GEAVET TRAINING PROGRAMME FOR CSA

GEAVET TRAINING PROGRAMME FOR CLIMATE-SMART AGRICULTURE (CSA):

KENYA

UNIT 2.I SOIL TESTING & INTERPRETATION

ENGLISH VERSION

GEAVET Project n° 101129027

Open Educational Resources

PART I – LEARNING MATERIAL

1. Introduction

Healthy soil is the foundation of a productive and resilient farm. In Kenya, declining soil fertility, often due to continuous cultivation without adequate nutrient replenishment, is a major constraint to crop yields, and consequently to the availability of quality livestock feed.

This module empowers learners with the practical skill of soil testing — a fundamental Climate-Smart Agriculture (CSA) practice. Understanding soil health enables informed decisions on fertilizer and manure application, leading to increased forage production, cost savings, and reduced environmental pollution from nutrient runoff. This approach builds farm-level resilience against climate shocks.

2. Knowledge

2.1. The Principles of Soil Health

Soil health refers to the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans. It's not just about chemical fertilizers. Healthy soil has three key components:

1. Chemical: The availability of essential nutrients and a balanced pH level.

2. Physical: Good soil structure that allows for water infiltration, root growth, and air movement.

3. Biological: A thriving community of earthworms, microbes, and other organisms that decompose organic matter and recycle nutrients.

Climate-Smart soil management aims to improve all three aspects for long-term productivity.

2.2. Key Soil Nutrients & their Role in Plant Growth

Forages, like all plants, require essential nutrients for growth. The primary macronutrients are:

- **Nitrogen (N)**: For leafy, vegetative growth. Critical for high biomass in grasses like Napier.

- **Phosphorus (P)**: For root development, energy transfer, and early plant establishment.
- **Potassium (K)**: For overall plant vigour, disease resistance, and water regulation.

Secondary nutrients (Calcium, Magnesium, Sulphur) and micronutrients (e.g., Boron, Zinc) are also vital in smaller quantities. A soil test identifies which of these are deficient.

2.3. Local Soil Fertility Challenges in Kenya

Many Kenyan soils, particularly in high-intensity agricultural areas, are acidic and depleted of essential nutrients like Phosphorus and Nitrogen.

Common challenges include:

- **Soil Acidity:** Widespread in high-rainfall areas, which locks up nutrients and makes them unavailable to plants.
- **Nutrient Mining:** Continuous cropping without sufficient fertilizer or manure application removes more nutrients than are returned.
- **Low Organic Matter:** Reduces water-holding capacity and soil biological activity, making crops more vulnerable to drought.

2.4. The Link Between Soil Health and Feed Quality

The nutrient content of animal feed is directly linked to the nutrient content of the soil. For example:

- **Low Soil Nitrogen** results in Napier grass with low protein content, forcing farmers to buy expensive protein supplements.
- **Adequate Phosphorus** promotes strong root systems, helping forages survive dry spells.

Therefore, investing in soil health is the first step towards producing high-quality, home-grown feed that supports livestock productivity and reduces methane emissions.

3. Skills

3.1. Collecting a Representative Soil Sample

An accurate test depends on a good sample.

Tools Needed: Clean bucket, soil auger or panga, sampling bag/box.
When to Sample: Preferably before planting or after harvest.
Steps:

- **Clear the surface:** Remove litter, mulch, or grass from the sampling point.
- **Walk a "W" pattern:** Sample from 10-15 random spots in a uniform field (e.g., a Napier plot).
- **Take a slice:** At each spot, dig a V-shaped hole to 15cm depth (the root zone for most forages). Take a thin slice of soil from the side.
- **Mix thoroughly:** Place all sub-samples in the bucket and mix them completely.
- **Get the final sample:** Take about 500 g (a pint) of this mixed soil and place it in a clean labelled bag.
- **Label clearly:** Include Farmer Name, Location, Field, Crop to be Grown, and Date.

3.2. Using a Soil Test Kit for Basic In-Field Analysis

While lab testing is best, simple test kits can provide immediate insights.

➢ **pH Test:** Most common. Mix soil with indicator solution, compare colour to a chart.

Interpretation: pH < 5.5 is acidic; 6.0-7.5 is ideal for most forages.

➢ **N-P-K Test Kits:** Use colour strips or solutions to give a semi-quantitative estimate of nutrient levels.
Limitation: These are guides, not replacements for laboratory analysis for precise recommendations.

