SOIL SAMPLING GUIDELINES

STRENTHENING REGIONAL COLLABORATION ON SOIL ANALYSIS

Soil Sampling Guidelines

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1. INTRODUCTION

Careful soil sampling is critical for accurate soil analyses and reliable nutrient recommendations. Soil test results are of little value unless the samples submitted for testing represent the field, plantation, or area under study. The following are examples of unsuitable soil samples:

- Taking many soil samples carelessly from one or two pits in a field
- Keeping the samples in a moist state for several days or even weeks before sending to lab
- Sending soil samples to the laboratory in rusty cans or even old fertilizer bags
- Packing inappropriately without proper labeling

If soil samples are not collected properly, one cannot expect the soil test results to provide accurate information about the nutrient or mineral status of the soil. The analysis can only be as good as the sample.

One or two kilograms (kg) of soil collected from a field represents **only about a one to two millionth part of a hectare, i.e., 0.0001-0.0002%.** Of the collected soil samples, only a few grams (0.1-10 grams) are used in the test, depending on test parameters. It is therefore essential that the sample is carefully collected in the field to avoid contamination. Unusual areas of the field, such as near buildings, gates, field margins, roads, pathways, cow manure pads, recently fertilized areas, stony areas, wet areas, etc should also be avoided. Soil should be well mixed before being tested in the laboratory. The following points should be considered before taking a soil sample, and if the sample is to be sent overseas for laboratory analysis:

1. Field area (square metre)
2. Sampling depth
3. When to sample
4. Sampling procedure
5. Handling
6. Information form
7. Biosecurity/Quarantine import permit and compliance protocol
8. Location of SPACNET affiliated laboratories for soil analysis and other services.

2. FIELD SAMPLING

As a soil population to be studied may be very large and variable, it is often not physically or economically possible to measure all of it. Therefore, a composite soil sample must be collected in such a way that it represents as closely as possible the average character of the whole soil body. One composite soil sample per 0.5 hectare (5,000 square meters) is ideal, if the whole area is relatively uniform. The largest area represented by one composite sample should not exceed 4 hectares (40,000 m^2). If the sampling area is bigger than 4 hectares, more composite samples are needed based on the size of the area (one composite sample per 4 hectares), even from a uniform area (**Figure 1**). If the area is not uniform, more composite samples are also needed, each from a uniform area based on variation in land use, slope, soil type, soil fertility, etc as shown in **Figure 1**.

