FPI PRACTICAL SOIL PROFILE GUIDES

Southern Africa Practical Soil Profile Guide

Volume 1 • Field assessment and training



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Farmer's Pride International
Hunter's Global Network

Cover photographs: ISRIC specimens NA-001, ZA-011 and ZM-010. Genuine preserved soil profiles. Full credits and CC BY-SA 3.0 licence information appear on page 37.

How to use this guide

This practical guide is designed for farmers, agricultural trainers, extension teams and project assessors working in Southern Africa. It explains how to examine a soil profile, record evidence and connect observations with questions about land use. It is a field learning resource, not a substitute for a site investigation or laboratory interpretation.

The geographical scope includes Angola, Botswana, Eswatini, Lesotho, Malawi, Mozambique, Namibia, South Africa, Zambia and Zimbabwe, with relevant island considerations for Madagascar, Mauritius, Seychelles and Comoros. This is an editorial coverage convention, not an official regional boundary. The photographed examples come from Namibia, Zambia and South Africa; they are not a photographic inventory of every country.

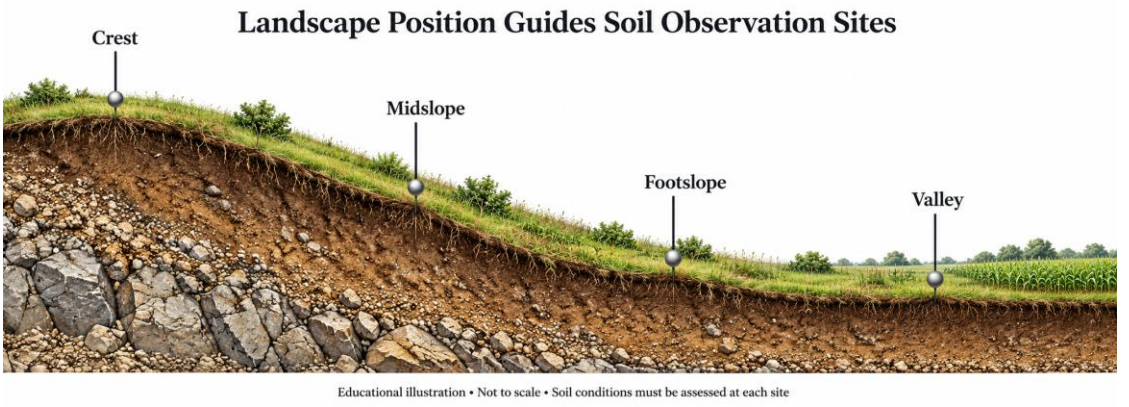
Read the observation chapters before using the profile examples. Then complete the site and horizon records during supervised fieldwork. Use the sampling and action-planning chapters to decide what must be checked before selecting a crop, irrigation system or soil treatment.

Photographs show genuine preserved soil monoliths from the ISRIC World Soil Reference Collection. A monolith is an extracted, preserved section of soil, photographed as a reference specimen. It is not an unaltered photograph of an open field pit. The soil group names reproduce the source labels and do not constitute a new classification under the latest WRB edition.

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Original teaching schematic. Not a measured field profile or a soil map; not to scale.

The region includes dry sand plains, coastal lowlands, interior plateaus, river valleys, mountains and wetter uplands. These settings influence the material from which soils develop, the movement of water and the time available for weathering. A country name alone cannot describe these differences.

Begin an assessment with the landscape. Note whether a field lies on a crest, midslope, footslope, valley bottom or floodplain. Look for exposed rock, deposited sediment, drainage lines and changes in vegetation. Compare vigorous and weak crop patches without assuming that every difference is caused by soil fertility.

A soil map is a planning aid. Its mapping units may contain several soil types and may not resolve a small farm. Record the map source and scale, then verify the actual field conditions with observations and sampling. A reference specimen from another district is a teaching comparison, not a substitute for describing the farm.

Island environments also require local assessment. Volcanic, coral-derived, alluvial and strongly weathered materials may occur in different settings. Do not transfer a mainland management recommendation to an island field without checking the soil, climate, water and land-use requirements.

Field task: sketch the property and divide it into provisional assessment zones using slope, land use and visible differences. Give each zone a code. Explain why each boundary was drawn and identify areas where uncertainty requires additional observation.

Planning a safe site assessment

Choose the assessment method before disturbing the ground. Surface observations, a hand auger, existing stable exposures and professionally prepared pits offer different information. An auger is useful for checking depth and changes in material, but it does not show undisturbed structure as clearly as a suitable exposed face.

Obtain landholder permission and identify underground services, access restrictions and sensitive habitats. Consider livestock, traffic, heat, remote working and the possibility of contaminated land. Work with a colleague where appropriate, carry communication equipment and record the site location.

Do not enter an unsupported excavation. Soil walls can collapse without warning, particularly when wet, sandy, cracked or disturbed. Excavation, access and protective measures require competent local supervision. Keep people and loads away from edges and secure the area against accidental entry.

Do not infer that a pit is safe because it is shallow or has stood overnight. If conditions are uncertain, use a lower-risk observation method and refer the excavation work to competent personnel. Restore or securely close the assessment area when work ends.

Record the depth actually examined and any limitation. Write “not observed below this depth” rather than assuming that the profile continues unchanged. A limitation honestly recorded is more useful than a complete-looking description based on guesswork.