3.3. Making Basic Fertilizer/Amendments Recommendations

Interpreting a soil test report means understanding what the results say about your soil's health and what actions you need to take. The report normally shows pH, Nitrogen (N), Phosphorus (P), Potassium (K), and sometimes Organic Matter and micronutrients. You don't need to be a scientist, you just need to know what each part means for your crops.

Watch this video to learn:

https://youtu.be/UK_L6xVAw_A?si=TWvh4_cqkEfkHSI7 (How to Understand #Soil Test Results , University of Illinois Extension).
Then read the quick guide below on how to understand the soil testing results.

3.3.1. Interpreting a Basic Soil Test Report in Simple Language

Why does interpretation of soil testing results matter? Correct interpretation saves money and increases yields.

- ➢ You (as a farmer) apply only what is needed, not what the neighbour uses.
- ➢ Crop yields improve because nutrients match crop needs.
- ➢ You reduce wastage and fuel costs.
- ➢ Soil becomes better at holding water which leads to more drought resilience.
- ➢ Good interpretation = correct fertilizer = higher profit

Look at the sample soil test below:
If your soil test shows a nutrient is at an “optimal,” “excessive,” or “very high” level, the soil already has plenty. Adding more will not help your crops grow. Extra nutrients usually don’t harm plants, but in very acidic soils some elements can become toxic. For phosphorus, if the report shows “medium,” “optimal,” or “very high,” you should not add any more.

