendix C) between FED and the university was created that will specifically supply water and electricity to the lab. A draft memorandum of understanding (MOU) was prepared by the Soil Specialist on September 7th and was being finalized by the MDF specialist at the time of this publication. This draft is to be given to Professor Korvah for approval from the university. Once the draft is approved, then both Albert Bass and Dennis Eaton will serve as the FED contacts for Professor Korvah once the MOU is implemented. Mr. Bass and Mr. Eaton will also be responsible for developing further MOUs between FED and the university. Once water and electricity are supplied to the lab, the labs will need to be made functional for laboratory classes in order to support the lecture classes. This may include assistance with laboratory curriculum and provision of small equipment (Ex. pH probes) and some consumables.

Activities while assisting BWI and NCCC with soy flour use as a fertilizer

Nimba County Community College (NCCC)

Over 11,000 bags of soy four were delivered to NCCC for use as a soil amendment on their demonstration and community gardens. NCCC did not have a storage facility to house the bags so initially the bags were placed in classrooms (pictured below). Classes were starting shortly and it became apparent that alternate storage was necessary. The bags were moved to an outdoor covered area where trade skills will be taught.


Students and community members moving soy flour out of classrooms.

Nathan Gono is a member of the college's agricultural staff and is in charge of the demonstration area on campus. The college has a total of 8 ha of agriculture land (6 ha of swamp rice, 1 ha of upland rice and 1 ha of cassava and vegetables). The Soil Specialist met with Mr. Gono and discussed the use of soy flour on the demonstration area. Mr. Gono showed an area that had been amended with soy flour a week earlier. Sweet potato starts had been transplanted into the amended raised beds (pictured below). As can be seen from the picture, the plants were burned and not healthy looking. Mr. Gono stated that they had applied 1 bag of soy flour (22.5kg) for each 10m long bed ($10m^2$). This was based on a 'recommendation' from the Soil Specialist, however there was a miscommunication resulting in an over application of soy flour. Instead of 22.5kg of soy for $10m^2$, they were instructed to apply 22.5kg of soy flour to $100m^2$. This miscommunication resulted in added 10 times more soy than was recommended. Regardless of the source of the error, the damage was done and Mr. Gono was not excited about using the soy flour as an amendment.

Raised beds amended with soy flour. Sweet potato starts were burned.

Recommendations for soy flour can be found in the following table (below). These were based on one bag of soy flour, as it was determined that this unit of measure could be most easily applied. The information in the table is based on crop needs and a complementary measure of phosphate and potassium are recommended for each bag. The area that one bag will cover depends on the crop nutrient requirements.

	Upland rice	Paddy rice	Cassava	Vegetables*	Onions	Sweet Corn	Chili pepper	Watermelon	Eggplant	Okra	Collards	Mustard	Carrots
one 22.5kg sack	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
kg rock phosph	2.5	3.5	5.5	2.5	3.5	3.5	2.5	2	3.5	2	7	7.5	3.5
kg of kcl	1.5	2	4.5	1.5	2	2	1.5	2.5	3.5	2	3.5	4.5	5.5
coverage area m^2	200	300	600	200	250	150	100	150	150	100	250	150	150
	*This along with ~5 t/ha of compost is recommended.												

It was recommended that the college establish some carefully monitored demonstration plots using soy flour as an amendment in the coming dry season. These plots will build confidence among the staff and the community in the use of soy flour as an effective soil amendment. After this is established, then large-scale application of the soy flour on the demonstration area could be carried out with full support of the NCCC staff. In order to facilitate this plan, a storage facility needed to be constructed on the NCCC campus. It was determined that this facility could also be used as a compost area, thus serving multiple functions. Staff from NCCC will be attending a composting workshop held by BWI on how to co-compost green-waste and soy flour. Albert Bass and Dennis Eaton are currently working with NCCC to begin construction as soon as possible.

The Soil Specialist also worked with Mr. Gono on the basics of experimental design. An Excel spreadsheet was used to plan out a replicated and randomized plot plan. Mr. Gono selected several treatments to test nitrogen additions on plant growth. These were set up in a 3x3 (3 treatments x 3 replications) grid in both a completely randomized arrangement and in a blocked arrangement. Mr. Gono was very interested in research activity and intends to use the design in the demonstration area. It is recommended that follow up training with Mr. Gono be carried out by Dennis Eaton.