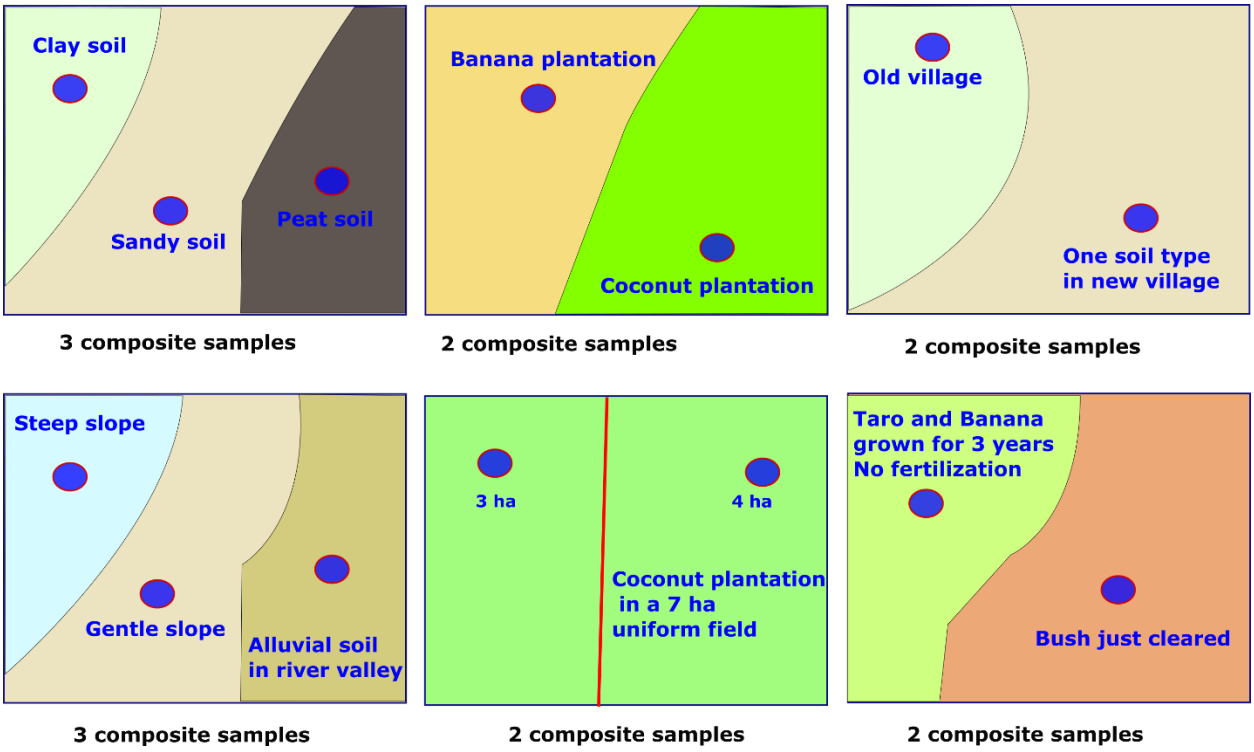

Figure 1. Number of composite samples required under different scenarios

3. SAMPLING DEPTH

Depth of soil sampling varies with the sampling objective as well as the types of crops that will be grown in the sampling area. Generally, soil samples are taken from surface soil for assessing fertility and from each soil horizon for studying profile/taxonomy. Surface soil depth also varies based on the crop that will be cultivated. Assessing soil fertility for field crops that have a fibrous root system, such as rice, maize, etc., requires samples that are taken from 0-15 cm soil depth. However, for root crops such as taro and sweet potato, or plantation crops like cocoa, coconut or fruit trees, orchard samples need to be collected from a greater depth based on the root system of the crop. Soil

sampling depths for commonly grown crops in Pacific Island countries are provided below in **Table 1**.

Table 1. Soil sampling depth for commonly grown crops in Pacific Island countries

Crops	Depth (cm)
Taro	0-30
Sweet potato	0-30
Cassava	0-30
Yam	0-30
Sugarcane	0-30
Banana	0-30
Bean	0-15
Cucumber	0-15
Okra/lady finger	0-15
Eggplant/brinjal	0-15
Tomato	0 -15
Rice	0-15
Maize	0-15
Watermelon	0-15
Peanut/groundnut	0-15
Perennial crops, plantations and orchard crops	Sampling from 3 depths 0-30, 30-60 and 60-90

4. WHEN TO SAMPLE

It is recommended to collect soil samples on a sunny day. In general, soil samples should be taken for a soil fertility assessment before planting a crop or applying fertiliser. Thus, fertiliser doses can be determined and applied accordingly based on the soil test results. Usually, fields are sampled every four years, which can provide sufficient data on soil fertility changes. However, soil samples can be taken as the need arises. For example, if it is observed that a perennial crop or a fruit orchard is not performing well and suffering from some nutrient deficiencies, then soil samples can be taken with standing crops.

5. SAMPLING PROCEDURES

The colour, texture, structure, and likely physical, chemical, and biological properties of soil, change from place to place. In a field, two spots 15 cm apart might have very different soil properties. Therefore, if a soil sample is taken from only one spot, test results might be non-representative and unusable. However, a small soil sample (sub-sample) taken from 10-20 spots that cover various parts of a field or plantation mixed to make a composite sample will produce a much better representative sample. Step by step soil sampling procedures are described below.

5.1. Step 1: Collection of equipment and stationaries

Sampling tools may include a spade, screw auger, tube auger or trowel as shown in **Table 2,** and a GPS-enabled smart phone or handheld GPS unit. A trowel and spade used together work when an

auger is not available. A plastic bucket is used for collecting and mixing the samples, or the samples may be put into plastic or polythene bags. Whatever equipment is used, it must be adequately cleaned between samples to prevent cross-contamination from the metal parts of the mills and sieves.

Table 2. Soil sampling tools

Tool name	Use	Figure
Bucket auger/standard auger/tube auger	Useful for sampling common soils, e.g., loam soil.	
Screw auger/spiral auger	Very useful for sampling gravelly soil.	
Clay auger	Very useful for sampling clay or wet soil but can be used for other soil types too.	
Spade	Used for soil sampling when auger is not available. It can be used for making a 'V' shaped soil cut.	
Trowel	Used for soil sampling along with a spade when an auger is not available. Used for collecting a uniform slice of soil from a 'V' shaped soil cut.	

5.2 Step 2: Determination of sub-sampling spots

First, decide the number of composite samples that need to be collected from the selected area as shown in **Figure 1**. A composite sample must include 10-20 sub-samples. Leave 1-1.5 m distance along the boundaries of the sampling field and determine 10–20 sampling spots for collecting sub-samples to get a composite sample from a uniform area as shown in **Figures 2** and **3**. Generally, distance between two sub-sampling spots varies from between 10-20 walking steps (one walking step equals 70-80cm) based on the size of the field. Sub-samples can be collected by a following zig zag pattern (left side) or layout or grid layout pattern (right side) as shown in **Figures 2** and **3**.