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Equipment and repeatable records

A basic kit includes a notebook or field form, pencils, measuring tape, sample labels, clean sample containers, a camera and location recording equipment. Select tools for the authorised assessment method. Include appropriate personal protective equipment and a clean water supply for texture observations.

Use a recognised soil colour reference when a formal colour description is required. Phone screens and camera processing can alter colour. Record whether the soil was dry, moist or wet. Retain the original photograph rather than editing its colours to make horizon boundaries appear stronger.

Assign identifiers before collecting samples. A useful system links project, site, horizon or depth interval, date and sample number. Use the same code on the container, field sheet, photograph register and laboratory request. Keep a duplicate electronic record.

Take a site overview, a full profile image and close views of selected features. Put a scale beside the observed face and avoid obscuring the soil with the label. Record the direction and lighting where these affect interpretation. Never invent scale markings after the photograph is taken.

At the end of each day, check that labels are legible, the register is complete and photographs can be matched to sites. Resolve missing information while the team still remembers the observations. This simple quality check prevents expensive confusion later.

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How soils develop

Soil development reflects the interaction of parent material, climate, organisms, relief and time. Human management also changes the profile through cultivation, traffic, erosion, irrigation and the movement of materials. Similar surface colours can therefore occur in soils with different histories and behaviour.

Parent material supplies the starting mineral material. Weathering changes it, while water can move dissolved substances and fine particles. Vegetation and other organisms contribute residues and modify the arrangement of soil. Landscape position influences whether material is lost, accumulated or periodically saturated.

In some profiles, layers represent different sediment deposits rather than development within one uniform material. A sudden increase in stones or a sharp texture change can therefore have several explanations. Describe the change first; do not automatically call every darker layer an old topsoil.

Management history is essential context. Ask about land clearing, cultivation depth, previous crops, fertilisers, manure, irrigation, earthworks and flooding. Treat farmer observations as valuable evidence, while distinguishing remembered events from measured records.

Training exercise: compare two locations on the same property. Identify which soil-forming and management factors appear similar and which differ. Write a short explanation of how these differences could influence the profile, then list the evidence needed to test that explanation.

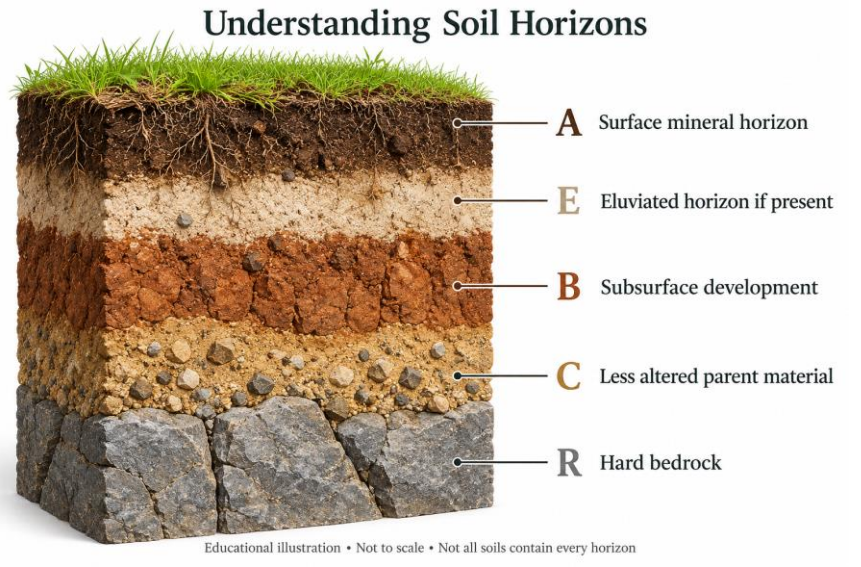
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Original teaching schematic. Not a measured field profile or a soil map; not to scale.

Horizon letters are a concise language for describing parts of a profile. In a simplified mineral-soil sequence, A identifies a surface mineral horizon influenced by organic matter; E identifies a horizon of removal or eluviation; B identifies a subsurface horizon changed by soil development; C identifies relatively little-altered material; and R denotes hard bedrock. Organic layers require their own descriptions.

These letters are not a compulsory sequence. Many soils lack an E horizon, some lack a recognisable B, and cultivated or deposited materials can complicate the pattern. A dark layer is not automatically an A horizon, and a red layer is not automatically a B horizon.

Measure boundaries downward from a clearly defined reference surface. Note whether a boundary is sharp or gradual, approximately level, wavy or irregular. Where a layer varies in thickness, record that variation instead of forcing it into a single exact number.

Use tentative descriptive layer numbers when uncertain. A defensible description of “layer 2, approximately 20–45 cm, finer textured than above” is preferable to an unsupported diagnostic classification. Formal soil naming requires the relevant diagnostic criteria and, often, analytical measurements.

The accompanying diagram is a teaching schematic. Its layers are not measured from a farm and its colours do not establish a soil type. Use it to learn the recording sequence, then describe actual sites independently.

Colour and visible concentrations

Describe the dominant soil colour separately for each layer. Observe a fresh surface under suitable natural light and record moisture condition. When using a standard colour chart, note the reference used so another assessor can understand the record.