Booker Washington Institute (BWI)

Professor Jacob Swee is the Dean of Agriculture at BWI and is in charge of using the soy flour. BWI received approximately 8,000 bags of soy flour and is currently storing the flour in the chicken facility. They currently do not have any chickens, but are hoping to have some later this year. In the next few months BWI will have the students rearrange the bags to the rear half of the chicken facility. This will open up the front area for use. Mr. Swee has already begun co-composting the soy flour with green waste. He has experimented with various mixtures and found that a 6:1 (green waste:soy) is the best recipe. This will use about 60-100 bags of soy each month. They will be using soy flour as a pre-plant fertilizer for 0.4ha of swamp rice in October. This will use approximately 600kg of soy. As they gain experience and confidence in the use of soy then they will use it more widely on other areas. BWI was provided with the same table given to NCCC on how to use soy flour for various crops and instructed in its use.

Mr. Swee was also trained on how to use an Excel spreadsheet to develop replicated and randomized plot designs. He had carried out some non-replicated demonstrations using compost last year and was eager how to make the results of his demonstrations scientifically significant. Sample data from last year's sweet corn trials were used to show how data can be graphed using Excel. Dennis Eaton is also providing Excel training for BWI staff. This will reinforce the exercises that Mr. Swee and the Soil Specialist began. Mr. Swee showed great interest in this type of activity and it is recommended that FED continue to support him in this pursuit.

Appendix A

LaMotte Soil Test Kit AST-5

Standard Operating Procedures

Prepared by FED, 2012 for use by Boimah Engineering Incorporated. Adapted from *LaMotte Model AST Series Instruction Manual.*

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Preparing soil samples to be tested.

Receiving soil samples-
Give customers 'Form 1' in Appendix A to be filled out before submitting soil samples.

When receiving soil samples to be tested, make sure that the samples are:

1) In clearly labeled plastic bags.
2) Soil samples should be between 50 and 300g.
3) Air dried and passed through a 2mm sieve.

If submitted samples do not meet this criteria, then the customer needs to make arrangements with BEI to complete this task for them (For ex. ~$5 processing fee to dry and sieve the soil).

When accepting soil samples, ask the customer for the completed 'Form 1' that lists: 1) the date submitted, 2) the name of the organization or person, 3) the name written on each sample, and 4) a six character sample ID (See example below). An electronic master spreadsheet should be kept of this information.

Date	Customer	Sample Name	Sample ID
8-25-12	DAI	Demo 1, Bong County, Rice 0-15cm, May 5	DAI001
8-25-12	DAI	Demo 2, Bong County, Rice 0-15cm, May 7	DAI002
9-6-12	GTZ	Tomato field, Lofa, 0-10cm, Aug. 24	GTZ001

As well as an electronic copy of the samples it is good to keep a paper copy in case something happens to your computer. A bound notebook can be used for this and should be kept in the laboratory at all times. Quality soil testing starts with good organization, so take time to stay organized. Use a permanent marker to label all the plastic bags with their corresponding six character ID. This six digit ID will be used to track the sample in the lab and test results will be reported in association with this ID. Store soil samples in a clean dry location until it is time to test them. Keep each customer's samples separate. Before testing check with the master spreadsheet/notebook to make sure that all the samples in a group are accounted for.

Testing soil samples-
Print out 'Form 2' with the sample IDs do be tested. Complete testing the samples in each group before starting a new group. Enter the results you filled out in 'Form 2' onto an electronic spreadsheet and place the hand written 'Form 2' your 'Lab Results' binder for record keeping.

Quality control-
Distilled water is to be tested for contamination of nitrate, phosphate and potassium each time a new batch (5 gallons) is purchased.

Samples that have unusually high or low test values should be retested to confirm the value. Each value should be written on 'Form 2.' Provide a note on the back of the form explaining what happened.

All equipment is to be cleaned with distilled water between samples to prevent cross contamination.

How to measure soil humus with the LaMotte soil test kit (EDTA chelation of polyvalent cations associated with humus, clay is flocculated and humus is left in suspension).

Materials needed:

Item description	Code
Humus screening reagent powder (50g)	5119-H
Soil flocculating reagent (60ml)	5643 WT-H
Extraction tube #1	0704
Extraction tube #2	0701
0.5g white plastic spoon	0698
Filter paper	0465
Plastic funnel	0459
Humus color chart (stored in white envelope)	1384

Step 1:
Use the 0.5g white plastic spoon to add 8 level measures to extraction tube #1.