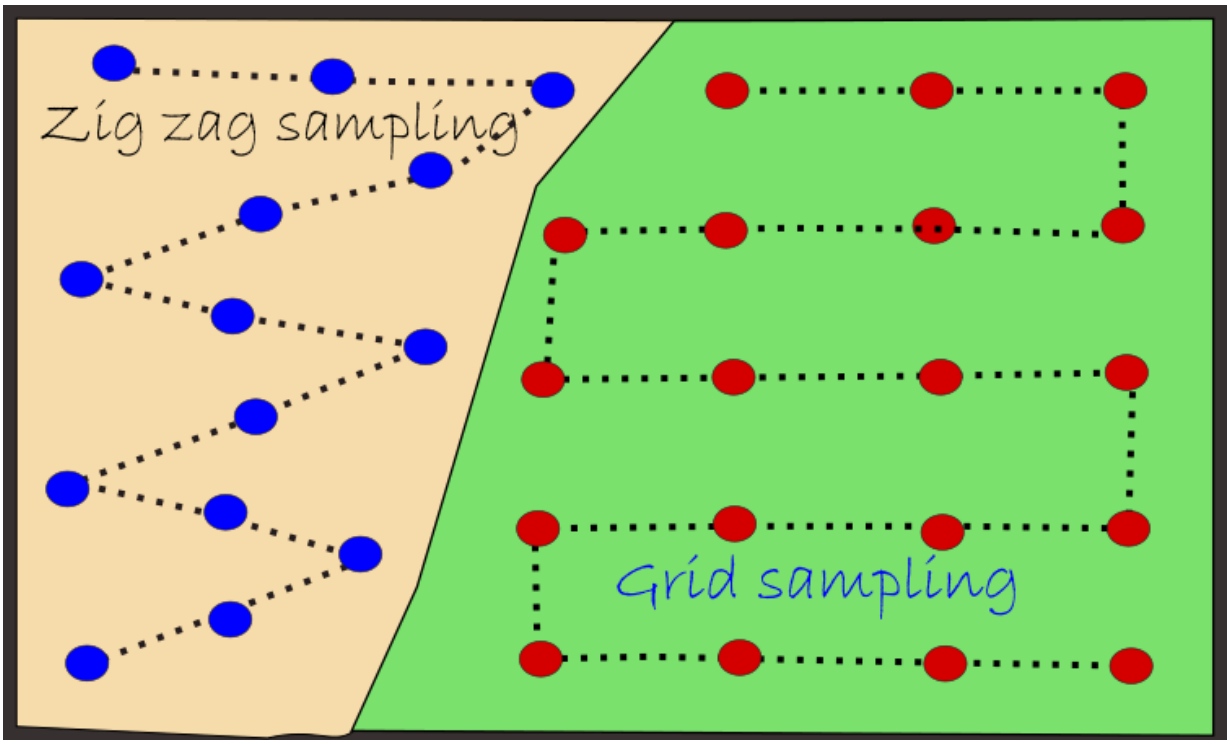

Figure 2. Zig zag and grid sampling layout in an uncropped area

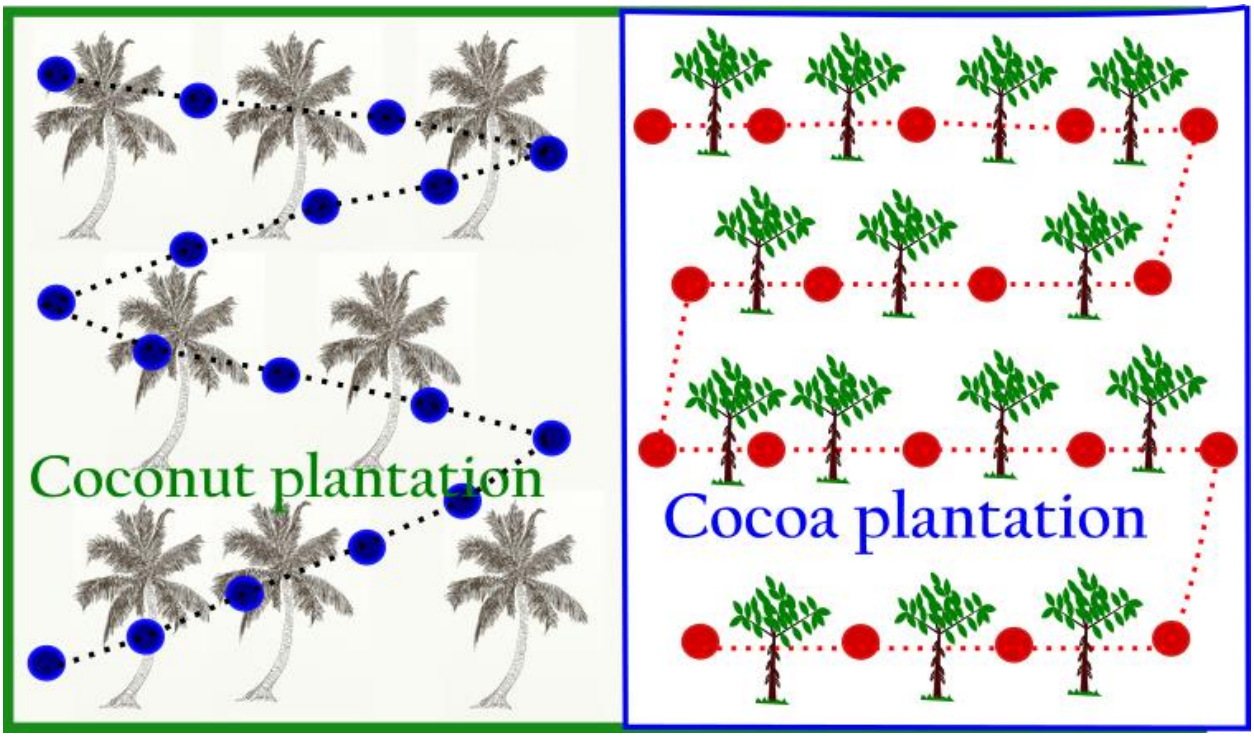

Figure 3. Zig zag (left) and grid sampling (right) layout in a cropped area

5.3 Step 3: Collection of sub-samples

First, clear away any surface litter. If an auger is available for collecting the sub-samples, insert the auger slowly down to the pre-determined soil depth as shown in **Figure 4**. Pull it out gently with the soil and put the soil in a bucket or plastic bag. If an auger is not available, a spade and trowel can be used. First dig a 'V' shaped hole up to the pre-determined depth as shown in **Figure 5(1)**. Take a slice of soil of approximately 5-7 cm uniform thickness from one side of the hole covering the entire depth as shown in **Figure 5(2).