Colour can suggest processes worth investigating, but it cannot establish fertility, organic carbon concentration, drainage class or crop suitability on its own. Red, yellow, grey and dark materials occur in different combinations across the region. Compare colour with texture, structure, position and rooting.

Record spots or mottles separately from the main colour: their colour, approximate abundance, size and position. Some patterns are associated with changes in oxidation and reduction; others may reflect parent material or older conditions. Confirm present water conditions with seasonal evidence rather than relying on one visual feature.

Describe visible nodules, coatings and pale accumulations without assuming their composition. Carbonates, salts, gypsum and other materials need appropriate identification methods. A white deposit is a reason to investigate, not sufficient evidence for a named soil problem.

Field task: photograph one sample dry and moist under similar lighting. Compare the appearance and explain why an image without moisture information can mislead. Keep any colour correction out of the evidential image and preserve the original file.

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Texture and the fine earth fraction

Texture concerns the relative proportions of sand, silt and clay in the fine earth fraction. It differs from structure, which describes how particles are arranged. Stones and gravel should be recorded separately because they reduce the volume occupied by fine soil and may influence cultivation and water storage.

A moist hand assessment can provide a useful field estimate. Examine how gritty, smooth, sticky or plastic the sample feels and how it behaves when worked gently. Use a consistent recognised procedure and practise against samples with laboratory results. A quick field estimate is not a substitute for particle-size analysis.

Describe texture for each layer. A sandy surface can overlie much finer material, and the change can matter more for root and water movement than the surface description alone. Record the depth and character of that transition.

The jar settling demonstration can support teaching, but incomplete dispersion, organic material and timing affect the result. Do not use an informal jar test to assign precise percentages or a formal soil classification.

Management question: if two layers have contrasting texture, where could water accumulate and where might roots become restricted? Treat these as hypotheses. Check structure, continuity, slope position and actual moisture observations before selecting irrigation or drainage measures.

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Structure and soil consistency

Structure describes the natural arrangement of soil into aggregates and the spaces between them. Granular, blocky, prismatic, platy and weakly structured materials can behave differently. Describe what a fresh sample reveals before it is crushed or heavily handled.

Examine the ease with which a natural aggregate separates. Note its shape and approximate size, visible pores and whether roots follow cracks or enter the aggregates. Do not mistake fragments created by digging for natural structural units.

Consistency changes with moisture. Material that is hard when dry may be workable when moist and sticky when wet. Record the condition during assessment so observations from different seasons are not treated as directly equivalent.

The management implication is functional: can air, water and roots move through the profile under normal field conditions? A neat-looking surface does not answer this question. Look beneath cultivated soil and compare trafficked and less disturbed locations.

Exercise: collect intact samples from two authorised shallow observation points and compare their natural aggregates. Record the differences without assigning a quality score until the site context is known. Photograph the samples with a scale and retain the assessment notes.

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Roots and effective soil depth

Effective rooting depth is the depth of soil a particular crop can use under the site's physical and chemical conditions. It may be less than the depth of visible soil. Rock, dense layers, seasonal saturation, salinity or other conditions can restrict access.

Describe roots by depth and distribution. Note whether fine roots are present throughout a layer, concentrated along cracks, flattened at a boundary or absent below it. Also record crop species, stage of growth and season, because these affect the root pattern.

A root turning sideways is evidence of a local change, not proof of compaction alone. Compare the material above and below, examine continuity and seek supporting measurements. An isolated stone and a continuous restrictive horizon have very different management implications.

Keep observed profile depth and effective rooting interpretation separate. If an auger stops, record whether the obstruction appears to be rock, gravel, a hard layer or an unidentified barrier. Do not assume that refusal at one point represents the whole field.

For long-term plantings and infrastructure, investigate sufficient locations to describe variability. Where a major restriction is suspected, obtain competent advice before committing to deep cultivation, drainage or permanent irrigation layouts.

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Drainage and seasonal wetness

Drainage assessment considers how water enters, moves through and leaves the soil and landscape. A dry inspection during the dry season cannot establish that a site remains aerated during the rainy season. Combine profile observations with local history and repeat visits.

Look for water in the observation hole, contrasting moisture above a boundary, surface ponding, restricted roots and relevant colour patterns. Record recent rainfall and irrigation, since a recent event can explain temporary conditions.

Distinguish water held above a restrictive layer from a broader groundwater problem. The appropriate investigation and management may differ. A proposed drain also needs an acceptable outlet and consideration of downstream effects and applicable land-use requirements.

Avoid treating wet areas as failed farmland by default. Some are environmentally sensitive or have uses incompatible with drainage. Check local requirements and obtain the necessary technical assessment before earthworks.

Field task: mark suspected wet patches on the property sketch and ask when they appear, how long they persist and whether the pattern follows irrigation. Plan a return visit under relevant seasonal conditions. Record unresolved questions instead of promising a drainage solution from one inspection.

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Sandy profiles and Arenosol examples



Namibia • Arenosol. ISRIC preserved monolith NA-001; source identification. Photo: Creutzberg, D & H, Scholz. CC BY-SA 3.0; full source on page 37.

The Namibia specimen NA-001 is source-labelled Arenosol. Its photograph provides a genuine reference for discussing a sandy profile. The preserved specimen records one location and sampling event; it does not represent all Kalahari sands or all sandy farms.

