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Research Paper

Collection and preparation of soil, water and plant samples for analysis

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Abstract
Sustainable agriculture aims to develop food and fiber production systems that benefit farmers and society both economically and environmentally. A key step toward that goal is helping farmers simultaneously use and improve the fundamental resources they have on their farms, such as air, water, soil, sunlight, labor, and capital. The more "tools"; farmers have for achieving that goal, the better they'll be able to meet their own and society's needs. Scientific approaches to crop nutrient management are based on data obtained by analyzing soil and plant tissue samples. Careful sampling techniques will ensure a representative sample. Precise analytical methods will ensure reliable data. However, the most carefully collected sample and the most precise analytical techniques will not ensure appropriate interpretation of the data. Proper, timely soil testing and plant analysis can be very valuable tools, provided they are coupled with fertilizer recommendations based on realistic yield goals, appropriate credits for organic sources of plant nutrients, and field-proven crop response trials.

Key words: Collection, Plant, Processing Sampling, Soil, Water,

The importance of having a true representative sample can be very well realized from the fact that only a minute fraction of huge soil mass of the field is actually used for the analysis in the laboratory to find out the quantity of essential nutrients available to plants and other relevant physical and chemical characteristics. Therefore, while collecting soil samples the following aspects should be carefully considered. The soil samples collected should be representative of the area. A field can be treated as single sampling unit if it is appreciably uniform in all respects. Variation in slope, colour, texture, crop growth and management practices should be taken in to account and separate set of composite soil samples should be collected from each unit of such area. The main purpose for which samples collected are:

a) Soil fertility evaluation and fertilizer recommendation.
b) Reclamation of problematic soils.
c) Plantation of orchards.

The methods of sampling to be used and the amount of soil to be collected mainly depends on

1. The purpose for which sample is required
2. The nature of soil
3. The time available

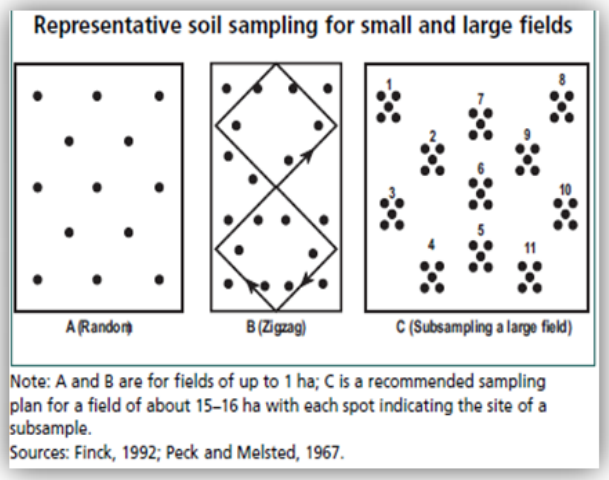
Tools and materials required :-

1) Soil auger, tube auger, spade, pick-axe, khurpi.
2) Bucket or tray.
3) Paper tages (Labels).
4) Information sheet
5) Cloth bags (alternatively polythene bags).
6) Ball point pen or copying pencil

Sampling for fertility evaluation and fertilizer recommendation

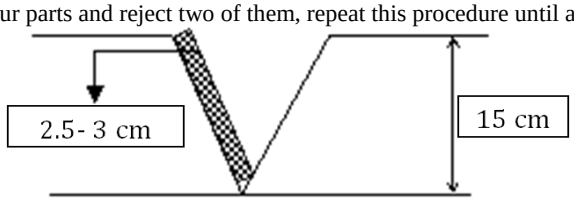
For soil fertility point of view, normally the samples are taken from the plough layer i.e., 0-15 cm depth. This is applicable for the fields growing cereals and other crop. In case of deep-rooted crops and under dry farming conditions, it may be necessary to obtain samples from different depths (or layers) of soil. For collecting proper soil samples following steps should be kept in mind

1. Divide the field into small areas so that each sample represents an area of approximately1 hectare.
2. A sample should be collected separately from areas which differ in soil colour or past management, e.g., liming, manuring, fertilization, cropping pattern etc
3. If a spade or khurpi is used for taking samples, then dig a V-shaped hole to a plough depth and cut 1.5 cm thick slice of soil from top to bottom of the exposed face of the V-shaped hole and collect soil in a clean bucket.



