GEAVET TRAINING PROGRAMME FOR CSA

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

MOZAMBIQUE

UNIT I.I INTERCROPPING

ENGLISH VERSION

GEAVET Project n° 101129027

Open Educational Resources

PART I – LEARNING MATERIAL

1. Introduction

Intercropping means growing two or more crops simultaneously in the same field. According to the row arrangement and co-growth time, intercropping can be divided into three types: mixed, relay, or strip intercropping. Mixed intercropping refers to growing two or more crops simultaneously with no distinct row arrangement. Relay intercropping denotes growing two or more crops simultaneously during part of their life cycles. A second crop is planted after the first crop has reached its reproductive stage of growth, but before it is ready for harvest. Strip intercropping is to grow two or more crops simultaneously in different strips that are wide enough to permit independent cultivation, but narrow enough for the crops to interact agronomically.

Intercropping systems are widely practiced in many parts of the world, including tropical and temperate regions. Intercropping is becoming common in the Americas, Asia, Africa, and Europe. It is found to play a role in securing the grain supply and raising the income of farmers in developing countries.

2. Definiting the Concept of Intercropping

Intercropping means planting two or more different crops on the same piece of land at the same time or in sequence, in a way that they support each other's growth. It is a key component of Climate-Smart Agriculture (CSA) because it enhances biodiversity, improves resource use, and reduces vulnerability to climate shocks (FAO, 2021). In Mozambique, intercropping is common among smallholder farmers, particularly in Zambezia, Nampula, and Sofala provinces, where combinations like maize + beans or cassava + groundnuts are traditional systems for food and income diversification (IIAM, 2020).

3. Role in Conservation Agriculture

Conservation Agriculture (CA) is a set of good farming practices designed to protect and improve the soil while maintaining stable crop yields over time. It focuses on working *with nature* instead of against it. Intercropping fits perfectly into CA because it supports its **three main principles**:

3.1. Minimum Soil Disturbance

In traditional farming, land is often ploughed deeply before planting, which breaks up the natural soil structure and increases erosion, especially during heavy rains. Under conservation agriculture, farmers disturb the soil as little as possible. Intercropping helps here because growing more than one crop keeps the soil covered and reduces the need for repeated tilling. The roots of different

crops also open the soil naturally, improving water infiltration and air movement. Over time, this leads to stronger, more fertile soils that can hold water longer—something especially valuable in Mozambique's dry regions.

3.2. Permanent Soil Cover

Keeping the soil covered all year round prevents erosion from rain and wind, protects beneficial soil organisms, and keeps moisture in the ground. In an intercropping system, the leaves of different crops form a natural "blanket" that shades the soil. After harvest, the remaining stalks, leaves, and residues can be left on the field as mulch. This organic cover decomposes slowly, adding nutrients back into the soil and feeding earthworms and microorganisms that improve soil health. In Mozambique's sandy soils, this principle is essential to prevent soil crusting and nutrient loss during intense tropical rains.

3.3. Crop Diversification

When farmers plant a mix of species—such as maize with cowpea or cassava with groundnuts—they create biological diversity in the field. This diversity helps the farming system become more resilient. Pests and diseases find it harder to spread because they cannot easily move from one plant type to another. The different crops also make better use of sunlight, water, and soil nutrients. For example, deep-rooted crops pull up nutrients from deeper layers, while shallow-rooted ones use the upper layers. This natural balance means fewer chemical fertilizers and pesticides are needed, saving costs and protecting the environment.

In Mozambique's semi-arid provinces such as Gaza and Tete, these conservation practices are particularly important. Farmers face unpredictable rainfall, degraded soils, and frequent droughts. Intercropping under conservation agriculture helps stabilize yields even in difficult seasons by improving soil carbon retention—that is, keeping organic matter in the soil—and maintaining its fertility. Over several years, fields managed with intercropping and minimal disturbance become more productive, need less external input, and are more resilient to climate change (FAO, 2020).

