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GEAVET TRAINING PROGRAMME FOR CSA

CLIMATE-SMART AND SUSTAINABLE AGRICULTURE, POST-HARVEST MANAGEMENT AND RENEWABLE ENERGY:

MOZAMBIQUE

UNIT 1.2 PLANTING /ZAI PITS

ENGLISH VERSION

GEAVET Project n° 101129027

PART I – LEARNING MATERIAL

1. Introduction

In environments where water and vegetation are scarce, the goal of farmers is to avoid losing rainwater to runoff and evaporation as much as possible. It is not enough to slow down runoff by placing earth or stone or vegetation barriers, slowing, spreading, retaining water runoff and facilitating water infiltration. It is also necessary to capture the water and concentrate it in small spaces where the cultivated vegetation can flourish.

Shaping basins, holes or patches with runoff catchment areas is one way to achieve this goal.

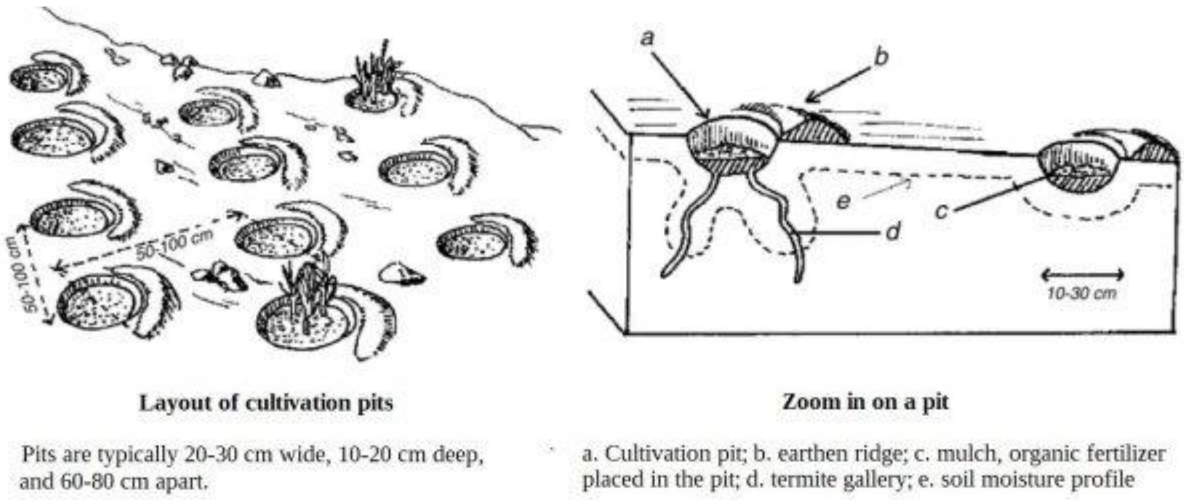

Figure 1. Zai planting pit (Kome, 2025)

In the Sahel and other semi-arid zones, a very old practice consists of making small, regularly spaced cultivated basins surrounded by catchment areas devoid of plants. The landscape thus shaped by humans resembles a succession of small oases.

The type of agricultural landscape that results from these developments is likely derived from observation of nature. Indeed, the plants of arid climates are not distributed uniformly, but in patches or zebra stripes according to the relief and folds, crevices, hollows, holes where water is concentrated.

This modality of distribution of natural vegetation in arid environments has been particularly studied by Doyle McKey, professor of ecology at the University of Montpellier in France. Noting the proximity of naturally self-organized designs to those constructed by humans in the same context, he developed the concepts of biocultural landscape and biocultural interactions.

In Moore, "zaï" would mean "to hurry", implied in this context to dig in the dry season a packed and crusted soil. In Niger, these small cultivated pits are called "tassa": "small cup" in the Hausa language, in Mali the Bambara speakers call them "towalen" and the Dogon "wegou". In English, cultivated holes are called "planting pockets", "planting basins", "micro pits" or "small water harvesting pits". French speakers tend to use the name "zaï".

These evenly spaced pit farming systems are most common in areas where soils are sloping, i.e., covered with an impermeable hardpan, and where rainfall is low and highly variable. Basin cultivation is often combined with other methods of runoff retention such as stone bunds. Since the 1980s, these traditional techniques have been rehabilitated and recognized as relevant endogenous responses to the fertility and moisture problems of these crusted soils.