Note: A and B are for fields of up to 1 ha; C is a recommended sampling plan for a field of about 15–16 ha with each spot indicating the site of a subsample.
Sources: Finck, 1992; Peck and Melsted, 1967.

4. Thoroughly mix the soil samples collected from 15 or more spots in a bucket.
5. Collect only ½ to 1 kilogram soil and discard remaining soil samples by quartering.
   Quartering is done by dividing the thoroughly mixed soil in to four equal parts and discarding two opposite quarters. Remix the remaining two quarters and again divide it into four parts and reject two of them, repeat this procedure until about one half kilogram of soil is left.



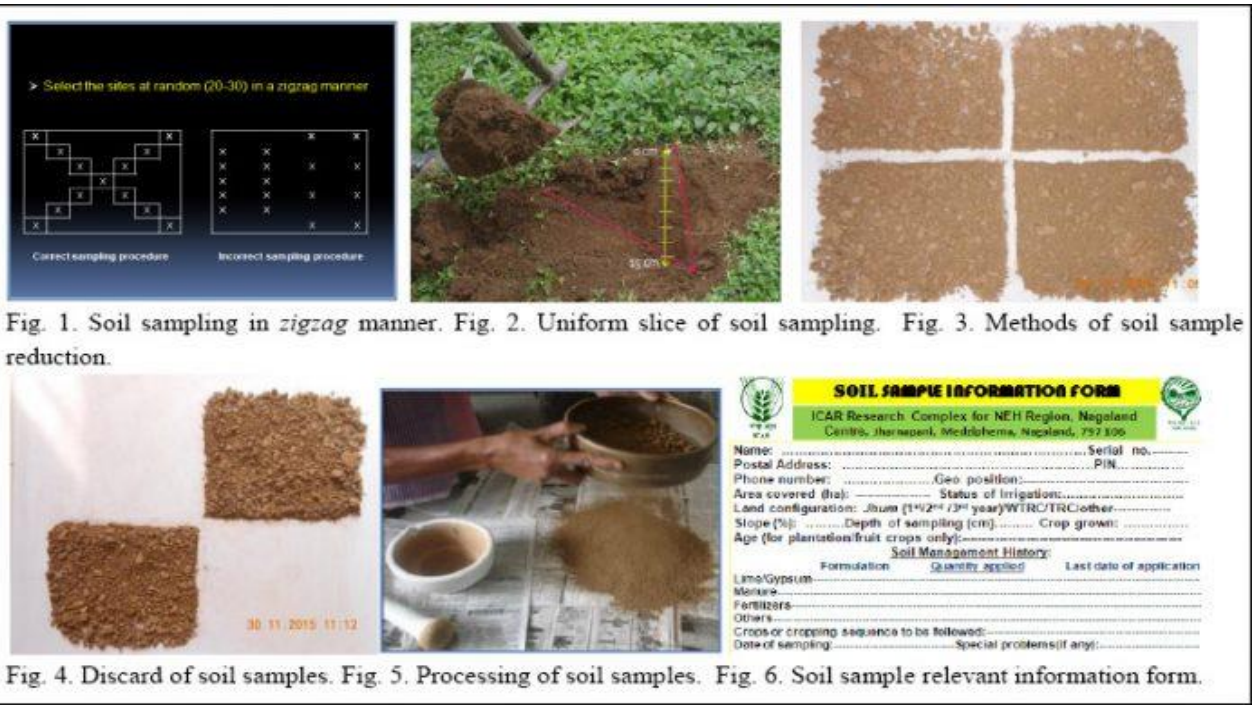


Fig. 1. Soil sampling in *zigzag* manner. Fig. 2. Uniform slice of soil sampling. Fig. 3. Methods of soil sample reduction.