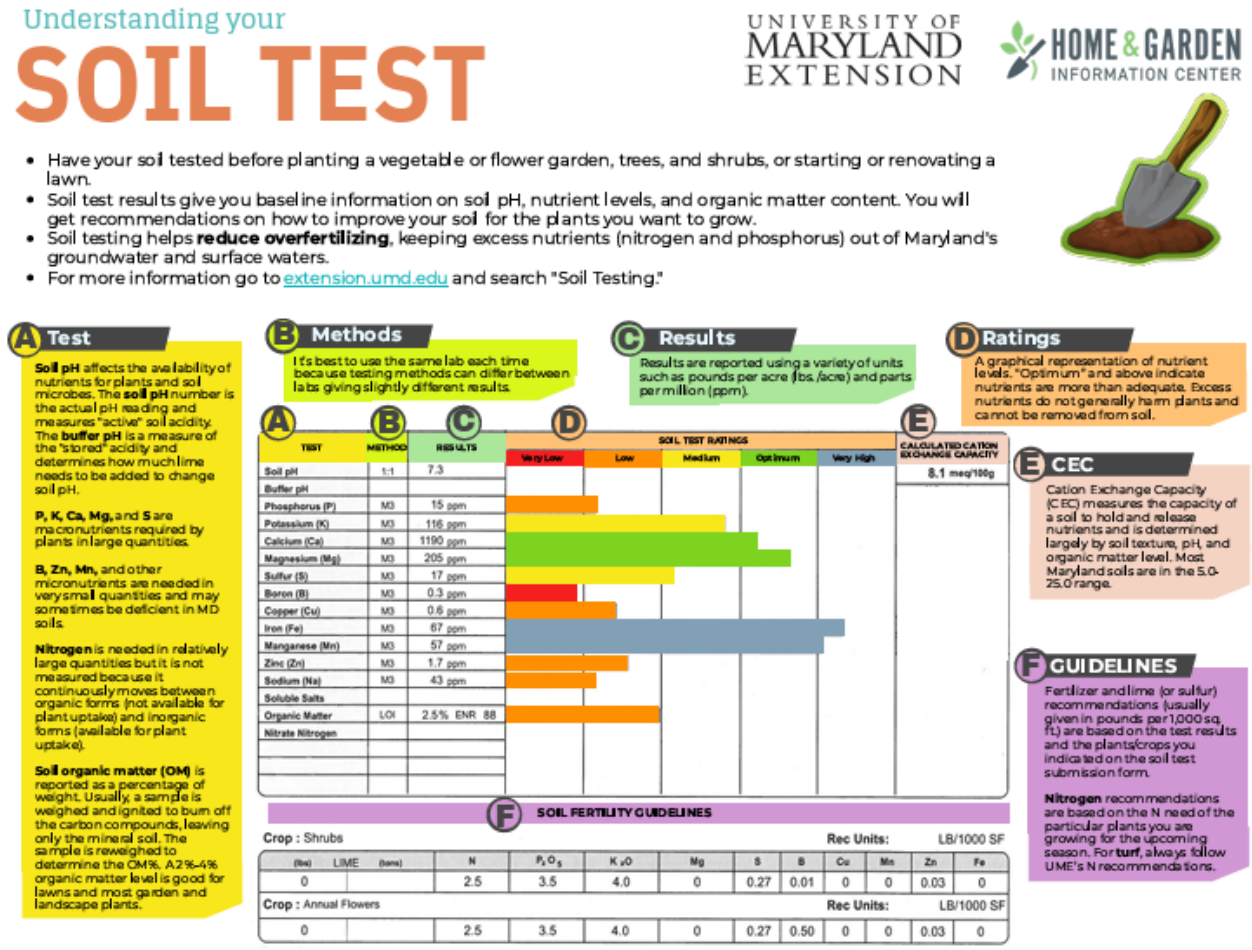

Image 2. Understanding your soil test report (University of Maryland Extension, 2023)

To understand a technical soil report, look at the guidelines below on pH, Nitrogen (N), Phosphorus (P), Potassium (K), and Organic Matter and micronutrients:

- **Understanding Soil pH (Acidity or Alkalinity)**

  pH tells you how acidic or alkaline your soil is. Most crops in Kenya grow well at pH 6.0–7.0. When soil is too acidic (pH 4.5–5.5), nutrients like phosphorus and calcium become unavailable. Even if you add fertilizer, the plant cannot use it.

  Field signs a farmer can observe (without a lab report):

  - ➢ Maize or cassava looks yellow and weak, even when fertilizer is applied.
  - ➢ Beans look stunted and fail to form many pods.
  - ➢ The soil looks reddish, very fine, and crusts when dry.
  - ➢ Few Earthworms.

➢ Water drains too fast.

Solution: Apply agricultural lime. The soil test report normally tells you how much.
Simple rule: Low pH = add lime
Neutral pH = good
High pH = avoid over-liming

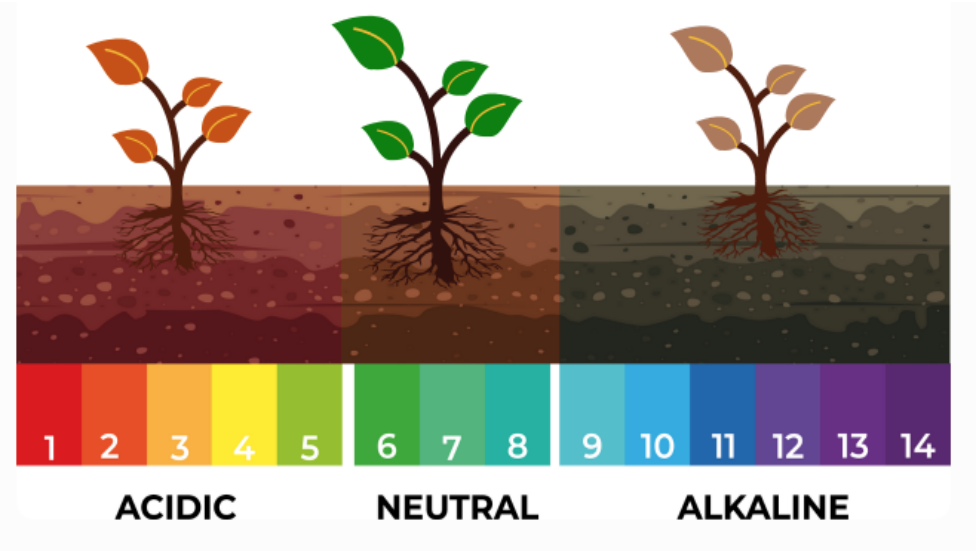

Image 3. How plants react to different pH of the soil (Sesi Technologies, 2025)

For more information watch the video:

https://youtu.be/93y8C30Y4U0?si=RPrUPq-JB1taLL0W

- **Understanding Nitrogen (N)**

Nitrogen helps plants grow green leaves and produce biomass.
Low Nitrogen = slow growth and pale colour.

Farmer field signs (without a soil test):

➢ Leaves look pale yellow-green.
➢ Napier grass is thin and grows slowly.
➢ Maize leaves start yellow at the bottom and move upward.
➢ Plants look “hungry” even after rain.

