



# GEAVET TRAINING PROGRAMME FOR CSA

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

### UNIT 2.2 EARLY WARNING SEASONAL FORECASTS FOR FOOD PROCESSING

**ENGLISH VERSION**

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Open Educational Resources



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## **PART I – LEARNING MATERIAL**

### **1. Introduction**

Early warning seasonal systems are crucial in agriculture and fishing because they allow for timely preparation to mitigate losses from climate-related risks like extreme weather and pests. They help farmers and fishers optimize timing for planting, harvesting, and fishing, improve resource management, and protect livelihoods by providing advanced information to make informed decisions.

#### **Importance for agriculture:**

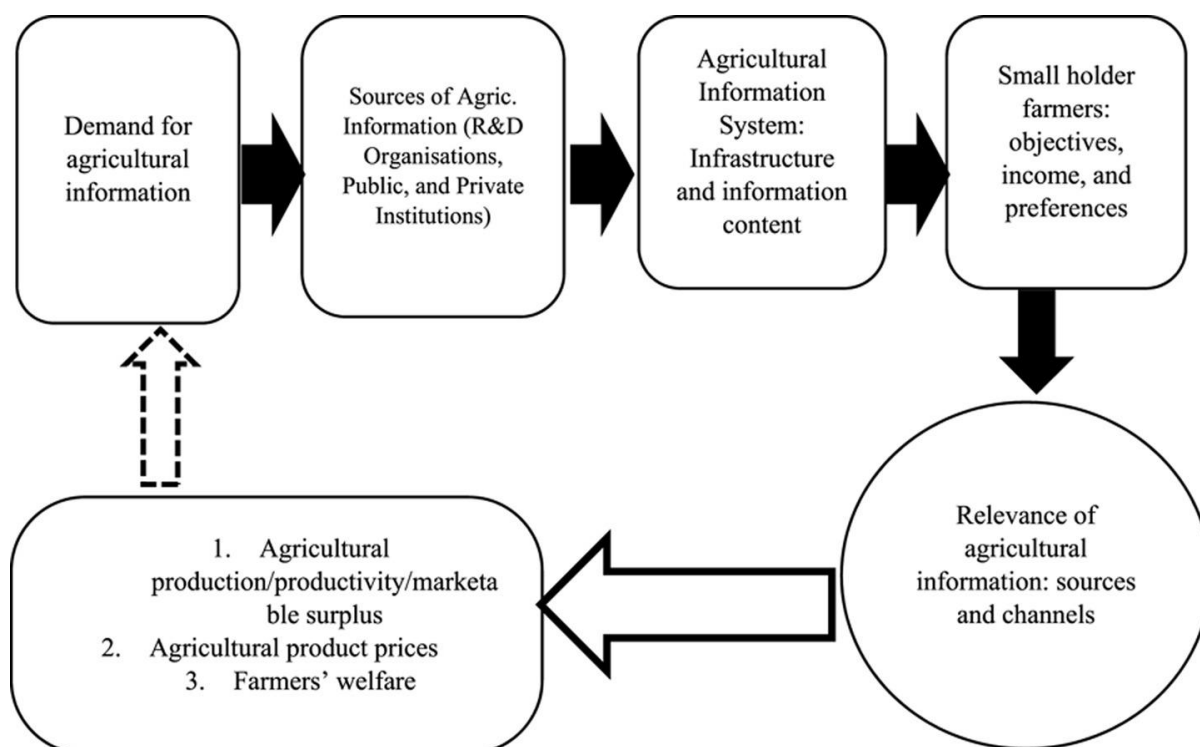
- **Pest and disease management:** Seasonal forecasts can predict the likelihood of pest or disease outbreaks, allowing farmers to implement timely control measures.
- **Optimized operations:** By anticipating weather patterns, farmers can determine the best times for planting, fertilizing, irrigating, and harvesting to maximize crop quality and yield.
- **Reduced risk:** Systems can warn of impending droughts, floods, or heatwaves, giving farmers time to store crops and animals safely and prepare for potential damage.
- **Improved resource efficiency:** Knowing weather patterns helps optimize the use of water, fertilizers, and pesticides, reducing waste and environmental impact.