For a sandy field, investigate the depth of coarse material, any finer layers, coarse fragments, rooting and actual soil water behaviour. A deep profile can still offer limited plant-available storage per unit depth. Texture alone does not establish a workable irrigation interval.

Management planning should examine water supply reliability, nutrient retention, surface protection and the ability to deliver smaller, timely inputs where appropriate. Use measured performance and crop demand rather than adopting a fixed schedule from another site.

Do not assume that manure, clay or other amendments can be added at any rate without testing. Consider nutrient loading, salinity, material quality, application cost and the condition of the receiving soil. Establish a small monitored trial when an amendment is uncertain.

Training prompt: list three observations that can be made from this specimen and three questions that the photograph cannot answer. In particular, do not derive fertiliser rates, yield estimates or crop suitability from its red colour.

Cracking clay profiles and Vertisols



Namibia • Vertisol. ISRIC preserved monolith NA-009; source identification. Photo: ISRIC World Soil Reference Collection; photographer not identified in source. CC BY-SA 3.0; full source on page 37.

The Namibia specimen NA-009 is source-labelled Vertisol. Visible cracks and blocky pieces in a preserved specimen offer useful teaching features, but the photograph cannot show the complete seasonal cycle of shrinking and swelling.

On a cracking-clay field, record crack pattern and width, moisture condition, surface relief, rooting and evidence of wetness. Large cracks during dry conditions do not mean that water will move equally freely after the soil wets and swells.

Planning requires attention to the workable moisture range. Traffic or cultivation at an unsuitable time can damage structure or create difficult seedbed conditions. Record actual field operations and compare their effects across seasons.

Irrigation design should account for changing intake behaviour and the possibility of uneven wetting. Surface drainage, levelling and scheduling require site-specific evaluation. Do not use the presence of clay as proof of high fertility or adequate drainage.

Decision exercise: a farmer reports that a field is hard to cultivate when dry and sticky after rain. Write the observations needed to understand this problem, a suitable timing trial and the measurements that would show whether the revised practice improved establishment.

Sodic subsoil and Solonetz examples



South Africa • Solonetz. ISRIC preserved monolith ZA-011; source identification. Photo: Creutzberg, D. CC BY-SA 3.0; full source on page 37.

South African specimen ZA-011 is source-labelled Solonetz. It shows a strong visual change between the upper material and large structural units below. The source identification is retained; this guide does not establish a new analytical diagnosis from the image.

Where a field has a dense, strongly structured subsoil, record depth, continuity, rooting and water movement. Consider several explanations. Texture contrast, natural structure and management effects can overlap, so a visual judgement alone should not trigger a chemical treatment.

Salinity and sodicity are different problems. Electrical conductivity helps assess soluble salts, while exchangeable sodium or appropriate water chemistry measures address other aspects of sodium risk. Laboratories should specify the extraction and reporting methods.

Gypsum is not a universal treatment for difficult soils. A defensible reclamation plan requires diagnosis, a calculated treatment requirement where relevant, suitable water, drainage and monitoring. Adding material without an outlet for displaced salts may not solve the problem.

Field task: prepare a laboratory question for a suspected sodium-related problem. Include site history, separate depth samples, irrigation-water information and observations. Ask what the results can and cannot establish before purchasing amendments.

Deep red profiles and Nitisol examples



Zambia • Nitisol. ISRIC preserved monolith ZM-010; source identification. Photo: Van Baren, JHV and PGF, Heilmann. CC BY-SA 3.0; full source on page 37.

Zambian specimen ZM-010 is source-labelled Nitisol. Its red appearance and visible structural detail provide a reference for discussing a strongly developed profile. Formal identification requires diagnostic evidence beyond colour.

When examining a red clayey field, describe aggregate shape, root distribution, depth and moisture behaviour. Some well-structured clay soils can offer useful rooting conditions, but neither clay content nor colour guarantees these conditions on a particular farm.

Assess chemical status independently. Record pH method, organic carbon, relevant nutrient tests and the laboratory's interpretation framework. A deep profile can have chemical constraints even where its structure appears favourable.

Conserve the surface through appropriate cover and field operations. On sloping land, consider runoff pathways and erosion before intensifying production. The visible depth of a reference specimen should not be taken as evidence that nearby fields have retained the same topsoil.

Exercise: compare this specimen with the sandy Namibia example. Write differences you can observe directly, then list the measurements needed to compare water storage, nutrient status and cultivation requirements. Do not rank either soil as universally better.

Dark surface profiles and Umbrisols



South Africa • Umbrisol. ISRIC preserved monolith ZA-007; source identification. Photo: Jacobs, T. ISRIC – World Soil Information. CC BY-SA 3.0; full source on page 37.

South African specimen ZA-007 is source-labelled Umbrisol. The photograph contains contrasting dark and brighter material. It is useful for learning to describe differences without assuming that a dark surface automatically indicates high fertility.

Record the thickness, moisture condition, texture and structure of dark material. Review the site's vegetation and land-use history. Organic carbon testing is needed to quantify carbon concentration; colour cannot provide a reliable percentage.

A dark surface also does not establish pH, nutrient availability or biological condition. Request the tests relevant to the proposed crop and production system. Keep any interpretation of acidity separate from what is visible in the photograph.