** Size the sub-samples by discarding excess soil from both sides of the slice and put the soil slice in the bucket or plastic bag. Collect sub-samples from all the pre-determined spots in the same way. Record the GPS coordinates of locations where each sample is collected. This information is useful for tracking the locations of samples, or it can be helpful if there is a need to return to the same sampling locations in subsequent sampling occasions.

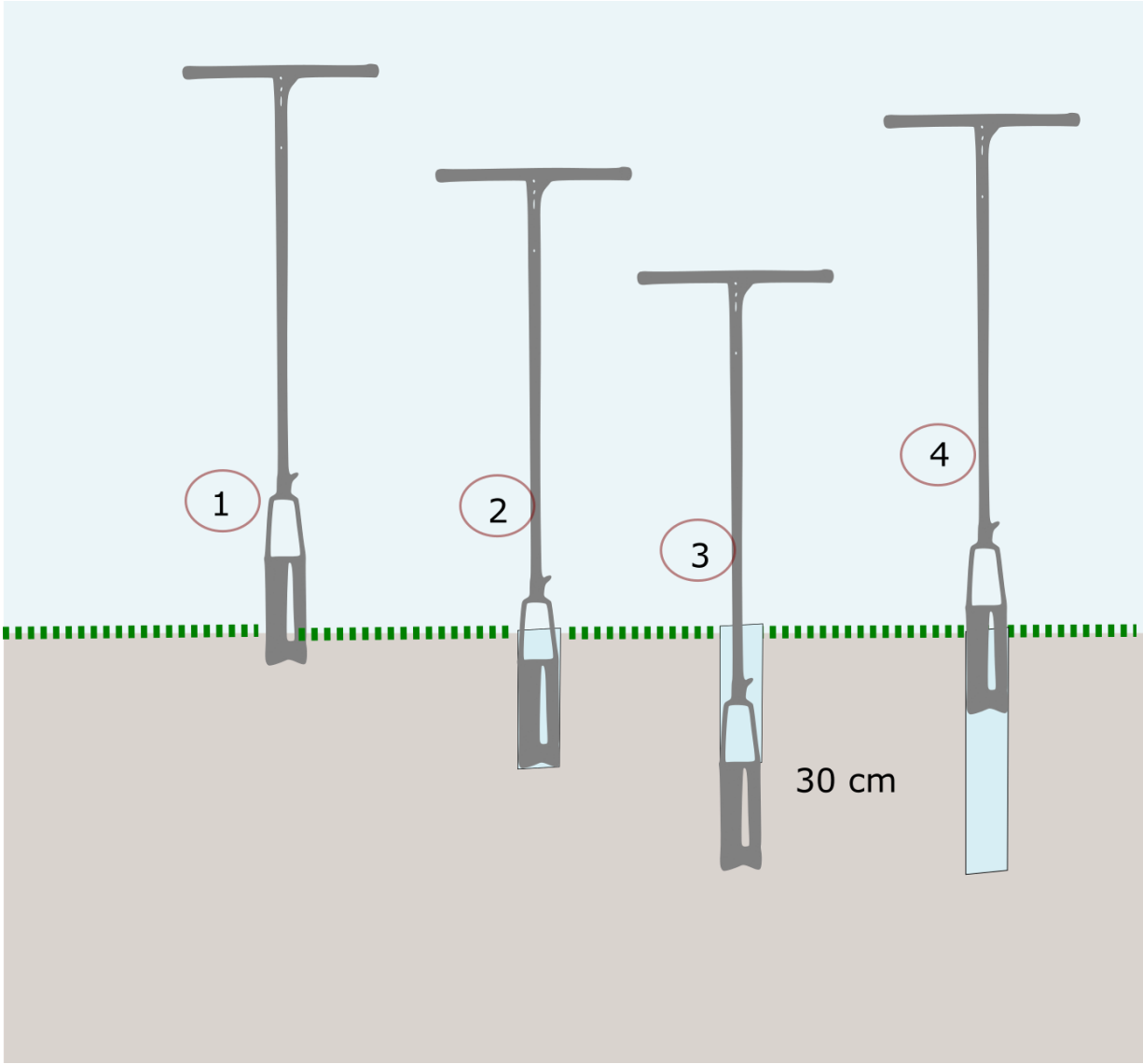

Figure 4. Soil sampling using an auger (1, 2 & 3: inserting auger into soil; 4: pulling out auger with soil)