#### **Importance for fishing:**

- **Hazard avoidance:** Systems can warn fishing communities about upcoming extreme weather events like storms, allowing them to avoid dangerous conditions at sea and reduce loss of life.
- **Operational planning:** Seasonal forecasts can help in planning fishing seasons, as weather patterns can affect fish migration and availability.
- **Vulnerability reduction:** By providing timely and reliable climate information, these systems help reduce the vulnerability of the fishing sector to unpredictable weather.

In Mozambique, where most food production and processing depend directly on rainfall and temperature, seasonal forecasts and early warning systems (EWS) are essential tools for protecting harvests and maintaining food quality. Each year, unpredictable weather—such as early rains, cyclones, or long dry spells—causes significant losses in crops waiting to be dried or processed. For instance, after Cyclone Idai in 2019, more than 50 000 tons of stored grain and cassava were spoiled by flooding in central Mozambique (FAO, 2020).

This unit explains how to understand, interpret, and apply seasonal climate forecasts and early-warning information in food-processing activities. Learners will explore what forecasts mean, where the information comes from, and how it can be used to make decisions—such as when to harvest, how to dry crops safely, or how to store products during humid or hot conditions.



**Figure 5. Concept map for agricultural information systems and farmers' objectives** (Mkuna, 2023)

Understanding these tools is vital for TVET learners in post-harvest, agro-processing, and agribusiness programmes because it enables them to anticipate risks rather than react to disasters. With accurate climate information, processors can reduce waste, plan energy use efficiently, and keep food safe for consumers—all key goals of Climate-Smart Agriculture and resilient value chains promoted by the GEA\_VET programme.