4. Types of Intercropping

Table 1. Types of Intercropping

Type	Description	Example (Mozambique and Further Resources)

Row Intercropping	In this system, two or more crops are planted in *alternate rows*. This makes it easy to weed, fertilize, and harvest each crop separately. The taller crop often provides shade or support for the shorter one.	**Maize + Beans** is a common example in **Nampula and Zambezia**. Farmers plant one row of maize followed by one or two rows of beans or cowpeas. This combination improves soil nitrogen and helps suppress weeds. *Watch*: Maize–Cowpea Intercropping for Climate Resilience – IITA Video *Learn more*: https://www.fao.org/agroecology/database/detail/en/c/1028831/?utm_source=chatgpt.com
Mixed Intercropping	Different crops are *grown together without strict row arrangement*, usually broadcast or planted irregularly. It imitates natural plant diversity and maximizes use of soil space.	**Cassava + Groundnuts**, often practiced in **Sofala and Zambezia**, is a typical mixed system. Farmers plant cassava stems first, then scatter groundnut seeds between them. This mix keeps the soil covered, reduces erosion, and gives two different harvests. *Watch*: https://www.youtube.com/watch?v=BSzC1ZA-KVA&utm_source=chatgpt.com *Read*: https://www.fao.org/4/i3278e/i3278e.pdf
Relay Intercropping	The *second crop is planted before the first is harvested,* so their growth periods overlap. It ensures the soil is never left bare and makes better use of rainfall.	**Maize followed by Cowpea** is used in **central and northern Mozambique**. Farmers sow cowpeas two to three weeks before maize harvest. The cowpea grows under maize shade until the cobs are removed. *Watch*: Relay Cropping Explained – African Farmer Channel *Read*: IITA Guide to Maize–Cowpea Relay Systems

Strip Intercropping	Crops are grown in *wide alternating strips*, allowing separate management (fertilization, weeding, harvesting) while benefiting from mutual effects along the borders.	**Maize and Soybean Strips** are used in **Manica and Niassa**. Maize provides vertical structure, while soybeans enrich soil nitrogen and control weeds. This system works well with small machinery and drip irrigation. *Watch*: https://www.youtube.com/watch?v=-mZYfS7GCck&utm_source=chatgpt.com *Read*: https://aiccra.cgiar.org/regions/kenya?utm_source=chatgpt.com

Digital field-mapping systems such as DroneDeploy and Google Earth GIS layers are increasingly being used in Southern Africa to plan such spatial arrangements (World Bank Digital Agriculture Report, 2021). Each intercropping type can be adapted to local soil, rainfall, and tools available. Farmers are encouraged to experiment with small plots before expanding, and to use digital tools such as *AgriPredict* and *PlantVillage Nuru* for crop and weather monitoring.

5. Benefits of Intercropping

5.1. Agronomic Benefits

- **Improved soil fertility:** Legumes like beans or cowpea fix nitrogen (N_2) via *Rhizobium* bacteria.
- **Better yield per area:** Combined productivity per hectare often exceeds monocropping (CIMMYT, 2019).
- **Reduced weeds:** Crop canopy shades suppress weeds (FAO, 2021).

5.2. Environmental Benefits

- **Erosion control:** Continuous soil cover minimizes run-off (FAO, 2020).
- **Biodiversity enhancement:** Supports pollinators and soil fauna (EU Biodiversity Strategy, 2020).
- **Efficient water use:** Root systems explore different soil layers (CGIAR, 2022).

5.3. Socio-Economic Benefits

- **Multiple harvests per year:** Improve income stability (World Bank, 2021).

- **Risk reduction:** Ensures food even during partial crop failure.
- **Gender & youth inclusion:** Simpler, low-cost systems suitable for family farming and youth start-ups (FAO & IFAD, 2021).

Farmers can also use digital record-keeping apps like *FarmOS* or *Digital Green* to track yields and share intercropping performance data (Digital Green, 2023).

6. Practical Examples for Mozambique

6.1. Example of Maize & Cowpea Intercropping

- **Why:** Cowpea fixes nitrogen and shades weeds; maize provides vertical support.
- **How:** 1 row of maize alternated with 1–2 rows of cowpea.
- **Best Areas:** Northern Mozambique (Nampula, Cabo Delgado).
- **Result:** +20–30% higher land equivalent ratio (LER) compared to monocrop maize (CIMMYT, 2019).
- **Smart Tip:** Farmers can use *PlantVillage Nuru* for early pest detection and for rainfall forecasts.

One of the most common and successful intercropping systems in northern Mozambique is the combination of maize and cowpea. This system works well because the two crops use soil nutrients differently and support each other's growth. Cowpea, a legume, can fix nitrogen from the air and enrich the soil, reducing the need for fertilizers. It also grows low to the ground, helping to control weeds between maize rows.