Solution: Add manure, compost, CAN, Urea, or grow legumes.
Simple rule: Low N = pale leaves → add N sources

For more information watch the video:
https://youtu.be/A8qTRBc8Bws?si=hDYVy9b1_NfI-CrZ

- **Understanding Phosphorus (P)**

  Phosphorus helps plants build strong roots and start growing well.

  Field signs of Low P:
  - ➢ Maize seedlings stay small for many weeks.
  - ➢ Leaves may have a purple or reddish tint.
  - ➢ Plants fail to establish strong roots.
  - ➢ Crops look as if they are stuck and not growing.

  Solution: Apply DAP, TSP, or compost rich in P.
  Simple rule: Low P = weak roots & purple leaves → add P fertilizer

- **Understanding Potassium (K)**

  Potassium helps plants stay strong, resist diseases, and manage water.

  Field signs of Low K:
  - ➢ Leaf edges turn brown or burn.
  - ➢ Plants wilt quickly under the sun.
  - ➢ Bananas may snap easily.
  - ➢ Grass loses strength and becomes “soft.”

  Solution: Apply MOP, wood ash, or manure.
  Simple rule: Low K = leaf-edge burn + quick wilting → add K

- **Understanding Organic Matter (OM)**

  Organic matter makes soil alive, moist, and easy to work.

  Field signs of Low OM:
  - ➢ Soil becomes dusty, light, or grey.
  - ➢ Soil dries very fast after rain.
  - ➢ Few Earthworms.
  - ➢ Soil cracks easily and becomes hard.
  - ➢ Germination is poor.

  Solution: Add compost, manure, mulch, or grow cover crops.
  Simple rule: Low OM = “dead” soil → add compost and manure

  3.3.2. Understanding Low–Medium–High Ratings

  Most soil test reports use simple words:
  - ➢ Low = not enough → needs input (You see poor colour, weak roots, slow growth.)

- ➢ Medium = enough for average growth (Crops look OK but not excellent.)
- ➢ High = plenty → avoid wasting money (Crops grow well even with minimal fertilizer.)

3.3.3. Turning Results into Action

This is where farmers combine all results into a plan. Don't guess. Let the soil test guide your inputs. Example actions:

- Low pH → add lime
- Low N → add manure or urea
- Low P → add DAP or TSP
- Low OM → add compost/manure + mulching

Field example for farmers:

- ➢ You see pale maize + purple leaves → likely Low N + Low P.
- ➢ You apply manure + a small amount of TSP → maize improves.

3.4. Making Basic Fertilizer/Amendments Recommendations

Based on the test interpretation, learners can make informed decisions.

- **For Acidic Soils (low pH)**: Recommend agricultural lime. The test report often specifies the amount (e.g., tonnes per hectare) needed.
- **For Low Phosphorus**: Recommend Phosphatic fertilizers like DAP, TSP, or organic sources like composted manure.
- **For Low Nitrogen**: Recommend Nitrogenous fertilizers like CAN, Urea, or planting leguminous fodder trees (e.g., *Calliandra*) that fix nitrogen from the air.
- **General Rule**: "Feed the soil, not just the plant" by combining inorganic fertilizers with organic matter like compost to build long-term health.

4. Case Study from Kenya: Reviving Soils for Dairy Success in Nandi

Background: Dairy farmers in Nandi were struggling with low yields from their Napier grass stands, despite applying fertilizer. Milk production was stagnant, and feed costs were high. Many assumed the problem was the grass variety or pests.

Intervention: A local cooperative, with support from the Kenya Agricultural and Livestock Research Organization (KALRO), initiated a community soil testing program. Over 100 farmers submitted samples from their Napier fields.

Findings & Outcome: The results revealed widespread severe soil acidity (pH < 5.0) and phosphorus deficiency. The farmers were taught to interpret their reports. Following recommendations, they applied agricultural lime and targeted P fertilizers.

Within two seasons, Napier grass biomass production increased by over 60%. Farmers reported healthier animals and a significant reduction in the amount of commercial dairy meal they needed to buy, drastically improving their profit margins. This case demonstrates the power of diagnosis before treatment.