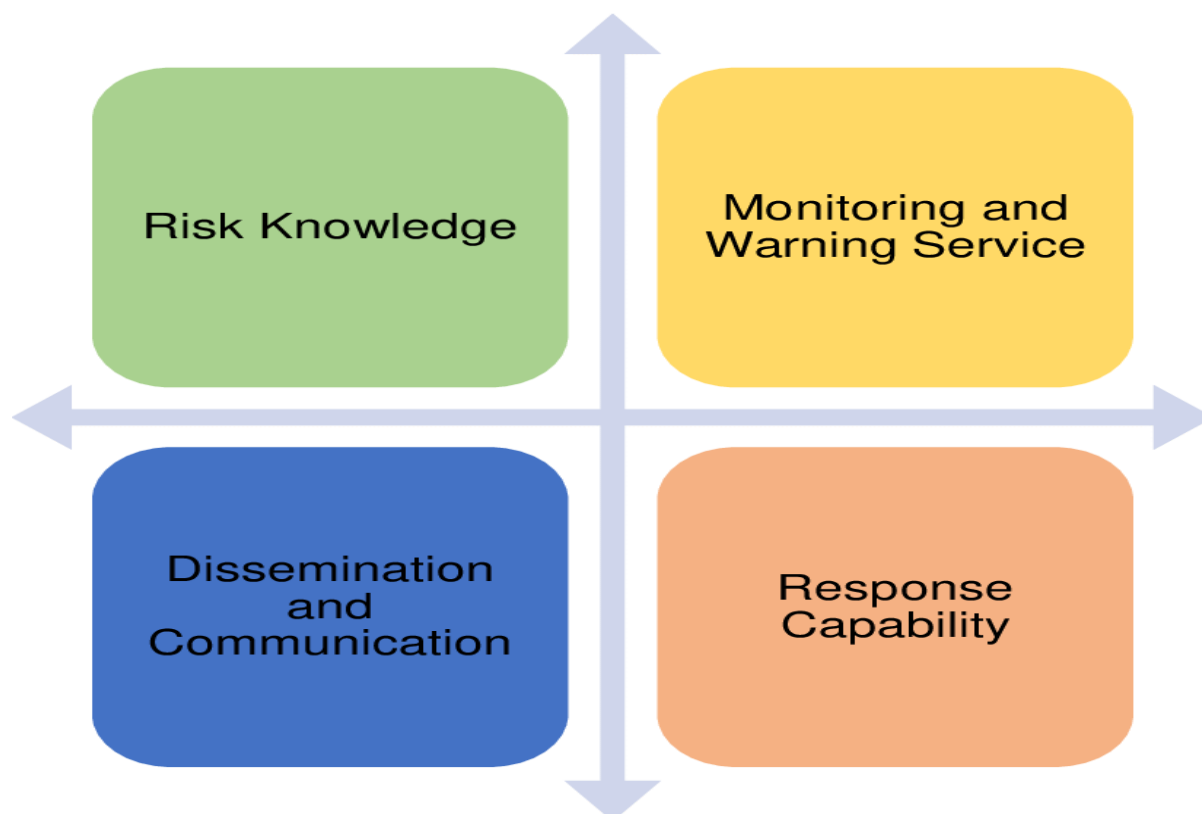
## 2. Key Concepts

### 2.1. Seasonal Forecasts

A seasonal forecast predicts the likely average weather (rainfall, temperature, humidity) for the next three to six months. It doesn't tell the exact weather for each day but gives a probability outlook—for example, "60 % chance of above-normal rainfall between December and March." In Mozambique, the National Meteorological Institute (INAM) issues such forecasts at the start of every

rainy season. According to INAM’s 2024–2025 outlook, the central provinces (Sofala, Zambezia, and Manica) have a 70 % probability of above-average rainfall, while the south is expected to be slightly drier (INAM, 2024).

These forecasts draw on data from satellites and global models managed by organizations like the World Meteorological Organization (WMO) and ICPAC. When shared early, they help processors plan for challenges such as humidity during drying or excess moisture affecting storage.



**Figure 6. Risk management chart** (Mkuna, 2023)

## 2.2. Early Warning Systems (EWS)

An Early Warning System (EWS) is a coordinated set of institutions, communication channels, and tools that detect risks and issue alerts before disasters occur.

Mozambique’s national system—known as MEWS and coordinated by National Institute for Disaster Management (INGD) with support from National Institute of Meteorology (INAM), Famine Early Warning System Network (FEWS NET), and World Food Program (WFP) – tracks floods, droughts, and cyclones.

### How does it work?

1. **Data Collection:** INAM collects data from surface and upper-air stations.

2. **Forecasting:** Data is analysed to forecast hazards like cyclones, floods, and droughts.
3. **Warning Dissemination:** Alerts are sent through various channels, including community volunteers and radios.
4. **Anticipatory Action:** Data triggers pre-agreed actions (like food distribution) before the disaster hits, minimizing impact.

A striking example was in January 2021, when Cyclone Eloise was forecast five days in advance. Thanks to early warnings, small fish-drying cooperatives in Beira managed to move their raw stock to safer buildings and save about 80% of their production compared with the 2019 cyclone losses (WFP, 2022).

EWS information is shared through SMS alerts, radio broadcasts, and community focal points, making it accessible even in rural areas.

### 2.3. Post-Harvest Vulnerabilities

After harvest, food products remain highly sensitive to weather. High humidity, rain, or heat can cause mould, fermentation, or pest infestation. According to the World Bank (2021), Mozambique loses about 30% of total crop production between harvest and market, largely due to poor drying and storage conditions following unpredictable weather. Early access to forecast data can therefore prevent massive economic loss, especially in small-scale cassava, maize, and fish-processing enterprises.

## 3. Why Forecasts Matter in Food Processing

Seasonal forecasts bridge the gap between climate science and practical decisions in food value chains. For processors, knowing whether the coming months will be wet, dry, or unusually hot is the difference between profit and loss.

When a forecast indicates above-average rainfall, processors can prepare by protecting drying areas or using covered solar dryers. A prolonged dry season suggests the need to plan bulk drying and invest in water supply for cleaning and cooling. During periods of high humidity, airtight storage and natural preservatives become crucial.

Forecasts also guide processing timing and quality control. For example, cassava fermentation may need more days if temperatures are cooler, while high heat can accelerate spoilage in dairy or fruit processing.