Fig. 4. Discard of soil samples. Fig. 5. Processing of soil samples. Fig. 6. Soil sample relevant information form.

Sampling for soil reclamation

For reclamation purpose the samples should be drawn to the plough layer but the salt crusts (visible or suspected) on the soil surface should be sampled separately. On saline and alkali soils, samples can be taken by either using a soil auger or digging a 90 cm deep pit. The samples should be collected as follow:

1. Make one side of the pit vertical (sun facing side) and put mark on it at 15, 30, 60 and 90 cm depth from the surface.
2. Hold a suitable container at 15 cm mark and scrap a uniform slice of soil from the surface down to this mark and collect about 500 gram of the soil sample. Transfer the soil sample to a cloth bag and mark it as 0-15 cm. Similarly, collect 500 gram soil sample from each layer, i.e. 15-30, 30-60 and 60-90 cm and put them separately in three cloth bags and then after dry in shade.

3. Take a separate sample of the surface crust also, if any.
4. Prepare two labels for each sample showing the depth from samples has been taken, name of farmer, name of village, exact location of the field, conditions and growth of crop if any.
5. Put up one label inside the bag and the other on the bags. Label should be written with a copying pencil/ball pan.
6. Information sheet may also be prepared if necessary as given in soil sample information sheet.
7. Send the sample along with information sheet to be nearest soil testing laboratory.

Precautions

1. Do not draw any sample from the extreme corners of the field, area recently manured or fertilized, old bounds and marshy spots.
2. Avoid sampling from furrows, acidic or alkaline pockets.
3. Keep the sample in a bag and tag it properly.
4. Do not take less than 0.5 kg of a composite sample.
5. Sampling should be done from a uniform piece of land.
6. If there is a hard pan in the pit, it should be sampled separately and also note down its depth and thickness.

Sampling for orchard plantation

For horticultural plants, the samples may be taken from different depth or layer depending upon the root penetration of plants. The success of fruit tree plantation depends upon the physico-chemical properties and fertility status of sub-soil layers. Therefore, it is necessary to test soil before fruit tree plantation. Soil samples for plantation are to be taken as follows:

1. Dig a pit 1.80 meter deep and make its one side vertical, put marks at 15, 30, 60, 90, 120, 150 and 180 cm depths from the surface.
2. Collect samples separately from 0-15, 15-30, 30-60, 60-90, 90-120, 120-150 and 150-180 cm depths in the same way that of saline alkali soils.
3. In case there is a hard pan in the pit, sample it separately and note down its depth and thickness.
4. Pack the soil samples depth wise in separate cloth bags.
5. Put up label on each cloth bags indicating the depth, name of farmers, name of village, location of the field etc.
6. Send the samples to nearest soil testing laboratory along with detailed information.

Preparation of samples for analysis

Drying: Wet soil sample should not be stored as changes may occur in the chemical nature of certain ions and organic matter. Samples are generally air dried at temperature (25-35^{0}C) and relative humidity (20-60%) then after are stored. Fresh samples from the field without any drying are required. For certain determinations such as ammonium and nitrate N, exchangeable K, acid extractable P and ferrous iron fresh sample from the field without any drying are required. Results of soil analysis are expressed on oven dry weight basis. This necessitates determination of moisture percentage by drying a small sample in an oven at 105 ^{0}C for 2 hours.

Sieving: Field moist samples prior to drying can be made to pass through a 6 mm sieve (about 4 mesh per inch) by rubbing with fingers. The practice seems of much advantage in case of heavy soils. Soil in the right moisture condition can be passed through a 2 mm sieve (about 10 mesh per inch). The common practice of sieving a portion of the gross sample through a 2 mm sieve and discarding the rest is undesirable as it increase the concentration of most of the elements involved in soil fertility. When the gravels in the soil exceeds 2% limit over a 2 mm sieve their exact percentage should be recorded.