Where land is cultivated, monitor whether the surface layer is being lost, mixed or compacted. Repeated photographs at a fixed point can show changes, but measurements and management records are needed to explain them.

Training prompt: explain to a farmer why "black soil" is an incomplete assessment. Give a short description of the additional information required before recommending a crop or purchasing fertiliser.

Dark mineral profiles and Phaeozems



South Africa • Phaeozem. ISRIC preserved monolith ZA-016; source identification. Photo: Creutzberg, D. CC BY-SA 3.0; full source on page 37.

South African specimen ZA-016 is source-labelled Phaeozem. Compare its visible surface material and underlying change with the Umbrisol specimen. These two reference names must not be assigned to a farm merely because its soil resembles either photograph.

Field description and classification serve different purposes. Description records observable features; classification organises soils using defined diagnostic criteria. Related-looking profiles may differ in measurements that a photograph does not reveal.

For agricultural assessment, examine rooting volume, drainage, structure, crop history and analytical results. A reference group name can provide context, but it does not replace the information needed to manage a particular crop.

When discussing productive potential, consider the whole enterprise. Water reliability, slope, machinery access, crop demand and market requirements can alter the feasibility of a project even where soil properties are favourable.

Exercise: prepare a neutral profile caption for this image. Identify its source and specimen number, describe two visible features and state one limitation. Avoid claims about crop yield, profitability or suitability that have not been measured.

Pale horizons and Podzol examples



Zambia • Podzol. ISRIC preserved monolith ZM-001; source identification. Photo: Van Baren, JHV. CC BY-SA 3.0; full source on page 37.

Zambian specimen ZM-001 is source-labelled Podzol. The specimen is included to illustrate regional diversity and the need for evidence-based classification. It should not be interpreted as a common condition in every Zambian agricultural setting.

Where a profile has a pale layer above darker material, record the depth, thickness, texture and boundary of each layer. A pale horizon may raise questions about removal and redistribution of materials, but different processes and parent materials can produce similar appearances.

Check drainage, acidity and nutrient status through appropriate observations and testing. The photograph cannot establish the current water table, crop response or amendment requirement. Historical reference labels should be retained accurately when comparing them with modern terminology.

In training, use unusual profiles to challenge assumptions. A farmer may associate a darker layer with fertility or a pale layer with sand, but those interpretations require confirmation. The correct first response is a better description, followed by targeted investigation.

Exercise: identify the visible contrast without assigning new horizon letters. List the information a soil specialist would require to confirm a classification and the separate information an agronomist would need for crop planning.

Shallow carbonate and alluvial settings

Shallow and stony soils require careful attention to usable rooting volume. Measure the depth to the observed restriction and distinguish continuous hard rock from scattered stones or an unidentified hard layer. Check several locations before drawing a boundary on the farm map.

Calcareous materials may contain visible pale accumulations or carbonate-rich fragments, but appearance is not confirmation. Laboratory or suitable specialist field methods are needed. High pH and nutrient availability questions should be assessed directly rather than inferred from colour.

Alluvial settings can contain alternating deposits with different texture and permeability. A productive-looking river terrace may also face flooding, buried coarse layers or variable drainage. Describe the layers and investigate flood history and land-use restrictions.

These environments are management settings, not a complete classification key. Terms such as Leptosol, Calcisol and Fluvisol have formal definitions that require appropriate evidence. Use descriptive language until those requirements are met.

Comparison exercise: consider three proposed fields, one shallow, one with pale accumulations and one on a river terrace. Write a different investigation priority for each. Explain why a standard fertiliser package would not resolve their main uncertainties.

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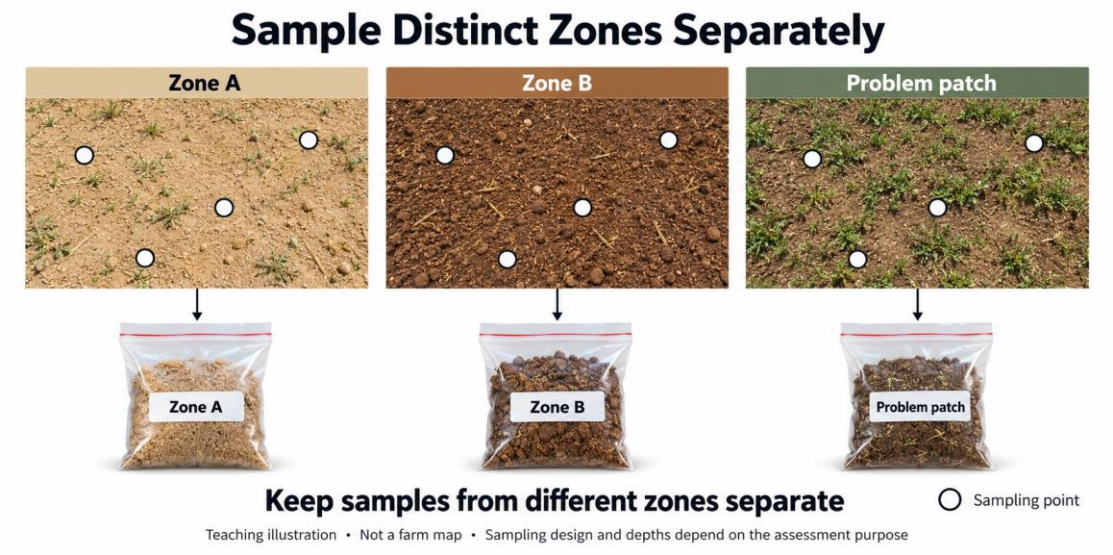
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Designing a soil sampling plan



Original teaching schematic. Not a measured field profile or a soil map; not to scale.