The following video gives a picture of how zai pits have helped in Burkina Faso: www.accessagriculture.org/slm06-zai-...anting-pits

2. Notable African Variations of Hollow Culture

Among the different African modulations of pit farming, two variants are noteworthy: the "half-moons" used in the Sahel and the "ngolo" pits of the Matengo of Tanzania, which enabled this people to cultivate the steep slopes lacking in arable land in the highlands where they once took refuge.

Image 4. Typical mode of occupation of a hillside by the Matengo (ESSAP, 2014)

2.1. Half Moons

Half-moons are cultivated pits in the shape of a semicircle dug perpendicular to the slope. Like the zaï, they are most often placed on glacis to collect runoff water and facilitate its infiltration in circumscribed areas where the soil has been loosened by removing its hard surface. The soil thus removed and placed at the edge of the curve of the structure forms a small dike. These half-moons are used to grow vegetables, grain, fodder, or even trees.

Image 5. Half moons in Niger (Jean-Luc Galabert, n.d.)

In summary the planting pit/zaï/tassa/towalen/wegou present the following advantages and disadvantages:

Advantages	**Disadvantages**
• They increase the cultivable areas by rehabilitating uncultivated land; • They significantly increase yields • It's an endogenous technique well mastered in the Sahel; • Zaï can be combined with other techniques such as stone barriers or "embocagement" • It can be used for reforestation • It requires only a small investment.	• There is a risk of wilting of young plants in case of drought or asphyxiation in case of heavy rainfall (particularly for millet and cowpea); • The short "life" of the zaï makes it necessary to restore them regularly; • The good functioning of the system requires the contribution of important quantities of organic matter and manure.

2.2. Ngolo Pits (Matengo pit cultivation)

Ngolo (also written *ngoro* or "Matengo pit cultivation") is an indigenous soil and water conservation system developed by the Matengo people on the steep slopes of the Matengo Highlands in southern Tanzania.

Fields are laid out as a grid of small pits surrounded by ridges on slopes often ranging from about 10% to 60%, allowing cultivation on land that would otherwise be highly erosion-prone.

Under the ngolo system, crop residues and grass from the previous season are arranged in square grids (roughly 1–2 m^2), then covered with soil excavated from pits dug at the centre of each grid; the pits act as micro-catchments that trap runoff and sediment, while the buried residues decompose to build soil organic matter and fertility. Crops such as maize, beans, cowpea and coffee are planted on the ridges, benefiting from increased soil moisture, reduced erosion and a steady nutrient supply, which together can sustain higher and more stable yields than conventional cultivation on similar slopes.

Ngolo has been practised for more than a century and is recognised as a highly sustainable "pit farming" system that simultaneously conserves soil, regulates water, and maintains or improves soil fertility; however, like other intensive pit systems, it is labour-demanding and depends on sufficient biomass for residue management.

3. Local adaptation highlights

Planting pits are small holes that harvest runoff and concentrate organic matter around crops. They are well-suited to Mozambique's semi-arid and drought-prone zones (e.g., parts of Gaza, Inhambane, Manica, Tete), where soils may crust and rainfall is erratic. Pits are laid out across the slope to slow water, increase infiltration, and rehabilitate degraded fields.

- **Agro-ecological zones & soils** Prioritise semi-arid districts (e.g., Gaza, Inhambane, Manica, Tete) where sandy or crust-prone Ferralsols/Arenosols dominate and runoff is common on bare fields. Avoid waterlogged vertisols and riverine depressions.

- **Rainfall & timing:** Main rain season is November–March with high intra-season variability. Begin pit excavation 4–6 weeks before expected rains; amend and mulch 1–2 weeks before onset; sow after the first effective rain (≥20–30 mm within 2–3 days) to ensure establishment.

- **Pit specs & spacing:** Start with Ø 20–40 cm, depth 10–25 cm. In areas <500 mm annual rainfall, use closer spacing (60–80 cm) and heavier mulch; in >600 mm, spacing can widen to 80–100 cm. Maintain rows across slope with overflow gaps between pits to spread water.

- **Crops & intercrops:** Core options include maize (milho), sorghum (mexoeira), pearl millet, cowpea (feijão-nhemba), groundnut (amendoim), and sesame. Promote intercrops like maize+cowpea or sorghum+groundnut for risk-spreading, nitrogen input, and food diversity.

Image 6. Maize and cowpeas (Fidelia Bohissou, 2019)

- **Organic inputs:** Target 1–2 handfuls of well-decomposed manure/compost per pit; avoid fresh manure at sowing. Encourage household composting, pen manure collection, and community residue banks.