Grinding: A roller, rubber pestle in an agate mortar, or a motorized grinder is commonly used. Crushing of the gravel or primary sand particles should be avoided for heavy soils, it is better to pass these through a 2 mm sieve before allowing them to get completely air dried.

Mixing: Sample should be thoroughly mixed by rolling procedure. Place the dried ground and sieved sample on a piece of cloth. Hold all the four corners of the cloth and then up the one corner and down the other corner across the sample alternatively. Now repeat the process in the reverse direction to roll the soil from one corner to another. Continue this until thorough mixing is assured.

Storage: Store the soil in paper carton (soil sample box) using a polythene bag as in inner lining. Label the carton mentioning cultivators name, plot number, date of sampling and initials.

Soil sample information sheet

1. Name of farmer---------- Date----------
2. Address----------
   Village---------- P.O. ---------- Block----------
   District ----------
   State----------
1. Sample No. ---------
2. Depth of sampling (cms) -------
3. Area (in hectare) ----------
4. Slope or topography- level/sloping/ undulating
5. Elevation ----------Up land/ low land
6. Drainage----------Well drained/ moderate/ impeded
7. Irrigation ----------Irrigated/unirrigated (rain fed)
8. Source of irrigation ---------Well /tube well/ canal/ pond
9. Type of soil ----------Sandy/loamy/ clayey
10. Special soil conditions--- Hardpan layer/rocky subsoil/
11. Cropping Details ----------

Crop variety:

	Seed rate (Kg/ha)	Yield (Kg/ha)
For previous years 1. 2.		
For proposed years 1. 2.		

12. Fertilizer and manuring history

Year	Crop Manure/fertilizer	Quantity /applied (kg/ha)
20..		
20..		

13. Any other information to be furnished

14. Other remarks (if any)

Water Sample collection and preparation for analysis

Water sampling and analysis is a vital part in agricultural and environmental applications for studying the quality of water treatment process, distribution system, or source of water supply. Therefore, water sampling programme starts with collections of samples which accurately represent the characteristics of the bulk material and handled conveniently in the laboratory while still providing test results. The major source of error in the whole process of obtaining water quality information often occurs during sampling. **Over 50 % of the faulty data that occur in laboratory test results are due to sampling error, rather than during laboratory analysis**. Much of what is presented here is based on standard methods for the examination of waters and wastewaters (APHA, 1998).

High Sodium, excess salinity and high bicarbonates are all big problems when irrigating crops. Knowing the chemistry of water will help better management of the water and soil. The sodium adsorption ratio (SAR) for example, is a critical calculation for assessing the suitability of irrigation water and is based on the relationship between sodium, calcium and magnesium in water. Water with a high SAR can quickly degrade soil structure – but this can be avoided, with the use of gypsum and planting crops more resistant to saline waters.

In addition to irrigation water analysis we can also perform ;

1. Heavy metal analysis
2. Pesticide residue analysis

if these are identified as potential hazards to your production

How to take an irrigation water sample

Water samples for irrigation water analysis must be collected in clean bottles,and care must be taken to prevent accidental contamination of the bottle or water sample during sampling and transportation to the water testing laboratory.

Samples should be taken every 6-12 months, depending on the stability of the source water. In general take samples more often from rivers and surface water and less often for borehole water. Below are procedures for Collecting samples from a tap,river,stream,hand or electric pump,borehole and a well.

Equipment

1. Sample bottles.
2. Water proof marker pen.
3. Labels.

Collecting a sample from a tap

Procedure

1. Remove any external fittings from the tap,such as anti splash nozzle or rubber tube.
2. Clean carefully the outside nozzle of the tap,especially any dirt/grease which has collected.
3. Turn the tap on full.
4. Fill the sample bottle from a gentle flow of water,and replace the cap of the bottle.

Allow the water to run for a while to clear the pipes. This allows time for the nozzle of the tap to be flushed and any stagnant water in the service pipe is discharged.