5. European Case Study: The Soilmentor APP/ Platform

The Regenerative Agriculture Revolution project Project (See https://www.eitfood.eu/projects/regenag-mentoring-farmers).
EIT Food (European Institute of Innovation & Technology) is a European organisation that helps farmers, businesses, and trainers work together to try new, better ways of farming. They started a project called the "Regenerative Agriculture Revolution" to help farmers in the Mediterranean region improve their soils. Farmers there have been hit hard by drought, soil erosion, low yields, and high input costs. Many are struggling to make a living.

To support these farmers, the project uses a tool called Soilmentor. It helps farmers and advisors check how healthy the soil is and see whether new farming methods are working. About 75 farmers in Spain and Portugal are part of this programme, receiving advice from soil and regenerative agriculture experts.

Image 4. **Soilmentor app** (Soils for life, 2025)

Why Soilmentor tool is useful:

1. It helps farmers understand their soil. Instead of only looking at crops above the ground, the tool helps farmers pay attention to what is happening underground. It teaches them that healthy soil is the real base of good harvests.
2. It helps agronomists monitor the land more cheaply and more often. Sending soil to a lab is expensive, and project funding only allows one lab test per farm each year. But farms have many different fields. With Soilmentor, farmers and advisors can check several plots themselves, so they get a clearer picture of what is happening on the whole farm.
3. It helps the programme track if the new farming practices are really improving soil health. EIT Food needs to show that the money supporting farmers is being used well and that soils are improving. Soilmentor makes it easy to record changes and see progress.

Who has used the tool so far?

Mostly soil advisors and agronomists. One soil expert visited 65 farms across Spain and Portugal, doing the same simple tests on each farm and recording all the results in the app. There is already a lot of information stored for each farm. Soon, farmers will start using the app directly. The project is also releasing YouTube videos that show step-by-step how to do each soil test, and these videos will be translated into Portuguese, Spanish, Italian, and Polish so more farmers can learn easily.

Key Takeaway for Kenyan Learners: Kenyan farmers can replicate this by testing one field each season, recording results digitally, and collaborating with cooperatives.

Useful Resources for Trainers and Farmers:

Soilmentor website (guides & methods): https://soils.vidacycle.com/
Case-study inspiration (Philip Fernandez – EIT Food): https://soils.vidacycle.com/blog/case-study-philip-fernandez-eit-food/
How Soilmentor works with organisations: https://soils.vidacycle.com/blog/how-soilmentor-works-with-organisations/

6. Digital training tools

Table 7. Digital training tools and their use in module and skills reinforced

Tool / Platform	Use in Module	Skills Reinforced
SoilCares App / FAO Soil Tool	Input soil data and receive localized recommendations.	Data Management; ICT for Agriculture

GEA_VET LMS	Hosts videos, quizzes, and reflection forums.	Digital Literacy; Communication & Collaboration
WhatsApp / Telegram	Share soil test results and field photos for peer learning.	Digital Communication; Community Learning
Google Forms	Collect and analyze soil data during group exercises.	Data Management; Digital Collaboration

7. References:

FAO Soil Testing and Fertility Management. (n.d.). *Climate-Smart Agriculture Sourcebook* (2nd ed.). Rome: FAO. https://www.fao.org/3/i3325e/i3325e.pdf

Sesi Technologies. (n.d.). *The science behind soil pH: Why it matters for your crops*. Retrieved from https://sesitechnologies.com/the-science-behind-soil-ph-why-it-matters-for-your-crops/

Soils for Life. (n.d.). *Soilmentor initiative for Australian farmers*. Retrieved from https://soilsforlife.org.au/soilmentor-initiative-for-australian-farmers/

University of Illinois Extension. (n.d.). *How to understand soil test results* [Video]. YouTube. https://youtu.be/UK_L6xVAw_A?si=TWvh4_cqkEfkHSI7

University of Maryland Extension. (n.d.). *Understanding your soil test report*. Retrieved from https://extension.umd.edu/resource/understanding-your-soil-test-report/

Vidacycle. (n.d.). *Soilmentor: Soil health assessment tools*. Retrieved from https://soils.vidacycle.com/

Vidacycle. (n.d.). *Case study: Philip Fernandez, EIT Food*. Retrieved from https://soils.vidacycle.com/blog/case-study-philip-fernandez-eit-food/

Vidacycle. (n.d.). *How Soilmentor works with organisations*. Retrieved from https://soils.vidacycle.com/blog/how-soilmentor-works-with-organisations/

PART 2 – CURRICULUM

Learning Objectives:

KNOWLEDGE	SKILLS	ATTITUDES
Students will know: ● The principles of soil health ● Key soil nutrients and their role in plant growth ● Local soil fertility challenges in Kenya ● The link between soil health and feed quality	*Student will be able to:* ● Collect a representative soil sample ● Interpret a basic soil test report ● Make basic fertilizer/ amendments recommendations ● Use a soil test kit for basic in-field analysis	*Student will develop the following mindset:* ● Valuing evidence-based decisions ● Precision and resource efficiency ● Long-term stewardship
TRANSVERSAL SKILLS INTEGRATED: ● **Critical Thinking & Problem Solving:** Diagnose soil issues, interpret test data, and plan cost-effective soil amendment strategies. ● **Collaboration & Community Learning:** Organize community soil sampling groups and share results. ● **Entrepreneurship & Efficiency Mindset**: View soil testing as an investment optimizing input costs ● **Communication & Knowledge Sharing**: Explain soil results clearly in local terms ● **Adaptability & Innovation**: Adjust soil management practices based on results and climate conditions.		
DIGITAL SKILLS INTEGRATED: ● **Digital Literacy / ICT for Agriculture (ICT4Ag)**: Use smartphones to access soil health videos and digital platforms. ● **Mobile-Based Advisory Tools:** Receive soil test results via SMS or apps. ● **Digital Communication & Collaboration:** Share soil test data via WhatsApp or LMS. ● **Data Management & Interpretation:** Track soil test data over seasons. ● **Cyber-awareness & Digital Responsibility:** Securely store and share digital soil data.		
GREEN SKILLS INTEGRATED: ● **Agroecology & Sustainable Land Management**: Apply fertilizers precisely using		

soil test data.

- **Climate Resilience & Risk Assessment**: Use soil organic matter data to improve drought resilience.
- **Circular Economy & Organic Waste Management**: Optimize compost/manure use based on nutrient status.

Implementation plan of pedagogical activities - Scheme of work

Duration: 2 hours and 45 minutes				
Target: VET learners, smallholder farmers, and agricultural advisors (gender-balanced; mixed experience)				
No. of Activity	**Timing**	**Training Methods / Activity**	**What the trainers do**	**What the participants do**
1.	40 min	Problem-Based Learning (PBL): 'The Struggling Napier Plot'	• Present a scenario • Guide group analysis of causes • Lead towards soil testing solutions	• Brainstorm, discuss, and present problem analysis
2.	45 min	Hands-on Demonstration & Peer Coaching: Soil Sampling Relay	• Demonstrate correct technique • Facilitate peer coaching and relay activity	• Collect samples in teams • Evaluate peers' performance • Discuss corrections
3.	40 min	'Be the Soil Doctor' Interpretation Workshop	• Provide reports • Assist with interpretation • Facilitate group discussions	• Diagnose soil issues • Write recommendation • Share results

4.	30 min	Digital Data Exercise (Soil App Practice)	• Demonstrate soil app use • Assist with data entry • Moderate group comparisons	• Input soil data • Compare manual vs. digital outputs • Discuss lessons
5.	15 min	Collaborative Reflection Forum	• Guide online posting of reflections • Moderate discussions	• Post reflections • View peers' posts, comment, and share insights
Materials (What trainers need to have prepared): • Soil sampling tools (augers, pangas, buckets, sample bags, markers) • Simple soil test kits (pH, NPK) • Simulated soil test reports • Smartphones or tablets with preinstalled soil apps • Scenario briefs and worksheets for group work				
Other notes:				

PART 3 – ACTIVITY GUIDE

DESCRIPTION OF THE ACTIVITIES

1. 'The Struggling Napier Plot' – Problem-Based Learning

Learners are given a scenario where a farmer's Napier grass is performing poorly despite regular fertilizer use. Groups brainstorm potential causes, learning to consider soil as the foundation of the issue. The trainer guides discussion towards the importance of soil testing. This builds analytical skills and reinforces evidence-based decision-making.

1. **Aim of the activity:** To help participants recognise soil health as a key factor in crop performance and understand the role of soil testing in diagnosing production problems.
2. **Duration:** 40 min
3. **Material required:**

- Printed or projected scenario description
- Flip charts or notebooks
- Markers or pens

4. **Step-by-step instruction of the task/practical exercise/case study:**

➢ **Introduction:** Trainer presents the Napier grass scenario and explains the task.
➢ **Group brainstorming:** Learners discuss possible reasons for poor performance.
➢ **Guided discussion:** Trainer prompts consideration of soil-related factors.
➢ **Key learning point:** Trainer introduces soil testing as a diagnostic tool.
➢ **Reflection:** Groups summarise what information is needed before applying solutions.