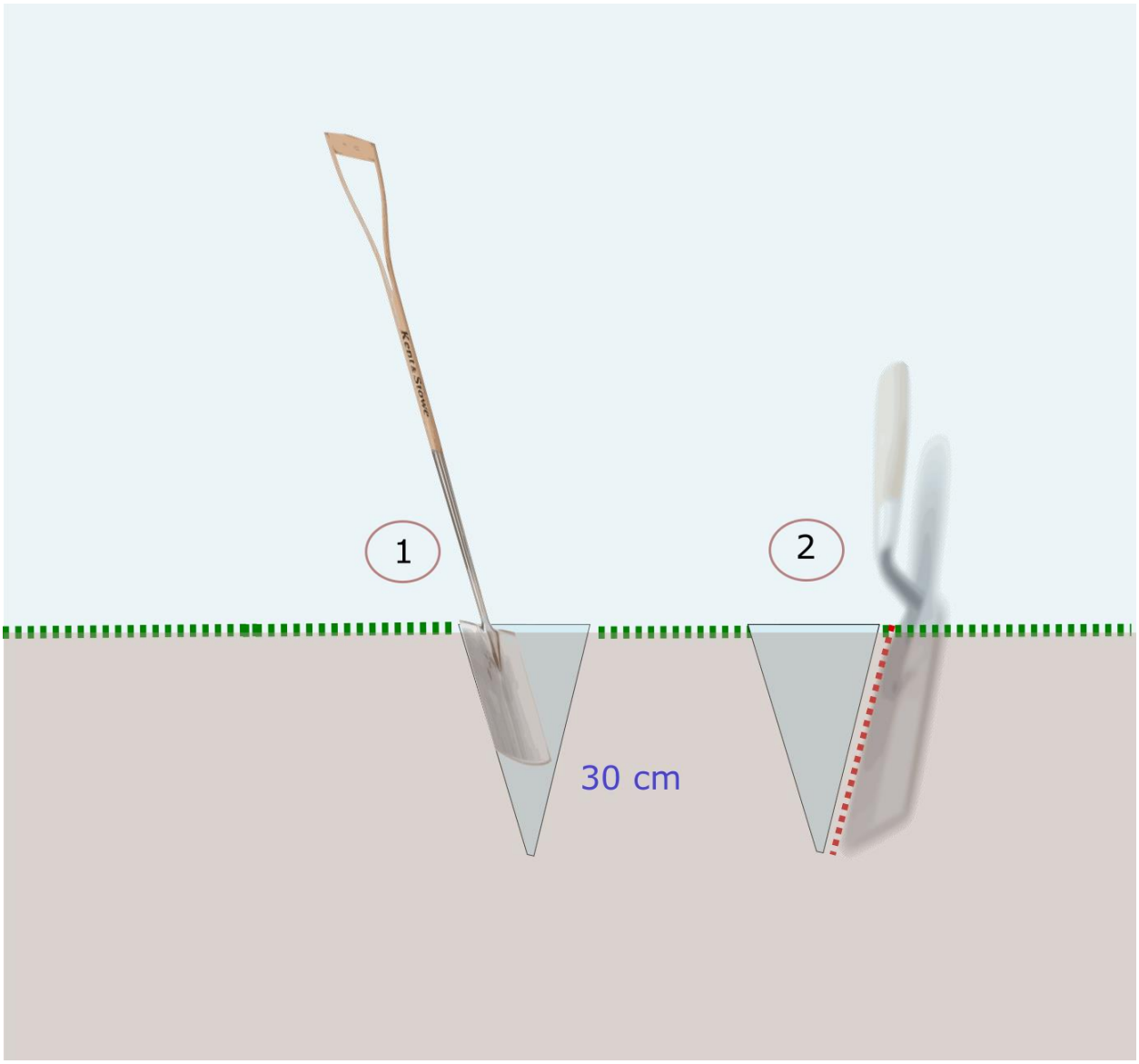

Figure 5. Soil sampling using a spade and trowel (1: making a 'V' shaped hole by a spade; 2: collecting a uniform soil slice from one side of the 'V' shaped hole by a trowel)

5.4 Step 4: Mixing sub-samples for compositing and discarding additional soil volume

All sub-samples should be mixed thoroughly for making a composite sample for a uniform field as shown in **Figure 6**. The samples should be free from stubble, stones, grass, rubbish, plant roots and stems, etc. before mixing. In most cases, 15-20 sub-samples make up approximately 3-5 kg soil. However, only about 400-500 grams of soil is needed for a routine soil fertility analysis. Therefore, additional collected soil samples should be discarded. For discarding, divide the mixed composite sample into four components on a plastic sheet or brown paper as shown in **Figure 7**. Discard any two components from the opposite corners (shown as a red cross in **Figure 7**) and mix the remaining two components again. Continue this process until the volume of soil reaches the expected amount.