- **Mulch strategy:** Cover the pit surface with 5–10 cm of residues (maize/sorghum stalks, grass). In termite-active areas, expect faster residue turnover—top up after early rains.

- **Labour & ergonomics:** Organise team rotations, use short-handled hoes/digging sticks as appropriate, schedule work in cool hours, and ensure hydration and sun protection.

- **Risk management:** In drought years, prioritise fewer rows with higher quality pits and drought-tolerant crops/sowing windows. Integrate micro-catchments and windbreaks where feasible.

- **Monitoring:** Keep a simple field log (date, rainfall events, pits completed, inputs used) and photo points to track emergence and mulch condition.

Lastly, here is a success story of how China has used the planting pits to overcome the desert: ://youtu.be/k8J1NuWj7mE

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PART 2 – CURRICULUM

Learning Objectives:

KNOWLEDGE	SKILLS	ATTITUDES
Student is able to: ● Functions and agronomic rationale of pits in semi-arid Mozambican contexts. ● Locally adapted pit dimensions, spacing, and across-slope layout for milho, mexoeira, feijão-nhemba, amendoim. ● Seasonal timing (pre-rains excavation, sow after first effective rain), mulching, and early maintenance. ● Integration with conservation agriculture, risk management, and post-harvest considerations	*Student is able to:* ● Select/mark sites; lay out rows across slope with A-frame/line level; measure spacing for local rainfall. ● Dig pits to target size; blend topsoil+compost/manure; sow and mulch; design intercrops (e.g., maize+cowpea, sorghum+groundnut). ● Document the plot (photos, GPS points) and maintain a field log (rainfall events, seed rate, inputs, observations).	*Student is able to:* ● Stewardship of soil/water ● Efficient use of local residues ● Safety ● Teamwork ● Reflection for continuous improvement.
TRANSVERSAL SKILLS INTEGRATED: ● **Critical thinking & problem solving:** Diagnose runoff, choose spacing, and adapt pit size to rainfall. ● **Collaboration & communication:** Team rotations, peer checks, shared decision logs. ● **Time & project management:** Back-schedule excavation before rains; organise materials and labour. ● **Leadership & facilitation:** Assign roles, supervise quality checks, ensure safety. ● **Numeracy & basic data skills:** Count pits, measure spacing, track inputs and		

rainfall. ● **Entrepreneurship mindset:** Cost small inputs, explore community residue banks and service provision.
DIGITAL SKILLS INTEGRATED: ● **Digital literacy & ICT4Ag:** Use phones for photos, notes, and advisory apps (offline capable where possible). ● **Data management:** Maintain simple digital logs (date, rainfall, pit counts, inputs) and back-up to shared drives when available. ● **Geospatial awareness:** Record GPS waypoints/photo points to monitor plot change over time. ● **Digital communication & safety:** Share results with class/extension; practise cybersecurity basics for shared devices.
GREEN SKILLS INTEGRATED: ● **Sustainable land & water management:** Across-slope layout, micro-catchment function, and mulch for evaporation control. ● **Agroecology & soil health:** Organic amendments, residue cover, termite/soil fauna interactions. ● **Climate resilience & risk reduction:** Drought-aware timing, intercrops for stability, and erosion control. ● **Circular economy:** Composting household/pen wastes; efficient use of residues. ● **Integrated pest/ecosystem management:** Habitat for beneficials through cover and diversity.

Implementation plan of pedagogical activities - Scheme of work

Duration: 4 hours				
Target: TVET learners in agriculture (beginner–intermediate)				
No. of Activity	**Duration**	**Training Methods / Activity**	**What the trainers do**	**What the participants do**
1.	60 min	Interactive theory + demo (dimensions spacing, across-slope layout)	● Present concepts ● Show tools/materials ● Demonstrate	● Observe ● Practise measuring and marking across slope in small teams

			marking a contour/row ● Facilitate Q&A	
2.	120 min	Field practical: pit digging & preparation	● Coach safe tool use ● Check dimensions ● Guide compost/topsoil mixing ● Demonstrate mulching	● Dig pits ● Blend topsoil & compost/manure ● Backfill ● Apply mulch ● Peer-check dimensions
3.	60 min	Sowing, intercropping design & reflection	● Demonstrate sowing density ● Discuss crop choices ● Lead reflection & simple data logging	● Sow seeds ● Design intercropping pattern ● Photo-document plots ● Complete reflection checklist

Materials (What trainers need to have prepared):

- Hoes/digging sticks
- Measuring tape/rope
- Stakes/line
- Compost or manure
- Topsoil access
- Mulch
- Water (if available)
- Seed (e.g., maize and cowpea)

● PPE (gloves, boots, sun protection) ● First-aid kit ● Smartphone/tablet for photos/GPS.
Other notes: ● Adjust pit spacing and pit count to rainfall and class size. ● Ensure shade/water breaks and enforce PPE use. ● Include a quick tool-safety briefing before fieldwork.