Step 2:
Fill the extraction tube up to the 14ml mark with distilled water.

Step 3:
Use the 0.5g white plastic measuring spoon to add 2 level measures of Humus Screening Reagent Powder. You may need to add more distilled water if the water level drops below 14ml in the extraction tube. Place the cap on the extraction tube and shake vigorously for one minute.

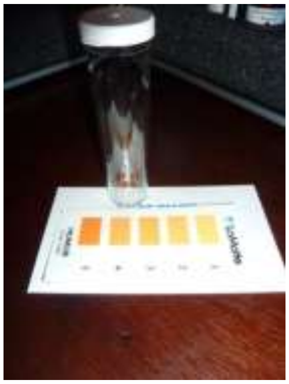
Step 4:
Add 15 drops of Soil Flocculating Reagent. Cap and mix the soil solution gently. Allow the soil to settle for three minutes.

Step 5:
Use filter paper and a funnel to filter the soil mixture. Filter the solution into extraction tube #2. Please see the description of how to use the filter paper below.

How to fold filter paper- Fold the circular filter paper in half. Fold the semi-circle in half.

Pinch the top corners of the cone. The filter paper will now fit in the funnel. There will be three layers on one side and one layer on the other side.

Step 6:
Match the color of the filtrate in extraction tube #2 with the humus color chart. Report the value on 'Form 2.'



Empty the soil solution and used filter paper in the soil waste container. Use distilled water to clean all equipment. Place items on a clean paper cloth to dry.

How to measure soil solution pH with the LaMotte soil test kit (Flocculating solution removes suspended solids, indicator dye is pH sensitive).

Materials needed:

Item description	**Code**
Tricon Flocculating Reagent (500ml)	5941-L
Wide Range Indicator (30ml)	2218-G
Two Test Tubes With Caps	0106
0.5g Plastic White Spoon	0698
1ml Plastic Pipet	0354
Octa-Slide Viewer	1100
Octa-Slide Color Bar For pH	3424

Step 1:
Fill test tube to the 5ml line with Tricon Flocculating Reagent

Step 2:
Use the 0.5g plastic white spoon to add three measures of soil to the test tube. Use the strait edge of another plastic white spoon to level off each spoonful of soil. Place the cap back on the test tube and invert back and forth for one minute.

Step 3:
After the soil particles have settled, use the plastic pipet to remove 2.5ml of clear soil solution to a second test tube.

Step 4:
Add 6 drops of Wide Range Indicator to the second test tube. Place the cap on the test tube and mix.

Step 5:
The soil solution in the second test tube should have turned color. Place the test tube in the Octi-Slide Viewer and slide the Wide Range pH Octi-Slide Bar into the viewer to match the color of the sample. Record the pH of the soil solution on 'Form 2.' If the color of the sample is lower than pH 4.5 (off the scale) then simple report '<4.5'.

Dump the soil solution from both test tubes in a soil waste container. Clean the test tubes, pipet and spoon with distilled water and test tube brush. Place cleaned items on a paper cloth to dry.

Soil nutrient extraction (Melich 1 extraction, dilute HCl and H_2SO_4).

Materials needed:

Item description **Code**

Acid extracting solution (120ml)	6361-J
Charcoal suspension (60ml)	5638-H
Filter paper	0465
Funnel	0459
1ml plastic pipet	0354
Plastic test tube #1	0701
Plastic test tube #2	0701
1g white plastic spoon	0697

Step 1:
Use the 1ml plastic pipet to add 1ml of Acid Extracting Solution to plastic test tube #1. Add distilled water to plastic test tube #1 up to the 15ml mark.

Step 2:
Use the 1g white plastic spoon to add 3 level measures of soil to plastic test tube #1. Add 0.5ml of Charcoal Suspension to plastic test tube #1. Cap plastic test tube #1 and shake for five minutes.

Step 3:
Use the filter paper and funnel to filter the soil solution into plastic test tube #2 (Refer to page 6 for how to fold the filter paper so it fits in the funnel.). This is the soil extraction solution that will be used for the nitrate, phosphate and potassium tests. It should be used within four hours after it is made. Keep the cap on the test tube when not in use.

Dump the used filter paper in a soil waste container. Clean the test tubes, pipet, spoon and funnel with distilled water and test tube brush. Place cleaned items on a paper cloth to dry.

How to measure soil nitrate using the LaMotte soil test kit (Acid extraction, reduction to nitrite and color change due to a diazotization reaction).