Farmers usually plant one row of maize alternated with one or two rows of cowpea. This layout makes it easy to manage and harvest both crops. The best planting time is at the beginning of the rainy season when the soil is moist.

Studies by CIMMYT and IITA in Mozambique and Malawi have shown that this system can increase total yield by 20–30% compared to growing maize alone. Farmers in Nampula and Cabo Delgado use this combination because it provides both staple food and protein. Using digital tools like PlantVillage Nuru to detect early pest attacks and to plan sowing dates can make the system even more productive (CIMMYT, 2019).

Image 1. Maize & Cowpea Intercropping (IIAM, 2020)

Images 1 and 2 show maize rows with cowpea plants in between; for example, a study in Mozambique's Vilankulo district documented maize–cowpea intercropping.

Image 2. Maize & Cowpea Intercropping (IIAM, 2020)

6.2. Example of Cassava & Groundnuts

- **Why:** Groundnuts fix nitrogen, mature early, and provide cash income while cassava takes longer to grow.
- **How:** Cassava planted first, groundnuts added between rows 3–4 weeks later.
- **Best areas:** Central Mozambique (Zambezia, Sofala).
- **Result:** Reduces erosion, improves soil organic matter by 12% over 3 years (IIAM, 2020).

- **Smart Tip:** Drone imagery or smartphone photos can track canopy coverage and detect pest infestation zones.

In central Mozambique, especially in Zambezia and Sofala provinces, farmers often combine cassava and groundnuts. This method is effective for improving both soil fertility and income security. Cassava has deep roots that reach lower soil layers, while groundnuts spread closer to the surface. This difference means the two crops do not compete strongly for nutrients or water.

Farmers usually plant cassava first and then sow groundnuts in the spaces between cassava rows about three to four weeks later. Groundnuts grow quickly and are harvested earlier, giving farmers food and income before the cassava is ready. The leftover leaves and stems from groundnuts add organic matter to the soil, helping maintain fertility.

Research from IIAM and FAO shows that this system improves soil organic content and reduces erosion, especially on sloping fields. Using drones or mobile cameras to monitor the field can help detect early signs of pest damage or poor plant growth, allowing farmers to act before losing yield (IIAM, 2020; FAO, 2021).

6.3. Example of Sorghum + Pigeon Pea

- **Why:** Drought-tolerant system where pigeon pea fixes nitrogen and shades sorghum roots.
- **How:** Plant sorghum first, pigeon pea 2 weeks later.
- **Best areas:** Drier regions (Tete, Gaza).
- **Result:** Increases soil nitrogen by up to 30 kg N ha^{-1} yr^{-1} and reduces erosion by 25% (ICRISAT, 2021).
- **Smart Tip:** Simple soil moisture sensors (e.g., *Tensiometer Probes* linked to mobile apps) help farmers decide irrigation timing.

In the drier provinces like Tete and Gaza, where rainfall is unpredictable, farmers can adopt sorghum and pigeon pea intercropping. Both crops tolerate dry conditions, making them ideal for climate-smart agriculture. Sorghum grows fast and provides grain for food and fodder, while pigeon pea grows slowly, fixing nitrogen in the soil and giving shade to sorghum roots.

Farmers plant sorghum first at the beginning of the rainy season and add pigeon pea about two weeks later. When sorghum is harvested, the pigeon pea continues growing, protecting the soil from erosion and wind. This system helps the land stay productive even in dry years. Research from ICRISAT shows that this method can add up to 30 kilograms of nitrogen per hectare each year and reduce erosion by a quarter. Simple soil sensors or tensiometers

connected to mobile phones can help farmers decide when limited irrigation is needed (ICRISAT, 2021).

Image 3 illustrates the drier-area intercropping system of sorghum with pigeon pea, which fits well for regions in Mozambique like Tete or Gaza.

Image 3. Sorghum & Pigeon Pea (IIAM, 2020)

7. Local Considerations for Mozambique

Mozambique's agriculture is shaped by two main seasons—a wet season with heavy rains and a dry season with high temperatures. In many areas, rainfall is irregular, and soil fertility is low. Intercropping helps farmers adapt to these conditions because it keeps the soil covered, reduces evaporation, and ensures that if one crop fails due to drought or pests, another can still provide food or income.

The soils in much of Mozambique are sandy and acidic, which means nutrients are easily washed away. Including legumes such as cowpeas, groundnuts, or pigeon peas in intercropping systems naturally increases soil nitrogen and organic matter.