In 2022, a cooperative in Zambezia Province applied INAM's seasonal forecast to shift its cassava-chip drying schedule two weeks earlier; the result was a 20 % reduction in spoilage compared to the previous season. Below is a simplified decision table

showing how forecast information can be transformed into practical processing actions:

**Table 2. Practical processing actions based on forecast information**

<b>Forecast Insight</b>	<b>Recommended Decision in Processing</b>
<b>Above-average rainfall</b>	Increase use of solar or mechanical dryers; prepare covered drying areas; adjust harvesting schedule.
<b>Prolonged dry season</b>	Plan early harvest and bulk drying; secure water for cleaning or cooling.
<b>High humidity forecast</b>	Avoid open-air storage; use airtight containers; consider natural preservatives.
<b>Cyclone/flood warning</b>	Delay processing; evacuate stock and protect machinery.
<b>Cooler temperatures</b>	Adjust fermentation or drying duration; increase monitoring of moisture content.

Forecast-based planning enhances **efficiency, quality control, and safety** in post-harvest value chains.

Examples of actions include:

- Adjusting drying times or temperature for **cassava flour** based on humidity forecast.
- Scheduling **grain cleaning and packaging** before expected rainfall.
- Prioritising **cold-storage use** during high-temperature seasons.
- Diversifying sourcing regions to spread climate risk (e.g. purchasing from northern provinces when southern yields are at risk).

## **4. Practical Examples from Mozambique**

### **A. Cassava Processing (Chips & Flour)**

- **Forecast:** Heavy rainfall expected in mid-season (December–February).
- **Action:** Plan **early harvesting** before heavy rains; apply **mechanical or solar dryers**; store dried chips in sealed polypropylene bags to avoid mould.

- **Result:** Reduces post-harvest losses by up to 25 % compared with open-air drying (FAO, 2021).

### B. Fish Smoking & Drying

- **Forecast:** High humidity and fewer sunshine days (often in coastal provinces Sofala & Zambezia).
- **Action:** Prioritise **smoking** over open-air drying; stock additional firewood; process smaller batches.
- **Result:** Improves shelf life and reduces spoilage during cyclonic seasons (World Bank, 2021).

### C. Grain Storage

- **Forecast:** Post-harvest rains likely (March–April).
- **Action:** Increase use of **solar or mechanical dryers**; store in **hermetic PICS bags**; elevate structures to prevent flood damage.
- **Result:** Maintains seed viability and food quality, especially for maize and beans (IIAM, 2020).

## 5. Sources of Seasonal Forecasts in Mozambique

- **INAM (Instituto Nacional de Meteorologia):** Publishes seasonal climate outlooks and early-warning bulletins through its website and local radio
- **FEWS NET (Famine Early Warning Systems Network):** Provides regional food-security and climate analyses for Southern Africa.
- **ICPAC & AGRHYMET:** Offer regional rainfall forecasts via the Greater Horn of Africa Climate Outlook Forum (GHACOF).
- **Local radio / SMS alerts:** Used by INGD and private providers for community dissemination.
- **Indigenous indicators:** Traditional signs such as flowering trees or insect activity are combined with scientific forecasts to improve reliability.

## 6. Role of Early Warning Systems

Early warning systems link **forecast data** with **response actions**. They operate in four stages:

1. **Monitoring and data collection** – Satellite and ground stations record rainfall, temperature, and soil moisture.
2. **Forecast analysis** – Meteorologists and agricultural experts translate data into actionable risk maps.
3. **Communication and dissemination** – Forecast bulletins and SMS alerts are shared with producers and processors.

4. **Response planning** – Processors adapt drying, storage, or procurement plans accordingly.

The Mozambique Early Warning System (MEWS), coordinated by INGD, integrates these steps and supports anticipatory actions for floods, cyclones, and drought (Nobre et al., 2023).

## 7. Challenges and Possible Solutions

Although seasonal forecasts and early warning systems are increasingly available in Mozambique, several technical, communication, and behavioural challenges still limit their effective use in food-processing and post-harvest management. The table below summarises the main constraints and feasible solutions.