Begin with the question the samples must answer. Routine fertility assessment, investigation of poor crop growth, salinity assessment and formal profile classification may require different sampling designs. Agree the method, depths, containers and handling with the receiving laboratory before collection.

Separate areas with different soil, slope, management history or crop performance. Do not mix an abnormal patch into a larger composite if the objective is to explain that patch. Keep profile horizons separate when investigating vertical changes.

For a composite sample, use a consistent depth and a justified distribution of subsamples within the defined zone. Record the number of subsamples and area represented. The laboratory's local protocol should guide quantities and exclusions.

Use clean equipment and suitable containers. Avoid contamination from fertiliser residues, galvanised tools where relevant, dirty bags or unlabelled handling. Some tests require fresh, cooled or specially preserved samples; confirm requirements in advance.

Retain a chain of identification from site to laboratory. Record collection date, depth, purpose, handling and requested analyses. A precise laboratory result has little practical value if its sampling location or depth is uncertain.

Reading laboratory results

Check sample identifiers, depths and units before interpreting numbers. Confirm the analytical methods. Results produced using different extraction procedures may not be directly comparable, even where the property name appears the same.

Useful tests may include particle-size distribution, pH, organic carbon, electrical conductivity and nutrients appropriate to the local interpretation system. Investigations of sodium or other specific constraints need additional tests. Choose analyses according to the question, not the longest available package.

Distinguish a measured concentration from a recommendation. Crop requirements, expected production, water supply, previous inputs, soil properties and local calibration influence an application plan. A reference range from another country may not be suitable.

Ask the laboratory or qualified adviser to explain unusual results and any uncertainty. Where the result conflicts with the field record, check sampling, identification and method before accepting a convenient explanation.

Keep the original report and a separate interpretation note. Record who made the recommendation and when it should be reviewed. Do not convert this guide into a universal table of fertiliser, lime or gypsum rates; these decisions require local evidence.

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Soil information for irrigation planning

Irrigation assessment requires both the soil profile and the water source. Examine water quality, available supply, crop demand, rooting conditions, intake behaviour and drainage. A soil photograph cannot establish an irrigation design.

Differentiate surface intake from water movement deeper in the profile. Water may enter quickly but encounter a restrictive layer below. Conversely, a surface seal can limit intake even where deeper material is permeable. Record both conditions.

Measure and compare representative zones. Field infiltration demonstrations are useful for learning but are affected by initial moisture, installation, surface disturbance and test duration. Record the procedure so results are not compared as though methods were identical.

After installation, verify distribution and actual wetting in the root zone. Adjust scheduling using crop and soil observations and appropriate measurements. Do not wait for visible stress as the only indicator that irrigation is needed.

Before investing, document the unresolved risks: variable depth, poor water quality, wetness, unreliable supply or uncertain drainage. Resolve these with the relevant specialist and include monitoring costs in the operating plan.

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Organic matter and nutrient planning

Organic inputs can contribute nutrients and influence soil condition, but their properties vary. Compost, manure, crop residues and other materials differ in nutrient content, maturity, salt content and possible contaminants. Assess the actual material rather than relying on its name.

Match inputs to measured needs and the production standard being followed. Record source, batch, quantity, application date and field. Where food safety or certification requirements apply, confirm permitted materials and handling conditions before use.

Surface cover and appropriate rotations can be part of a soil management plan. Consider competing uses for residues, termite activity, fire exposure, grazing and water availability. Practices must be feasible under the farm's conditions.

Avoid promising that one product will correct acidity, salinity, compaction and nutrient deficiency together. Diagnose each constraint and choose an intervention with a plausible mechanism and measurable result.

Trial method: identify one objective, select a representative area, keep an untreated comparison where practical and record initial conditions. Use consistent management and measurements. Review the result before extending the treatment across the entire farm.

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Erosion and landscape protection

Observe whether soil is being detached, transported or deposited. Look for exposed roots, pedestals, rills, gullies, sediment fans, windblown material and changes at field boundaries. Record the setting and recent weather; a single feature may not reveal the long-term rate.

Plan cover, access routes and water movement together. Bare soil, concentrated runoff and poorly located tracks can interact. An isolated structure may shift the problem downstream if the wider catchment is ignored.

Select locally suitable measures with competent design where earthworks are involved. Slope, rainfall, soil depth, runoff volume and maintenance capacity affect what is appropriate. Do not copy dimensions from a photograph or construct a drain without understanding its outlet.

Track change using fixed photograph points and repeated observations after relevant events. Keep dates and the direction of view consistent. Where a major gully or unstable bank threatens land or infrastructure, obtain specialist assessment.

Exercise: draw the paths that water takes across the field. Mark bare areas, traffic routes and places where flow concentrates. Identify one low-cost observation or management change and one issue that requires technical design.