If soil samples are collected from different soil horizons or depths, it is recommended not to composite the samples. In this case, soil samples should be kept separate and labelled accordingly based on the horizons or depths.

Figure 6. Mixing sub-samples by hand to make a composite sample

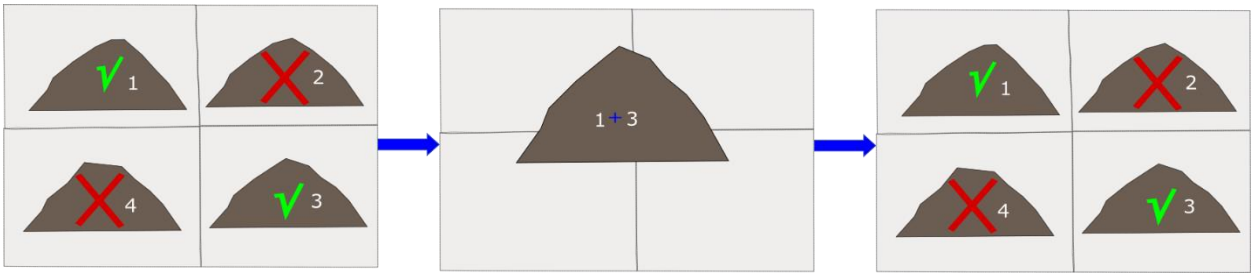

Figure 7. Discarding additional soil volume (left picture: dividing into 4 components and discarding component 2 and 4, middle: mixing again component 1 & 3; right: repeat the process by dividing again into 4 components and discarding component 2 and 4)

6. HANDLING SOIL SAMPLES

Some laboratories do not allow fresh samples due to biosecurity requirements, or to reduce the risk of soil property alteration during collection of biosecurity permits and sample transportation to a laboratory in another island country. If the laboratory is in the same island country and it is possible to submit the soil samples within 1-3 days, fresh samples can be sent. Generally, the chemical and biological properties of fresh samples become altered very quickly compared to dry samples if they are not stored at a low temperature (4°C). In consideration of this, sending air-dried samples to Pacific Island country laboratories is recommended, particularly for countries that do not have their own soil laboratory. Samples should be air-dried in a shady place by spreading on a brown paper or plastic sheet as shown in **Figure 8**. The drying room should be cleaned and kept dust free to avoid contamination. One composite sample requires approximately 0.5-1 m^2 area for drying. Avoiding sun drying is strongly recommended as it alters chemical properties of the soil. Dried samples should be pulverized with a wooden hammer or a piece of clean hard dried wood (not metal to avoid

contamination). Fresh or dried and pulverized soil samples should be placed in a plastic or polythene bag, zip locked or closed tightly with a thread and placed inside another plastic bag before sending to the laboratory. A one-gallon size or (25.4 cm x 25.4 cm or 25.4 cm x 30.5 cm) Ziploc freezer bag is preferable, but any other type of clean plastic bag may be used.

7. LABELLING SOIL SAMPLES

An information sheet (tag) should be placed between the two plastic bags. An additional information sheet (tag) should be tied at the neck (where the bag is tied with thread) of the outside bag. This information has considerable value in interpreting test results. The sheet should contain the following information:

1. Site location (field number or plot number, village name, any specific identification marks (e.g., 100 m north from Robert Louis school) including farmer's name
2. Geolocation (GPS coordinates)
3. Date of sampling
4. Depth of sampling
5. Previous crop and crop to be cultivated
6. Drainage characteristics (e.g., well drained, poorly drained, etc)
7. Soil type (e.g., sandy soil, clay soil, loam soil, etc.)
8. Past fertilizer use (if any)
9. Previous soil test results (if any)
10. Deficiency and disease symptoms (if identified)

Figure 8. Drying, bagging, and tagging a soil sample

8. BIOSECURITY/QUARANTINE COMPLIANCE

When sending soil samples to a registered soil laboratory in another country for analysis, the following Biosecurity/Quarantine compliance protocols must be observed:

1. Apply and obtain a biosecurity/quarantine import permit from the Biosecurity Authority to send soil samples to the registered laboratory in that country
2. Dry soil samples properly before packing in sample bags
3. Label soil samples properly and pack them in double Ziplock bags to avoid spillage and contamination
4. Ensure to wrap a copy of the import permit in clear plastic and place this in the carton of soil samples. Also paste a copy of the import permit on the side of the carton or in the document pouch attached to the carton
5. Pack all the soil samples in a carton and label it properly. State the following information given in the example below:

   - **1 carton said to contain**: 8 packages soil samples for research purposes/ soil analysis.
     Overall weight: 8kg

   - **Sender**: Ministry of Agriculture-Niue
     Name: Mr. Niue
     Contact: Email: …… Phone: ……

   - **Receive**r: The University of the South Pacific Agricultural Chemistry Laboratory.
     Name: Dr. USP
     Contact: Email: ……Phone: ……..