References/Sources/Further materials:
No specific references or further materials are required.

2. Hands-on Demonstration & Peer Coaching: Soil Sampling Relay

Conducted in a real or simulated field, teams collect samples using proper procedures, ensuring accuracy. They assess each other's technique and labeling. This practical session enhances collaboration, peer learning, and confidence in sampling.

1. **Aim of the activity:** To develop practical skills in correct soil sampling procedures and promote peer learning and quality assurance.

2. **Duration:** 45 min

3. **Material required:**

- Soil auger or spade
- Sample bags or containers
- Permanent markers and labels
- Gloves and bucket for mixing samples

4. **Step-by-step instruction of the task/practical exercise/case study:**

➢ **Demonstration:** Trainer demonstrates correct soil sampling steps.
➢ **Team activity:** Teams collect soil samples in assigned plots or stations.
➢ **Peer coaching:** Teams observe each other's technique and labeling.
➢ **Feedback session:** Peers and trainer provide corrective feedback.
➢ **Wrap-up:** Trainer reinforces best practices and common mistakes.

References/Sources/Further materials:
No specific references or further materials are required.

3. 'Be the Soil Doctor' Interpretation Workshop

Groups analyze anonymized soil reports to identify nutrient imbalances and recommend corrective actions. Trainers facilitate, ensuring learners connect data to practice. This builds technical literacy and confidence in interpretation.

1. **Aim of the activity:** To build learners' ability to interpret soil test results and translate data into practical soil management decisions.

2. **Duration:** 40 min

3. **Material required:**
- Printed anonymised soil test reports
- Reference charts for nutrient ranges
- Flip charts and markers

4. **Step-by-step instruction of the task/practical exercise/case study:**
➢ **Introduction:** Trainer explains the purpose of soil test interpretation.
➢ **Group analysis:** Learners review soil reports and identify key issues.
➢ **Recommendation development:** Groups suggest corrective actions.
➢ **Facilitated discussion:** Trainer clarifies concepts and corrects misconceptions.
➢ **Sharing:** Groups present findings and recommendations.

References/Sources/Further materials:
No specific references or further materials are required.

4. Digital Data Exercise (Soil App Practice)

Learners use mobile applications to input soil test data and receive amendment recommendations. They compare digital results with manual ones, reflecting on how technology supports precision farming and climate resilience.

1. **Aim of the activity:** To introduce learners to digital soil tools and demonstrate how technology complements traditional soil analysis.

2. **Duration:** 30 min

3. **Material required:**
- Smartphones or tablets
- Installed soil or agriculture apps
- Sample soil test data
- Internet access (if required)

4. **Step-by-step instruction of the task/practical exercise/case study:**
➢ **Introduction:** Trainer explains the role of digital tools in soil management.

- ➢ **Data entry:** Learners input soil test results into the app.
- ➢ **Result review:** Learners review app-generated recommendations.
- ➢ **Comparison:** Groups compare digital outputs with manual interpretations.
- ➢ **Reflection:** Trainer facilitates discussion on benefits and limitations of apps.

References/Sources/Further materials:
No specific references or further materials are required.

5. Collaborative Reflection Forum

Learners share one actionable insight via WhatsApp or LMS—such as applying lime or using organic matter. They comment on peers' posts to build community and reinforce shared learning.

1. **Aim of the activity:** To reinforce learning through reflection, peer interaction, and community knowledge sharing.
2. **Duration:** 15 min
3. **Material required:**

- Smartphones or computers
- WhatsApp group or LMS access

4. **Step-by-step instruction of the task/practical exercise/case study:**

- ➢ **Introduction:** Trainer explains the purpose of the reflection forum.
- ➢ **Individual posting:** Learners share one practical insight or action.
- ➢ **Peer engagement:** Learners comment on at least two peers' posts.
- ➢ **Trainer follow-up:** Trainer highlights recurring themes and good practices.
- ➢ **Closure:** Learners reflect on how shared insights can be applied locally.

References/Sources/Further materials:
No specific references or further materials are required.