PART 3 – ACTIVITY GUIDE

DESCRIPTION OF THE ACTIVITIES

1. Layout & Marking Across Slope

Learners examine why pits are aligned across slope to intercept runoff and promote infiltration on crusted or compacted soils common in semi-arid districts. The trainer demonstrates establishing a contour-like baseline using a simple A-frame or line level, then marking rows with stakes and line at spacing appropriate to expected rains (e.g., tighter at lower rainfall). Teams measure and mark pit centres along the line, checking distances to maintain consistent row and in-row spacing for milho/sorgo with intercrop options. The trainer rotates among teams to correct layout, reinforce hydration/sun safety, and discuss field variability (stoniness, anthills, micro-relief). Teams capture photos and note decisions (spacing, tools used, slope direction, obstacles) in a basic logbook or phone app. Short peer checks build confidence and accuracy across the class.

1. **Aim of the activity**: Accurate, safe, teamwork-based layout to enable efficient pit construction and learning data capture.

2. **Duration:** 1.5–2 hours

3. **Material required:**

- Stakes
- String/line
- Measuring tapes
- A-frame/line level
- Smartphones for photos
- PPE (hat, water).

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

➢ Purpose of across-slope layout

➢ Demonstrate baseline with A-frame
➢ Teams mark rows and pit centres
➢ Peer-check spacing
➢ Photo-document and log notes
➢ Quick debrief.

References/Sources/Further materials:
https://youtu.be/FNQeP2P0lb

2. Pit Digging, Preparation & Mulching

In this hands-on session, learners dig pits to target diameter/depth, placing topsoil aside. Under supervision, they incorporate compost or well-decomposed manure (estrume) into the base/topsoil mix to boost nutrient availability and soil biology. Emphasis is placed on consistent sizing, spacing, and safe, efficient tool handling. After backfilling to the appropriate level, learners apply mulch (maize/sorghum residues, grass) to reduce evaporation and protect the soil surface—critical in hot, windy conditions. Trainers use a quick quality checklist (diameter, depth, organic matter added, mulch coverage), and teams peer-assess sample pits. The group discusses adaptations for different crops/rainfall and locally feasible sources of organic matter (household composting, livestock pens, community residue sharing).

1. **Aim of the activity:** Competence in constructing functional planting pits with appropriate organic amendment and mulch adapted to local materials.
2. **Duration:** 2–3 hours
3. **Material required:** Hoes/digging sticks, compost/manure, mulch materials, water (if available), PPE.
4. **Step-by-step instruction of the task/practical exercise/case study:**

➢ Safety briefing (tools, heat)
➢ Demonstrate one pit
➢ Teams dig
➢ Mix topsoil + compost/manure and backfill
➢ Apply mulch
➢ Peer checklist
➢ Debrief.

References/Sources/Further materials:
No further references

3. Sowing & Intercropping in Planting Pits + Reflection

Learners practise sowing in prepared pits using examples suited to local systems such as maize + cowpea (feijão-nhemba) or sorghum + groundnut (amendoim). The trainer demonstrates seed placement and density, highlighting sowing after the first effective rain and the role of intercrops in resilience and dietary diversity. Learners sow, label rows, and note the configuration. A structured reflection follows: What went well? What would they change? How will they monitor germination, mulch condition, and early weed/pest pressure? Teams record simple data (pits prepared, seeds per pit, date of rain) and capture photos for a shared class log. Optional: link to post-harvest (drying, aflatoxin-aware storage).

1. **Aim of the activity:** Competent sowing/intercropping in pits with reflective learning and basic data logging.
2. **Duration:** 1.5–2.5 hours
3. **Material required:**

- Seed (maize, sorghum, cowpea, groundnut)
- Labels/markers
- Smartphones for photos
- PPE

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

- ➢ Demonstrate sowing density and timing
- ➢ Teams sow and label
- ➢ Peer feedback walk
- ➢ Record photos/data
- ➢ Reflect and plan follow-up observations.

References/Sources/Further materials:

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