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Compaction and field traffic

Compaction assessment combines soil condition, moisture, rooting and management history. Compare wheel tracks, turning areas and less trafficked ground. A hard dry soil is not automatically compacted, and a soft wet surface does not prove that deeper layers are unrestricted.

Record where roots change direction, aggregate shapes become platy or pores appear reduced. Measurements such as penetration resistance depend strongly on moisture and method. Compare results only when conditions and procedures are suitable.

Prevention often requires changes to timing, load and traffic patterns. Identify which operations are essential and whether routes can be kept consistent. Avoid working soils under conditions known to damage their structure.

Deep ripping is a specific intervention, not a routine cure. Establish whether a breakable restrictive layer exists, whether the operation is feasible and whether subsequent traffic will recreate the problem. Consider risks to buried services, stones, erosion and irrigation systems.

Monitoring exercise: select paired locations with contrasting traffic history. Describe structure and roots and record moisture condition. Repeat after an agreed management change. Use the results to decide whether the intervention helped rather than relying on appearance immediately after cultivation.

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Crop selection and botanical production

Crop planning should combine soil evidence with climate, water, farm capability and market requirements. Use the guide to identify constraints and questions, not to issue a universal suitability rating for a soil colour or reference group.

For Moringa and other botanical crops, assess rooting depth, drainage, irrigation-water quality and the ability to maintain appropriate field conditions. Also consider access for harvest, hygienic handling, drying and traceability. A crop can establish successfully yet fail to meet a buyer's quality requirements.

Keep planting-density and yield assumptions separate from soil description. A proposed density requires agronomic evaluation and trial evidence under the intended management system. It cannot be validated by selecting a photograph of a favourable-looking soil.

Where land has an uncertain use history, consider whether contaminant investigations are needed. Visual inspection does not demonstrate that a site is free from chemical residues or other contamination.

FPI assessment output: a clear site record, identified constraints, test results, a provisional management approach and conditions that must be satisfied before scaling. Record who is responsible for resolving each condition and the evidence required for a decision.

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Worked example of a sandy field

Hypothetical training scenario. A producer proposes irrigated botanical production on a field with a sandy surface and uneven crop growth. This scenario is an exercise, not a report from an actual FPI farm.

First, divide the field into zones using crop performance, landscape position and management history. Describe the profile at representative locations and record depth, changes in texture, roots and wetness. Check whether poor patches follow irrigation distribution or another visible pattern.

Second, plan separate soil samples and obtain irrigation-water information. Ask whether low nutrient supply, restricted rooting, water shortage, uneven delivery or another cause best explains the observations. Several causes may occur together.

Third, identify a small trial that addresses the leading explanation. For example, compare a revised irrigation practice with the existing practice while holding other management as constant as possible. Record applied water and crop response using agreed measurements.

Decision record: state the observation, hypothesis, test, result and next action. Do not jump from “sandy” to a predetermined amendment or fertiliser rate. The aim is to reduce uncertainty before a larger investment.

Apply this chapter to your site

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Worked example of a wet field

Hypothetical training scenario. A farmer reports patchy establishment in a low-lying field after heavy rain. A surface layer appears lighter than the material below. No laboratory result or drainage survey is yet available.

Begin with flood and irrigation history, topography and the timing of crop symptoms. Record the profile from a safe assessment point, including moisture above and below boundaries and the distribution of roots. Do not enter a wet unsupported pit.

Consider alternative explanations: short-term rainfall saturation, perched water above a restrictive layer, a groundwater issue, poor surface drainage or a combination. The lighter layer alone does not establish which explanation is correct.

Plan repeat observations under relevant seasonal conditions and obtain specialist assessment where drainage works are proposed. Check whether a lawful and technically acceptable outlet exists and whether the site contains sensitive wetland features.

A sound decision might delay permanent planting until the uncertainty is resolved. In the exercise, trainees must explain what additional evidence would justify proceeding, changing the production system or selecting a different field. No drainage solution is assumed in advance.

Apply this chapter to your site

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Practical training session

Purpose: enable participants to produce an accurate, clearly identified soil description and distinguish observation from interpretation. Use a safe authorised site or the reference photographs where field access is unsuitable.

Preparation: the trainer selects two contrasting examples, checks access and equipment, prepares field forms and explains specimen provenance. Participants are told which data are measured, supplied or unknown.

Activity one: participants independently describe visible layers, boundaries, colour and structure. They then compare records and identify disagreements. The trainer asks what additional observation would resolve each disagreement.

Activity two: teams develop a sampling plan for a defined agricultural question. They specify zones, depths, identification and the laboratory request. Teams must explain why they would keep certain samples separate.

Activity three: each team writes an action note for the landholder. It must contain findings, limitations, recommended investigations and a review point. Assessment should reward accurate records and justified reasoning, not confident guesses about soil names.

Completion check: can the participant link a photograph to a site, describe the observed depth honestly, identify an unsupported claim and explain when laboratory or specialist assistance is needed? Retain completed forms as training evidence.

Apply this chapter to your site

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Glossary for field use

Aggregate: a natural grouping of soil particles. Boundary: the transition between described layers. Cation exchange capacity: a measure associated with the soil's ability to retain exchangeable cations, reported using a specified method.

Composite sample: a combined sample made from subsamples collected under a defined plan. Consistency: how soil resists deformation or rupture under specified moisture conditions. Drainage: the removal and movement of water from soil and its landscape setting.