**Table 2. Forecasting challenges and possible solutions**

Challenge	Description / Example	Possible Solution / Good Practice
<b>Limited access to reliable forecast information</b>	Many small processors in rural areas receive forecast updates too late or only through radio once per week.	Expand <b>SMS and WhatsApp alert systems</b> managed by INAM and INGD; train youth extension agents to share digital bulletins in local languages.
<b>Low understanding of forecast terminology</b>	Terms such as “probability,” “anomaly,” or “normal rainfall” are difficult for non-experts to interpret.	Include <b>climate-literacy training</b> in VET curricula; use simple graphics, colour codes, and translation into Emakhuwa, Sena, or Changana for local audiences.
<b>Weak link between forecasts and business decisions</b>	Processors often receive forecasts but don’t know how to apply them to drying, packaging, or storage plans.	Develop <b>decision-support guides</b> that translate forecasts into concrete actions (e.g. “If high humidity → use sealed storage”); integrate into extension visits.
<b>Infrastructure limitations</b>	Lack of dryers, sealed storage, or electricity	Promote <b>low-cost solar dryers</b> , improved hermetic bags, and cooperative storage funded

	prevents adaptation to adverse weather.	under climate-resilience programmes (e.g. Green Climate Fund).
<b>Unpredictable extreme events</b>	Rapid-onset floods or cyclones may differ from seasonal outlooks and still cause losses.	Combine <b>short-term weather alerts</b> with seasonal forecasts; apply <b>anticipatory action protocols</b> (e.g. move stock, protect machinery) when warnings are issued.
<b>Dependence on traditional methods</b>	Some producers rely only on indigenous signs, ignoring scientific forecasts.	Encourage <b>blending traditional and scientific knowledge</b> , recognising indigenous indicators as early cues verified by INAM data.
<b>Gender and youth inclusion gaps</b>	Women and young entrepreneurs often have less access to climate information tools.	Support <b>gender-sensitive training</b> and provide mobile access subsidies for youth-led processing enterprises.

## 8. References

Di Matteo, F. (2024). *Smallholders' experiences with inclusive agribusiness models in Mozambique: From inclusion to embedded autonomy* (Doctoral dissertation, Utrecht University).

European Commission. (2019). *The European Green Deal* (COM [2019] 640). Brussels, Belgium.

European Commission. (2020). *EU 2030 Biodiversity Strategy*. Brussels, Belgium.

European Commission. (2021). *European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI)*. Brussels, Belgium.

FAO. (2021). *Climate-Smart Agriculture Sourcebook (2nd ed.)*. Rome: Food and Agriculture Organization.

FEWS NET. (2025). *Mozambique Food Security Outlook 2025*. Washington, DC: USAID. Retrieved from <https://fews.net/mozambique>

IIAM. (2020). *Boas práticas agrícolas para pequenos agricultores*. Maputo: IIAM Press. INAM (Instituto Nacional de Meteorologia). (2024). *Previsão Sazonal 2024–2025: Boletim Agrometeorológico*. Maputo: INAM.

Nobre, G. G., Mason, S., & Coughlan de Perez, E. (2023). *Forecasting, thresholds, and triggers: Towards developing anticipatory action in Mozambique*. *International Journal of Disaster Risk Reduction*, 91, 103823. <https://doi.org/10.1016/j.ijdrr.2023.103823>

World Bank. (2021). *Digital agriculture country profiles: Mozambique*. Washington, DC: World Bank.

## PART 2 – CURRICULUM

### Learning Objectives:

KNOWLEDGE	SKILLS	ATTITUDES
<p><i>Students will be able to:</i></p> <ul style="list-style-type: none"> <li>• The meaning and structure of seasonal forecasts and Early Warning Systems in Mozambique (INAM, MEWS), including key terms such as probability, above-normal rainfall, and humidity outlooks.</li> <li>• The main post-harvest vulnerabilities caused by rainfall, humidity and temperature, and how these affect cassava, fish, and grain processing.</li> <li>• The main sources of climate information in Mozambique (INAM, FEWS NET, ICPAC, SMS alerts) and how they support food-processing decisions.</li> </ul>	<p><i>Students will be able to:</i></p> <ul style="list-style-type: none"> <li>• Interpret forecast bulletins and translate them into operational decisions for drying, storage, smoking, packaging, or harvesting schedules.</li> <li>• Identify risks (rain, cyclones, humidity spikes) and apply appropriate mitigation actions such as shifting processing timelines, using hermetic storage, or protecting stock.</li> <li>• Use basic digital tools (mobile apps, SMS alerts, WhatsApp groups) to monitor seasonal forecasts and coordinate responses with peers/cooperatives.</li> </ul>	<p><i>Students will develop the following mindset:</i></p> <ul style="list-style-type: none"> <li>• A proactive mindset toward climate risks—anticipating problems instead of reacting after losses occur.</li> <li>• Greater trust in combining scientific forecasts with local knowledge to support safe and efficient food processing.</li> <li>• A collaborative attitude toward sharing climate information within cooperatives and community groups to reduce collective post-harvest losses.</li> </ul>