Intercropping also plays an important social role. Women are often responsible for cassava and legume crops, while men focus on cereals such as maize and sorghum. Working together in mixed cropping systems allows families to share tasks and resources more fairly. Youth can be encouraged to participate by integrating digital tools—such as smartphone-based weather apps or low-cost soil sensors—into daily farming routines.

Finally, farmers who produce intercrop combinations like maize–beans or cassava–groundnuts can access better market prices through cooperatives such as *IKURU Ltd.* or *CLUSA Mozambique*, which support collective marketing and value addition (Di Matteo, 2024).

8. Challenges and Possible Solutions

Although intercropping is a proven system, Mozambican farmers face several challenges in adopting and optimizing it. One major issue is the **lack of knowledge** about the best crop combinations, spacing, and management. To address this, the GEA_VET programme provides e-learning videos, local-language manuals, and on-farm demonstrations.

Another problem is **limited access to quality seed**. Some farmers use recycled or low-germination seeds, reducing productivity. The national research institute, IIAM, together with FAO, is working to expand the distribution of certified seeds adapted to local climates.

Unpredictable rainfall is another challenge, especially in the southern and central provinces. Farmers can reduce risk by subscribing to SMS-based climate alerts provided by the National Meteorological Institute (INAM), which sends early warnings on rainfall and dry spells.

Finally, **pest and disease outbreaks**—such as fall armyworm in maize or aphids in cowpea—are growing threats under climate change. Simple digital diagnostic tools like *AgriPredict* or *PlantVillage Nuru* can help farmers identify pests and follow integrated pest management (IPM) advice directly from their phones. Together, these measures make intercropping more resilient and profitable (CGIAR, 2022).

9. References/Sources

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PART 2 – CURRICULUM

Learning Objectives:

KNOWLEDGE	SKILLS	ATTITUDES
Student is able to: ● The basic concepts and principles of intercropping, including how different crop species complement each other in nutrient use, pest control, and soil protection. ● The role of intercropping in Conservation Agriculture, and how it supports minimum soil disturbance, permanent soil cover, and crop diversification in Mozambican contexts. ● The main intercropping systems used in Mozambique (e.g., maize + cowpea, cassava + groundnuts, sorghum + pigeon pea) and their environmental and economic benefits for smallholder farmers.	*Student is able to:* ● Design and plan an intercropping layout suitable for their local area, selecting crops based on soil type, rainfall, and available resources. ● Apply sustainable land-management techniques such as mulching, minimal tillage, and residue retention to maintain soil health. ● Use digital tools (e.g., mobile apps, sensors, or online weather platforms) to collect field data, monitor crop growth, and make evidence-based decisions about planting and pest management.	*Student is able to:* ● Environmental responsibility – a willingness to protect soil and biodiversity through sustainable cropping choices. ● Collaborative and innovative thinking – valuing teamwork, farmer-to-farmer knowledge exchange, and openness to adopting new agricultural technologies. ● Adaptability and resilience – confidence to face climate variability and experiment with improved farming practices to ensure food security and income stability.

TRANSVERSAL SKILLS INTEGRATED:

(most relevant for agricultural teamwork and innovation)

- **Critical Thinking: I**nterpreting field data, assessing soil and rainfall conditions, and making logical decisions about crop combinations.
- **Collaboration:** Working effectively in groups and with local communities to share experiences and manage intercrop plots.
- **Problem Solving:** Identifying on-farm challenges (pests, drought, nutrient loss) and designing context-appropriate solutions.

DIGITAL SKILLS INTEGRATED:

(for digital & smart agriculture use)

- **ICT for Agriculture (ICT4Ag):** Using mobile and web-based tools to access advisory information, pest alerts, and market data.
- **Data Management:** Recording and analyzing field data (soil moisture, rainfall, yield) to evaluate intercrop performance.
- **Mobile-Based Advisory Tools:** Using apps such as *PlantVillage Nuru* or *AgriPredict*, for real-time decision support.

GREEN SKILLS INTEGRATED:

(aligned with EU Green Deal & FAO CSA principles)

- **Sustainable Land Management:** Maintaining soil fertility, reducing erosion, and managing water efficiently through continuous soil cover and mixed cropping.
- **Agroecology:** Understanding ecological interactions between crops, soil organisms, and pests to design resilient systems.
- **Climate Resilience:** Planning and practicing adaptive farming methods that withstand drought, erratic rainfall, and other climate stresses.