Collecting a sample from a river, stream or other surface water

Procedure

1. Remove the cap and cover of the sample bottle,
2. Face the mouth of the bottle upstream.
3. Plunge the neck downwards about 30 cm below the water surface,
4. Tilt the neck slightly upwards to let it fill completely.
5. Carefully replace the cap and cover.
6. Where there is no current, push the bottle forward horizontally until it is filled.

Collecting a sample from a hand/electric pump/borehole

Procedure

1. Continuously operate the pump for at least 5 minutes.
2. Let the water flush the fittings and pipes.
3. Collect a sample of water by allowing the water from the pump to flow directly into the sample bottle.
4. Carefully replace the bottle cap and cover.

Collecting a sample from a well

Procedure

If the well is one from which water can be raised only by means of a bucket or can,use a bottle attached to a weight to collect the sample as follows:

1. Tie a sterile sample bottle onto a length of rope or strong string.
2. Use a stone or weight, and attach the bottle just above the weight.
3. 9ooooooooooooooooooo8 Remove the cap from the bottle,and lower the bottle into the well to a depth of about 1 meter.
4. When no more air bubbles rise to the surface,raise the bottle out of the well and replace the cap.

Plant Sample collection and preparation for analysis

Representative ampling should be done of specific plant parts at the growth stage that is most closely associated with critical values as provided by research data. Sampling criteria and procedures for individual samples are similar to those of soil testing in that the sample should be representative of the field. A predetermined, representative number of plants from a homogenous sampling unit contribute to the composition of bulk sample.The composite sample should be about 200-500 g fresh weight. Factors such as the desired precision of recommendation, the nature of the crop(seasonal or perennial) and economic considerations should be taken into account. The following procedure is suggested:

1. For analysis of seasonal crop plants, pick a few representative plants at random from each plot. Remove the shoot (aerial part) with the help of a sharp stainless steel cutter for whole shoot analysis or the desired part for analysis of specific plant parts.
2. If roots are to be included, uproot the whole plant carefully from wet soil, retaining even the fine/active roots. Dip the plant roots gently in water several times to remove adhering soil.
3. Wash with water several times
4. Wash the samples with about 0.2% detergent solution to remove the waxy/greasy coating on the leaf surface
5. Wash with 0.1 M HCL followed by through washing with plenty of water. Give a final wash with distilled water
6. Wash with DDW if micronutrients analysis is to be carried out
7. Soak to dry with tissue paper
8. Air dry the samples on a perfectly clean surface at room temperature for at least 2-3 days in a dust free atmosphere
9. Put the samples in an oven and dry at 70^0C for 48 hours
10. Grind the samples in an electric stainless steel mill using a 0.5 mm sieve. Clean the cup and blades of the grinding mill before each sample.
11. Put the samples back in the oven, and dry again for constant weight. Store in well stoppered plastic or glass bottles or in paper bags for analysis.

What Not to Sample

1. Do not include diseased or dead plant material in a sample.
2. Do not sample or include plants or leaf tissue that have been damaged by insects or mechanically injured in a sample. When whole plants are sampled, remove the roots and wash the upper portion to remove soil particles.

Do not sample plants that have been stressed extensively by cold, heat, moisture deficiency, or by excess moisture. Examine both the below-ground as well as the above ground-ground portion of the plant.The presence of nematodes or roots damaged by other insects or diseases should preclude the need to sample.

General Sufficiency or optimal range of nutrients in plants

Nutrients	Sufficiency or optimal range
Macronutrients	**%**
N	2.0-5.0
P	0.2-0.5
K	1.0-5.0
Ca	0.1-1.0
Mg	0.1-0.4
S	0.1-0.3
Micronutrients	**(µg/g)**
Zn	20-100
Fe	50-250
Mn	20-300
Cu	5-20
Mo	0.1-0.5
B	10-100