#### TRANSVERSAL SKILLS INTEGRATED:

*(most relevant for agricultural teamwork and innovation needed to interpret information, make decisions, and work in groups.)*

- **Critical Thinking:** Reading forecasts, understanding probabilities, linking them to processing choices.

- **Problem Solving:** Adjusting drying, storage, and harvesting in response to forecast conditions.
- **Collaboration:** Necessary for group decision-making in cooperatives and sharing community alerts.

#### **DIGITAL SKILLS INTEGRATED:**

*(for digital & smart agriculture use directly supporting reading forecasts, using mobile alerts, and making processing decisions.)*

- **Digital Literacy:** Learners need the basics: using phones, reading SMS alerts, navigating simple apps.
- **ICT for Agriculture (ICT4Ag):** Core to the unit: using ICT tools (mobile forecasts, digital bulletins).
- **Mobile-Based Advisory Tools:** Essential: most EWS in Mozambique is via SMS, WhatsApp groups, and mobile apps.
- **Digital Communication:** Needed for sharing alerts within cooperatives and coordinating processing decisions.

**(Advanced tools like GIS, drones, precision agriculture are excluded here as they are not relevant for this unit and are unsuitable for the target group.)**

#### **GREEN SKILLS INTEGRATED:**

*(aligned with EU Green Deal & FAO CSA principles linked to climate risk, post-harvest management, and resilience.)*

- **Climate Resilience:** Directly tied to anticipating rainfall, cyclones, humidity impacts on processing.
- **Climate Risk Assessment:** Matches the core of the chapter: interpreting seasonal forecasts and EWS for decisions.
- **Circular Economy:** Relevant for reducing post-harvest losses, efficient drying/storage, and waste reduction.
- **Environmental Stewardship:** Fits the mindset goal: protecting resources through low-loss, climate-smart processing.

### **Implementation plan of pedagogical activities - Scheme of work**

**Duration:** 2.5 – 3 hours

**Target:** Young VET learners and smallholder farmers in Mozambique , VET Orgs.

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

No. of Activity	Duration	Training Methods / Activity	What the trainers do	What the participants do
1.	45 min	Understanding Seasonal Forecasts & EWS: Digital introduction + guided interpretation of real forecast (INAM bulletin or SMS alert).	<ul style="list-style-type: none"> <li>● Present a simplified INAM seasonal forecast (digital slide or printed copy).</li> </ul>	<ul style="list-style-type: none"> <li>● Read a real INAM forecast/SMS alert.</li> <li>● Interpret key terms in pairs.</li> <li>● Identify one risk for their crop or processing.</li> <li>● Share quick answers in plenary.</li> </ul>
2.	60 min	Applying Forecasts to Food-Processing Decisions: Small-group scenario work: Processing decisions under different forecast conditions.	<ul style="list-style-type: none"> <li>● Provide short scenarios based on the chapter: e.g., Scenario A: High humidity forecast.</li> </ul>	<ul style="list-style-type: none"> <li>● Work in small groups on a forecast scenario.</li> <li>● Decide the correct drying/storage/harvest actions.</li> <li>● Justify choices using the forecast.</li> <li>● Present their solution briefly.</li> </ul>
3.	45–60 min	Mini Field Demo: Drying & Storage Risk Check: Mini demonstration (on-site or simulated): Assessing a	<ul style="list-style-type: none"> <li>● Set up two simple stations: <b>Station 1</b> (open-air drying table) &amp;</li> </ul>	<ul style="list-style-type: none"> <li>● Rotate between demo stations (open-air vs. covered drying; sealed storage).</li> </ul>