Materials needed:

Item description	Code
Mixed acid reagent (500ml)	V-6278-L
Nitrate reducing reagent (10g, health risk-read label)	V-6279-D
Plastic test tube with cap	0106
0.1g white plastic spoon	0699
Octa-Slide Viewer	1100
Nitrate-Nitrogen Octa-Slide Bar	3422

Step 1:
Fill the plastic test tube to the 5ml mark with soil extract (from soil nutrient extraction procedure). Dilute to the 10ml mark on the plastic test tube using Mixed acid reagent.

Step 2:
Use the 0.1g white plastic spoon to add two level measures of Nitrate Reducing Reagent to the plastic test tube (do not touch the reagent or get on skin, clean up any spills with paper towels and throw them away). Cap the plastic test tube and invert 50-60 times in one minute. Wait for 10 minutes while a red color should develop in the soil solution.

Step 3:
Invert the sample one more time to mix. Place the plastic test tube in the Octa-Slide Viewer and compare to the Nitrate-Nitrogen Octa-Slide Bar. The values on the bar are in pounds/acre. This needs to be converted to ppm. To do this, divide the value from the bar by 2. Record this number on 'Form 2.'

Dump the soil solution in a soil waste container. Clean the test tube and spoon with distilled water and test tube brush. Place cleaned items on a paper cloth to dry.

How to test for phosphate using the LaMotte soil test kit (Acid extraction, reduction of phosphor-molybdate).

Materials needed:

Item description	**Code**
VM Phosphate Reagent (60ml, caution-strong acid)	4410-H
Reducing Agent (5ml)	6405-C
Plastic test tube	0701
1ml plastic pipet	0354
0.5ml plastic pipet	0353
Plain plastic pipet	0364
Octa-Slide Viewer	1100
Phosphorus Octa-Slide Bar	3423

Step 1:

Use a 1ml plastic pipet to add 1ml of soil extract (from soil nutrient extraction procedure) to the plastic test tube. Dilute to the 5ml line with distilled water. Use the 0.5ml plastic pipet to add 0.5ml of VM Phosphate to the plastic test tube. Cap the plastic test tube and invert five times. Wait five minutes.

Step 2:
Use the plain plastic pipet to add two drops of Reducing Reagent to the plastic test tube. Cap the plastic test tube and mix by swirling it around. The solution should turn blue within 10 seconds.

Step 3:
Invert the plastic test tube once and place in the Octa-Slide Viewer. Compare the color of the solution with the values on the Phosphate Octa-Slide Bar. The values on the bar are in pounds/acre. This needs to be converted to ppm. To do this, divide the value from the bar by 2. Record this number on 'Form 2.'

Dump the soil solution in a soil waste container. Clean the test tube and pipets with distilled water and test tube brush. Place cleaned items on a paper cloth to dry.

How to measure potassium using the LaMotte soil test kit (turbidity method).

Materials needed:

Item description	**Code**
Potassium TPB Solution	3825-K
Double Tube, Potassium	0796
1ml plastic pipet (2)	0354

Step 1:
Use a 1ml plastic pipet to add 2ml of soil extract (from the soil nutrient extraction procedure) to the round outer portion of the double tube. With the second 1ml plastic pipet, add 2ml of Potassium TPB Solution to the round tube. Wait five minutes.

Step 2:
Dilute to the top line of round tube with distilled water. Cap and shake to mix.

Step 3:
Carefully, remove the cap and slowly insert the square tube (with the plastic collar). The square tube will slide down into the round tube through the collar and fill with liquid. Look directly from above the double tube and look at the black dot on the bottom of the square tube. Slowly slide the square tube down into the round tube until the black dot is no longer visible. Be careful to not block the light in the tube with your hand. Hold the tube from the top of the tube. When the black dot is no longer visible, read the level of the liquid in the square tube. The values on the square tube are in pounds/acre. This needs to be converted to ppm. To do this, divide the value read on the tube by 2. Record this number on 'Form 2.'

Dump the soil solution in a soil waste container. Clean the test tube and pipets with distilled water and test tube brush. Place cleaned items on a paper cloth to dry.