   - Biosecurity Authority of Fiji **Import Permit** attached: ……

9. SUMMARY OF IMPORTANT POINTS

1. Number the areas and label the plastic bags accordingly before starting to collect the soil.
2. Avoid unusual areas, such as near buildings, gates, field margins, roads, pathways, cow manure pads, recently fertilized areas, stony areas, wet areas, etc.
3. Take a composite sample from each (if more than one) of your numbered areas (**Figure 1**). This is done by walking over each area at random and collecting approximately 20 soil sub-samples. Within each sampling area, each leg of the sampling walk should be of a similar length, but as the size of the area increases, so does the length of leg. The sub-samples are mixed together in a plastic bucket.
4. At each sampling point, scrape away the surface litter (if any) before inserting the auger, trowel or spade into the soil. Take only a small sample at each point, but always take a sample of about the same size. After collecting the sub-samples, and mixing each

composite sample, clean out the bucket and clean the implements, so as not to contaminate the following samples.

5. Do not delay bringing the sample to the laboratory if it is not dried. If wet soil is left unattended for three or four days, chemical changes will begin to take place in the sample, which may modify its characteristics.

ANNEX 1. CERTIFIED SOIL LABORATORIES

The South Pacific Agricultural Chemistry Laboratory Network (SPACNET) comprises several laboratories in the region as follows:

- Three in Fiji (Institute of Applied Sciences, USP – Laucala Campus; Sugar Research Institute of Fiji; Fiji Agricultural Chemistry Laboratory, Koronivia, Ministry of Agriculture)
- Two in PNG (National Agriculture Research Institute, Boroko; PNG University of Technology (UNITECH), Lae
- Analytical Laboratory, MAFF, in Tonga
- Analytical Laboratory, Alafua College, USP, Samoa
- Institute of Research for Development (IRD), New Caledonia
- The Solomon Islands Ministry of Agriculture analytical laboratory at Dodo Creek was an inaugural SPACNET member but the laboratory was destroyed during civil unrest in 2001. A new lab is due to be opened at another location in the future.
- The Analytical Laboratory, Landcare Research, Palmerston North, is the SPACNET coordinating laboratory

Soil sample shipping routes are provided in **Figure 9** and information on laboratory/country names, staff in charge and contact details are presented in **Table 3**. More information on SPACNET and certified laboratories can be found at: https://www.aspac-australasia.com/certified-labs.