Implementation plan of pedagogical activities - Scheme of work:

Duration: 2.5 – 3 hours

Target: Young VET learners and smallholder farmers in Mozambique, VET Organisations

Methodology: Blended (digital, group discussion, mini field demo)

No. of Activity	Duration	Training Methods / Activity	What the trainers do	What the participants do

1.	50 min	Interactive mini-lecture + guided discussion + video	● Explain core intercropping concepts and link to Conservation Agriculture ● Show short clips (maize–cowpea) ● Guide Q&A.	● Listen & ask questions ● Share examples of local mixed cropping ● Take short quizzes.
2.	55 min	Group simulation + digital mapping exercise	● Demonstrate crop-planning layout using an AI app and field map ● Circulate to support groups.	● Work in groups to choose crops ● Draw a simple intercrop layout ● Check weather data on phones.
3.	55 min	Practical demo + reflection session	● Prepare a small soil tray / plot or photo simulation ● Guide planting pattern demo ● Lead reflection discussion.	● Implement their plan on plot or paper ● Observe soil cover and moisture ● Record notes and present findings.
Materials (What trainers need to have prepared): ● Projector or screen				

- Video clip
- Flip-chart
- Markers
- Sample seeds (maize, cowpea, cassava, groundnuts, pigeon pea)
- Smartphones with apps (PlantVillage Nuru, AgriPredict)
- Local maps or field trays.

Other notes:

- Encourage mixed-gender group work.
- Use photos or videos if no field available

PART 3 – ACTIVITY GUIDE

DESCRIPTION OF THE ACTIVITIES

1. Understanding Intercropping and Conservation Agriculture

Learners receive a short introduction to intercropping concepts and how they relate to Conservation Agriculture's three principles. The trainer uses real Mozambican examples and shows a 3-minute video, *"Maize–Cowpea Intercropping for Climate Resilience"* (IITA YouTube). After the video, participants discuss benefits (soil protection, water retention, pest reduction) and connect these to their experience. A quick mobile or paper quiz helps check comprehension before moving to planning.

1. **Aim of the activity:** Build foundational knowledge and awareness of ecological benefits.
2. **Duration:** 50 min
3. **Materials required:**

- Projector
- Video
- Flip-chart
- Markers
- Quiz cards/ Mobile quiz (Kahoot/Mentimeter).

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

➢ Trainer introduces topic (5 min).

➢ Play video and highlight key points (10 min).

➢ Guided discussion (20 min).

➢ Question and answer to review and summary (15 min)

References:

FAO (2021); IIAM (2020); CIMMYT (2019)

2. Design Your Own Intercropping Plan

Working in groups of 3–4, learners design a simple intercropping plan focusing on how the system improves soil health and income stability, given a farm scenario (e.g., 1 ha in Sofala with sandy soil and low rainfall). Using flip-charts or mobile apps, they choose two crops, define row spacing and planting sequence, and justify their choices using weather data from any digital tools mentioned above in the digital skill box. Groups present their plan briefly.

1. **Aim of the activity:** Develop planning, problem-solving and digital agriculture skills.
2. **Duration:** 55 min
3. **Materials required:**

- Flipcharts
- Markers
- Smartphones with apps
- Crop reference sheets.

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

➢ The trainer explains the task and shows a sample layout (10 min).

➢ Groups design plan and consult digital data (30 min).

➢ Quick presentations and peer feedback (15 min).

References:

CGIAR (2022); FAO (2021); World Bank (2021).

3. Mini Demonstration and Reflection

The trainer sets up a mini plot (soil tray or open space) to show row, mixed, and relay patterns. Learners apply their own designs by placing seeds or labels in the correct pattern. They observe how plant cover reduces bare soil and how different root zones use water. Learners take photos or short videos to record their work and reflect on what they learned about soil care and teamwork.

1. **Aim of the activity:** Reinforce learning through practice and develop reflection and digital documentation skills.
2. **Duration:** 55 min

3. **Materials required:**

- Seeds or labels
- Small plots or trays
- Watering can
- Phones for photos.

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

➢ The trainer sets up a demo and explains patterns (10 min).

➢ Groups implement designs (30 min).

➢ Observation + reflection discussion (15 min).

References:

For more details see: ICRISAT (2021); IIAM (2020); FAO & GEF