Boimah Engineering Soil Testing
Form 1: Soil sample preparation and submission

Please use the following protocol when submitting soil samples to be tested:

1) Soil samples should be in clearly labeled plastic zip-loc (or similar) bags. Use a permanent marker to label each bag.
2) Samples should be air dried and sieved to 2mm (a flour sieve is acceptable if a standard sieve is not available). If you are not able to dry or sieve samples, then contact Boimah Engineering and make arrangements for them to do this at an additional cost of $5 per sample.
3) Soil samples should weigh between 50 and 300g of dry soil.
4) Please fill out the following sample list for all samples to be submitted. Give each sample a unique six character ID (Ex. DAI001). This ID will be used by the lab to track the sample and the results of the tests will be given using this ID. Please make a copy of this list for your own records.

Date	Company or Individual	Sample Name (name on bag)	Sample ID (six characters)

Form 2: Soil Test Results
Date tested:
Tested by:

Sample ID	pH	Humus (L, M, H)	Nitrate (ppm)	Phosphate (ppm)	Potassium (L, M, H)

Appendix B

FED fertilizer calculation sheet

Example Calculation

Copy the soil test results in the space below for a specific site

Location-___Joes Farmers Association, Lofa______
pH______5.25_________
Humus_____2.5%_______
Nitrate______2.5ppm______
Phosphate_______15ppm_______
Potassium______60ppm_______(if the values is <60ppm then assume it is 10ppm)

Crop to be grown_____Swamp Rice_______

Using the soil test values above, look up the corresponding nutrient requirements from the tables below. When a soil test value lies between two values, then choose the lower of the two values (For example, nitrate is 2.5ppm but the table has values of 0ppm and 5ppm, so use the 0ppm to locate the nutrient value(see highlighted numbers).

Fertilizer calculation tables: values of needed nutrients are given in kg/ha

$N\text{-}NO_3^-$ in soil

ppm	upland rice	swamp rice	cassava	vegetables*
0	80	60	30	80
5	70	50	16	70
10	59	40	2	59
15	49	31	0	49
20	38	21	-	38
30	17	2	-	17
40	0	0	-	0
50	-	-	-	-

P_2O_5 in soil

ppm	upland rice	swamp rice	cassava	vegetables*
0	40	40	30	40
5	30	30	16	30
10	19	21	2	19
15	9	11	0	9
20	0	1	-	0
30	-	0	-	-
40	-	-	-	-
50	-	-	-	-

K_2O in soil

ppm	upland rice	swamp rice	cassava	vegetables*
0	40	40	40	40
10	19	21	12	19
20	0	1	0	0
30	-	0	-	-
40	-	-	-	-
50	-	-	-	-
60	-	-	-	-
70	-	-	-	-
80	-	-	-	-
90	-	-	-	-

*It is recommended to add 5 t/ha or more of compost as well

Nutrient requirements from tables:
Nitrate ______60 kg N_____ Phosphate_________11 kg P_____ Potassium _____0 kg K__

Adjust these values by the area of your plot:

1) Write down the area of your plot from your 'soil sample collection data sheet.' _____1000___m²

2) Divide this number by the number of square meters in a hectare (10,000 m²).

   __1000__ m² / 10,000 m² = ______0.1_______

3) Multiply each of the nutrient values by the number just determined.

   _____60_____ kg N * ____0.1______ = _______6_____ kg N/plot area

   _____11_____ kg P * ____0.1______ = _______1______ kg P/pot area

   ______0_____ kg K * ____0.1______ = _______0______ kg K/plot area

Determine the amount of 15-15-15 needed:

1) Using the values based on your plot area, is 'kg P' or 'kg K' a larger number? Write the larger number here_____1_______.

2) Divide the number written down by 0.15. ______1_______ / 0.15 = _____6.7_______ kg 15-15-15

Determine additional urea needed to meet the nitrogen requirement:

1) _______6_______ kg N/plot area – (______6.7______ kg 15-15-15 *0.15) = ____5______ kg N still needed

   (Note: If this is a negative number then you don't need to add any urea.)

2) _____5_______ kg N still needed / 0.46 (fraction of N in urea) = ____10.9______ kg of urea

Fertilizer Calculations:

Copy the soil test results in the space below for a specific site

Location-________________
pH______________
Humus___________
Nitrate___________
Phosphate_____________
Potassium____________ (if the values is <60ppm then assume it is 10ppm)

Crop to be grown______________

Using the soil test values above, look up the corresponding nutrient requirements from the tables below.