Electrical conductivity: a method-dependent measure used in assessing soluble salts. Horizon: a soil layer with characteristics associated with soil formation. Infiltration: entry of water through the soil surface. Monolith: a preserved section extracted from a soil profile.

Parent material: the mineral or organic material from which soil develops. Profile: a vertical section showing the arrangement of soil materials. Reference Soil Group: a grouping within the World Reference Base classification system.

Salinity: the presence or concentration of soluble salts in the relevant soil or water assessment. Sodicity: a sodium-related soil condition assessed using appropriate measurements. Structure: the arrangement of particles and aggregates. Texture: the proportions of sand, silt and clay in the fine earth fraction.

Use these explanations as learning aids. Formal diagnostic definitions and laboratory interpretation require the applicable technical reference and method. A familiar word used loosely in conversation may have a narrower meaning in classification.

Apply this chapter to your site

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Site assessment form

Complete one record per observation site. Use the same site code on photographs, samples and the farm sketch. Leave unknown items clearly marked as unknown.

Project and site identifier

_____

_____

Assessor and assessment date

_____

_____

Location coordinates and recording method

_____

_____

Landholder and current land use

_____

_____

Landscape position slope and surface condition

_____

_____

Recent rainfall irrigation and seasonal history

_____

_____

Observation method and actual depth examined

_____

_____

Photograph references and sample identifiers

_____

_____

Horizon description form

Copy this page for each described layer. Record observations before assigning an interpretation or a formal horizon designation.

Site code layer identifier and photograph reference

_____

_____

Upper and lower depths and boundary characteristics

_____

_____

Colour including moisture condition and reference chart

_____

_____

Texture coarse fragments and natural structure

_____

_____

Roots pores coatings nodules and other features

_____

_____

Moisture condition and evidence requiring investigation

_____

_____

Sample identifier requested tests and handling

_____

_____

Interpretation uncertainty and required verification

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_____

Investigation and action register

Use this record to convert an assessment into accountable follow-up. Repeat the entry for each major issue. A recommendation should identify the evidence on which it depends.

Site and management zone

_____

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Observed issue and supporting photograph or measurement

_____

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_____

Possible explanations and information still needed

_____

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Investigation or trial and success measure

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Responsible person resources and target date

_____

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_____

Result decision and review date

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References and further reading

1 FAO soil description

FAO. 2006. Guidelines for Soil Description. Fourth edition. Rome. Used as a technical reference; no source figures or tables reproduced.

https://www.fao.org/4/a0541e/a0541e.pdf

2 Botswana profile recording

FAO. Botswana Soil Database. Guidelines for soil profile description.

https://www.fao.org/4/ar717e/ar717e.pdf

3 World Reference Base

IUSS Working Group WRB. World Reference Base for Soil Resources. Consult the official WRB website for the applicable edition and updates. Historical specimen labels in this guide are not reclassified.

https://wrb.isric.org/

4 Soil reference collection

ISRIC World Soil Museum and World Soil Reference Collection. Reference specimen and site information.

https://wsm.isric.org/gallery.html

5 Field assessment

USDA NRCS. Cropland In-field Soil Health Assessment Guide.

https://www.nrcs.usda.gov/sites/default/files/2023-06/Tech%20Note%20Cropland_In-field%20Soil%20Health%20Assessment-Guide.pdf

6 Water and salts

FAO. Irrigation Water Management training material. Chapter 7 Salty Soils.

https://www.fao.org/4/r4082e/r4082e08.htm

7 Sandy soil management

FAO. Management of Tropical Sandy Soils for Sustainable Agriculture.

https://www.fao.org/4/ag125e/AG125E23.htm

Technical topics in this guide are introductory. Consult the full source, the applicable classification edition and a competent local adviser when a decision requires diagnostic confirmation or engineering design.

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NA-001 Namibia • Arenosol | Creutzberg, D & H, Scholz

https://commons.wikimedia.org/wiki/File:ISRIC_monolith_NA-001.jpg

NA-009 Namibia • Vertisol | ISRIC World Soil Reference Collection; photographer not identified in source

https://commons.wikimedia.org/wiki/File:ISRIC_monolith_NA-009.jpg

ZA-007 South Africa • Umbrisol | Jacobs, T. ISRIC – World Soil Information

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ZA-011 South Africa • Solonetz | Creutzberg, D

https://commons.wikimedia.org/wiki/File:ISRIC_monolith_ZA-011.jpg

ZA-016 South Africa • Phaeozem | Creutzberg, D

https://commons.wikimedia.org/wiki/File:ISRIC_monolith_ZA-016.jpg

ZM-001 Zambia • Podzol | Van Baren, JHV

https://commons.wikimedia.org/wiki/File:ISRIC_monolith_ZM-001.jpg

ZM-010 Zambia • Nitisol | Van Baren, JHV and PGF, Heilmann

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UNDERSTAND THE SOIL BENEATH YOUR INVESTMENT

Southern Africa Practical Soil Profile Guide



Learn to observe soil layers, describe roots and structure, recognise questions about drainage and plan useful samples. Genuine reference photographs, practical exercises and editable field forms connect soil observations with better-informed agricultural decisions.

For farmers, agricultural trainers, extension officers, students and land assessment teams.

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