Typical plant parts suggested for analysis

Crop	Part to be sampled, with age or growth stage
Wheat	Flag leaf, before head emergence
Rice	3rd leaf from apex, at tillering
Maize	Ear leaf before tasselling
Barley	Flag leaf at head emergence
Pulses	Recently matured leaf at bloom initiation
Groundnut	Recently matured leaf at maximum tillering
Soyabean	3rd leaf from top, 2 months after planting
Cotton	Petiole, 4th leaf from apex, at initiation of flowering
Sugarcane	3rd leaf from top, 3-5 months after planting
Tea	3rd leaf from tip of young shoots
Potato	Most recent, fully developed leaf(Half grown)
Tomato	Leaves adjacent to inflorescence (Mid bloom)
Onion	Top non white portion(1/3 to ½ grown)
Beans	Uppermost, fully developed leaves
Pea	Leaflets from most recent, fully developed leaves at first bloom
Apple, pear	Leaves from middle of terminal shoot growth, 8-12 weeks after full bloom, 2-4 weeks after formation of terminal buds in bearing trees
Cherry	Fully expanded leaves, mid shoot current growth in July August
Peach	Mid shoot leaves, fruiting or non fruiting spurs, mid summer leaves
Strawberry	Fully expanded matured leaf without petiole at peak or harvest period
Banana	Petiol of 3rd open leaf from apex, 4 month after planting
Papaya	3-5 months old leaves from new flush
Pineapple	Middle third portion of white basal portion of 4th leaf from apex, at 4-6 month age

References

Bowen, J.E. 1990. Plant tissue analysis of sugarcane, pp. 449467. In: R.L. Westerman (Ed.), Soil Testing and Plant Analysis. SSSA Book Series 3. Soil Science Society of America, Madison, WI.

Chapman, H.D. 1967. Plant analysis values suggestive of nutrient status of selected crops, pp. 77-92. In: G.W. Hardy (Ed.), Soil Testing and Plant Analysis. Plant Analysis. Part 11. Special Publication No. 2. Soil Science Society of America, Madison, WI.

Cline, M. G. 1944. Principles of soil sampling. Soil Science 58:275-288.

Crepin, J., and R. L. Johnson. 1993. Soil sampling for environmental assessment Pages 5- 24 in M. R. Carter, editor, Soil Sampling and Methods of Analysis. Lewis Publishers, Boca Raton, Horida, USA

Goodall, D.W. and P.G. Gregory. 1947. Chemical Composition of Plants as an Index of their Nutritional Status. Imperial Bureau Horticultural Plantation Crops. Technical Communication No. 17. Ministry of Agriculture, London, England.

James, D., and K.L. Wells. 1990. Soil sample collection and han-dling: technique based on source and degree of field variability. In: R. L. Westerman (ed), Soil testing and plant analysis. 3rd ed. Soil Sci. Soc. Am., Inc. Madison, WI. p. 25–44.

Jones, J.B. Jr., and V.W. Case. 1990. Sampling, handling, and ana-lyzing plant tissue samples. In: R.L. Westerman (ed), Soil test-ing and plant analysis. 3rd ed. Soil Sci. Soc. Am., Inc. Madison, WI. p. 389–447.

Jones, Jr., J.B. 1994c. Tissue Testing (VHS video). St. Lucie Press, Delray Beach, FL.

Jones, Jr., J.B. and V.W. Case. 1990. Sampling, handling, and analyzing plant tissue samples, pp. 389427. In: R.L. Westerman (Ed.), Soil Testing and Plant Analysis. SSSA Book Series 3. Soil Science Society of America, Madison, WI.

Sabbe, W.E., and D.B. Marx. 1987. Soil sampling: spatial and tem-poral variability. In: J.R. Brown (ed), Soil testing: sampling, correlation, calibration, and interpretation. Soil Sci. Soc. Am. Special Publ. no. 21. Madison, WI. p. 1–14.

Kalra, Y.P., and D. G. Maynard. 1991.Methods Manual for Forest Soil and PlantAnalysis. Information Report NOR-X-319. Forestry Canada, Northwest Region, Northern Forestry Centre, Edmonton, Alberta, Canada.