Fertilizer calculation tables: values of needed nutrients are given in kg/ha

$N\text{-}NO_3^-$ in soil

ppm	upland rice	swamp rice	cassava	vegetables*
0	80	60	30	80
5	70	50	16	70
10	59	40	2	59
15	49	31	0	49
20	38	21	-	38
30	17	2	-	17
40	0	0	-	0
50	-	-	-	-

P_2O_5 in soil

ppm	upland rice	swamp rice	cassava	vegetables*
0	40	40	30	40
5	30	30	16	30
10	19	21	2	19
15	9	11	0	9
20	0	1	-	0
30	-	0	-	-
40	-	-	-	-
50	-	-	-	-

K_2O in soil ppm	upland rice	swamp rice	cassava	vegetables*
0	40	40	40	40
10	19	21	12	19
20	0	1	0	0
30	-	0	-	-
40	-	-	-	-
50	-	-	-	-
60	-	-	-	-
70	-	-	-	-
80	-	-	-	-
90	-	-	-	-

*It is recommended to add 5 t/ha or more of compost as well

Nutrient requirements from tables:
Nitrate ___________ Phosphate_____________ Potassium ____________

Adjust these values by the area of your plot:

4) Write down the area of your plot from your 'soil sample collection data sheet.' ___________m^2

5) Divide this number by the number of square meters in a hectare (10,000 m^2).

   ___________ m^2 / 10,000 m^2 = ____________

6) Multiply each of the nutrient values by the number just determined.

   ___________ kg N * ____________ = ____________ kg N/plot area

   ___________ kg P * ____________ = _____________ kg P/pot area

   ___________ kg K * ____________ = _____________ kg K/plot area

Determine the amount of 15-15-15 needed:

3) Using the values based on your plot area, is 'kg P' or 'kg K' a larger number? Write the larger number here___________.

4) Divide the number written down by 0.15. _____________ / 0.15 = ____________ kg 15-15-15

Appendix C

REPORT OF DISCUSSIONS BETWEEN TECHNICIANS OF (1) FOOD AND ENTERPRISE DEVELOPMENT PROGRAM (FED) AND (2) THE COLLEGE OF AGRICULTURE (CAF) OF THE UNIVERSITY OF LIBERIA (UL) –

Monday, 27th August 2012

In order to improve the quality and performance of the soil/plant Analytical Laboratory, a proposal seeking the assistance of FED was submitted by the college of Agriculture/Forestry on 6 August 2012. Discussions between and amongst technicians surrounding the implementation of the proposal was held on Monday, 27th August 2012. FED was represented by Matt Curtis (a visiting Soil Scientist), Albert Bass and Dennis Eaton. CAF was represented by P. Korvah. Further consultations were held with Dr. James Kaizolu and the Dean of CAF, Dr. Massaquoi.

FED agreed to help, but wanted to make incremental steps towards these goals. It was agreed that the water and power supply to the lab be the first to be installed. It was further agreed that water be supplied to the entire Engineering Building but the stand-by generator would serve the lab exclusively. Exclusive power supply to the lab is deemed necessary because some lab equipment require distinct power requirement. After this initial step (water and power), the next step to facilitate the teaching of laboratory exercises for the soil class will be examined. This may include chemicals, glassware, small instruments and training on the use of these items.

FED requested that the University provide a plan that will specify the roles of both FED and U.L. By way of discussions, the following roles were agreed upon:

1. **FED WILL BE RESPONSIBLE FOR THE FOLLOWING**:
   1.1 Provide a 15KVA generator; (If there is a need for a larger generator, then some justification or list of equipment and their power consumption needs to be provided.)
   1.2 Provide one 4 to 5 horsepower water pump to be powered by the generator;
   1.3 Provide air conditioning for sensitive laboratory equipment (3);
   1.4 Provide fuel for the generator during the project period (about three months).
2. **THE UNIVERSITY OF LIBERIA WILL BE RESPONSIBLE FOR THE FOLLOWING:**
   2.1 Construct a generator house for the stand-by generator;
   2.2 Maintain pump and supply adequate water to the lab; Dig the well, provide and install pipes and elevated tanks;
   2.3 Repair doors and windows of the lab to ensure security of equipment and materials;
   2.4 Provide personnel for running the generator and water pump.
   2.5 Provide the soil science laboratory curriculum (ex. Intro to soil science, soil physics, soil chemistry etc.) that will be taught to the students using the labs new improvements.

   After obtaining reasonable commitment from the leadership of UL to undertaking the above, a memorandum of understanding will be signed by authorities of both organizations leading to a prompt commencement of the project.

Submitted: **Asst. Prof. Peter N. Korvah**