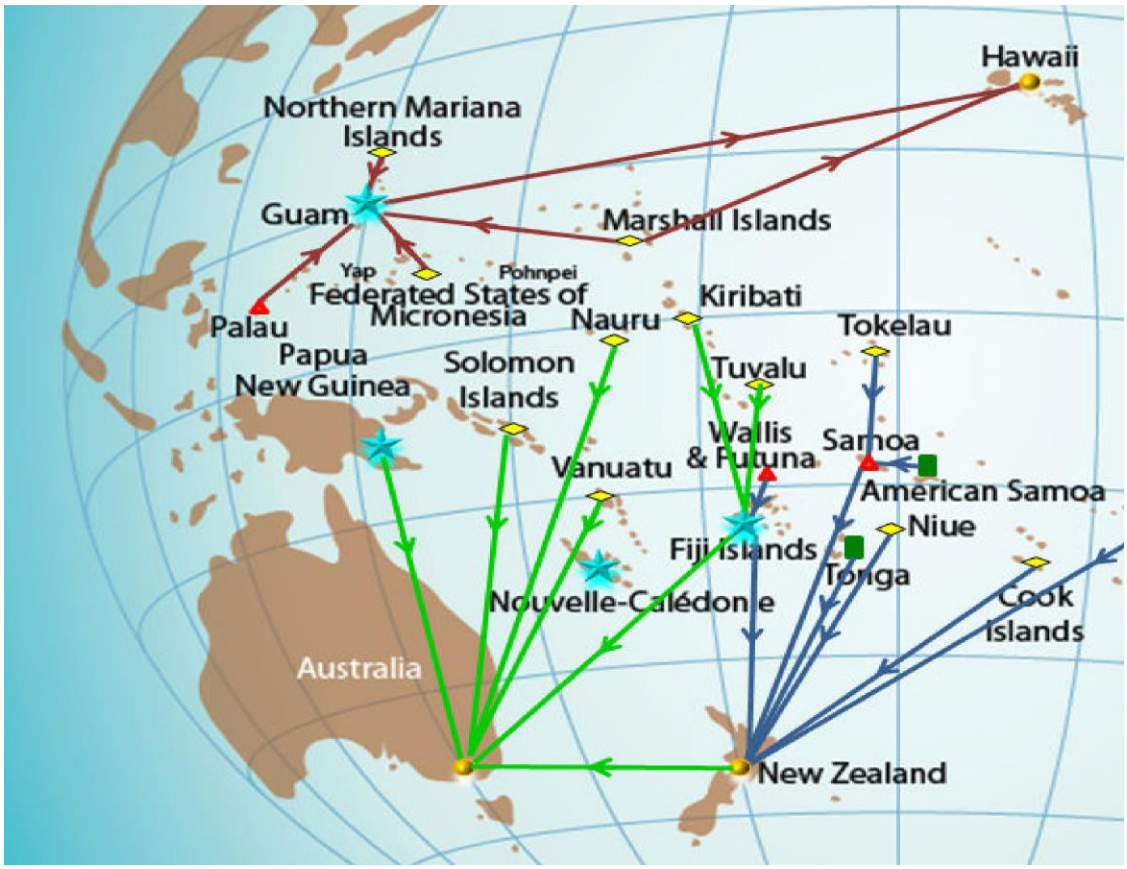

Figure 9. Soil Samples Shipping Routes

Table 3. Laboratory name/country, analytes and contact details

Laboratory name & country	**Analytes**	**Contact and address**[±]
CSIRO Analytical Chemistry Group	Soil, plant, water	CSIRO Analytical Chemistry Group, Building 101, Clunies Ross Street, Black Mountain, ACT 2601, Australia
MWLR Analytical Laboratory, NZ	Soil, plant	Ngaire Foster, Laboratory Manager, Soils & Landscapes, Manaaki Whenua Landcare Research, Palmerston North, New Zealand
Fiji Agricultural Chemistry Lab, Suva, Fiji	Soil, plant	Mr. Ami Sharma, Principal Research Officer, Koronivia Research Station, PO Box 77, Kings Highway, Nausori,Fiji Phone: +679 347 7044 Email: ami.sharma@govnet.gov.fj

Fiji National University College of Agriculture, Forestry and Fisheries; Koronivia, Suva, Fiji	Soil, plant	Dr Deeksha Krishna, Soil Scientist, FNU, CAFF, Koronivia, Suva, Fiji Islands, (679) 347 9200 Ext: 5001. (679) 340 0275 Deeksha.krishna@fnu.ac.fj
Institute of Research for Development (IRD), Noumea, New Caledonia	Soil, plant, water	Leocadie Jamet Laboratoire des Moyens Analytiques Noumea Leocadie.jamet@ird.fr
MAFF –Vaini Research Station, Nukualofa, Tonga	Soil, plant	Mr. Vunivesi Minoneti, Soil Scientist, Vaini Research Station, MAFF, Tonga, Hala Vuna, Queen Salote Wharf, Nuku'aloa Address: P.O.Box 14 Nuku'alofa, Tonga. Phone: +676 23038. Fax: +676 27401 Email: minonetivesi@gmail.com
National Chemistry Analysis Laboratory, Kila Kila, PNG	Soil, plant	The Laboratory Manager, National Chemistry Analysis Laboratory. PO Box 8277, BOROKO NCD, PNG Landline: (675) 3212690 / 3202345 / 3201516. Mobile: (675) 70569862 / 75792487. Fax: (675) 3202411 Email: narichemistry@nari.org.pg Email: Morris.oromu@nari.org.pg Email: Janet.lipai@nari.org.pg
Scientific Research Organisation of Samoa (SROS), Apia, Samoa	Food, nutrients, soil, plant	Dr Seuseu Tauati, CEO, SROS P.O. Box 6597, Nafanua, Apia, Samoa. Ph:(+685) 20664 or (+685) 20352. Email: seuseu@srosmanagement.org.ws
Sugar Research Institute of Fiji (SRIF), Lautoka, Fiji	Soil, plant	SRIF, Drasa Rd., 679 Lautoka, Fiji Email: info@srif.org.fj
PNG UNITECH	Soil, biological tissue, plant, feed, water	Ngayamo Antonio, Executive Secretary, ngyamo.antonio@pnguot.ac.pg
USP-IAS, Chemistry Lab, Laucala Campus, USP, Fiji	Food, feed, nutrients, water	Dr. Vincent Lal, Manager, Laboratory Services, Faculty of Science and Technology, Private Bag, Laucala Campus, Suva, Fiji. Contact: +679 323 2976 Email: vincent.lal@usp.ac.fj

USP -SAFT, Alafua, Apia, Samoa	Soil, plant	Dr. Md. Abdul Kader, Senior Soil Science Lecturer, USP-SAFT. Samoa Campus, Private Bag, Apia, Samoa. Tel: (685) 21671. Fax: (685) 23424 Email: mdabdul.kader@usp.ac.fj
Solomon Islands, Ministry of Agriculture and Livestock, Honiara, SI	N/A	Mr Jules Damutalau Email: Jules.Damutalau@sig.gov.sb
University of Guam		Prof. Dr Mohammed Golabi Email: mgolabi@triton.uog.edu
Land Resources Division, SPC, Suva, Fiji	Pests and disease diagnostics	FeretiA@spc.int, EllenI@spc.int, SPC-LRD, Narere Campus, Suva

Source: *https://www.aspac-australasia.com/certified-lab and others*
[±]Information may need to be updated

ANNEX 2. REFERENCES

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