		drying or storage setup based on forecast conditions.	<b>Station 2</b> (covered/solar dryer or sealed storage → PICS bag)	<ul style="list-style-type: none"> <li>● Assess which setup fits the given forecast.</li> <li>● Spot weaknesses and propose fixes.</li> <li>● Discuss why their adjustments reduce losses.</li> </ul>
<p><b>Materials (What trainers need to have prepared):</b></p> <ul style="list-style-type: none"> <li>● Copies (printed or digital) of an <b>INAM seasonal forecast</b> or sample SMS alert.</li> <li>● Smartphone with <b>weather/EWS apps</b> for demonstration.</li> <li>● Simple <b>scenario cards</b> (high humidity, cyclone alert, prolonged dry season, etc.).</li> <li>● Two mini demo setups: <b>open-air drying surface</b> and <b>covered/solar dryer or sealed storage (PICS bag)</b>.</li> <li>● Flipchart or small whiteboard + markers.</li> <li>● Basic <b>handouts</b> summarising forecast vocabulary and decision examples.</li> <li>● Access to <b>WhatsApp group</b> (or mock-up) for digital communication practice.</li> </ul>				
<p><b>Other notes:</b></p> <ul style="list-style-type: none"> <li>● Keep examples <b>Mozambique-specific</b> (cassava, fish drying, maize storage).</li> <li>● Use <b>local languages</b> (Emakhuwa, Sena, Changana) where needed for clarity.</li> <li>● Prioritise <b>practical decisions</b> over theory; avoid overloading learners with technical meteorology.</li> <li>● Ensure all activities reinforce <b>digital skills</b> (using alerts), <b>green skills</b> (climate resilience), and <b>transversal skills</b> (problem-solving, collaboration).</li> <li>● Adapt the field demo to whatever simple materials are available – the goal is decision-making, not equipment quality.</li> </ul>				

## PART 3 – ACTIVITY GUIDE

### DESCRIPTION OF THE ACTIVITIES

#### 1. Interpreting Seasonal Forecasts & Early-Warning Information

Learners are introduced to Mozambique’s seasonal forecasts and Early Warning Systems (INAM, MEWS). The trainer presents a simplified INAM seasonal climate

outlook and a sample SMS alert used in rural areas. A short demonstration of a mobile weather/EWS app shows how digital tools distribute climate information. Through guided questioning, learners interpret key forecast terms such as “above-normal rainfall,” “probability,” and “humidity outlook.”

In pairs, participants identify one likely risk for their crop or processing activity (e.g., mould risk for cassava chips, delays in fish drying). A short oral check confirms understanding before moving to decision-making tasks.

1. **Aim of the activity:** Develop basic knowledge of forecasts and build confidence in reading climate information for post-harvest decisions.
2. **Duration:** 45 min
3. **Materials required:**
  - INAM forecast printouts/digital slides
  - Sample SMS alert
  - Mobile app demo
  - Flip-chart.
4. **Step-by-step instruction of the task/practical exercise/case study:**
  - Trainer introduces key forecast concepts and presents an INAM bulletin (10 min).
  - Short demo of an SMS alert / weather app (5 min).
  - Pair discussion interpreting forecast terms and identifying risks (20 min).
  - Short recap and oral comprehension check (10 min).

**References:** See INAM (2024); FEWS NET (2025); WFP (2022) for more information.

## 2. Using Forecasts for Food-Processing Decisions (Scenario Exercise)

Learners work in small groups on practical scenarios that reflect typical Mozambican conditions: high humidity forecast in coastal areas, a cyclone alert affecting storage sites, or prolonged dry-season conditions that affect cleaning and cooling processes. Each group receives one scenario card and must decide how to adjust their processing plan—shifting drying dates, choosing covered solar dryers, using sealed storage, or relocating stock.

Groups justify their decisions using the forecast information provided. The trainer circulates, challenges weak reasoning, and pushes learners to connect decisions to specific climate risks. Groups present their solutions in a short pitch.

1. **Aim of the activity:** Strengthen problem-solving and application of climate information to real drying, storage, and harvesting decisions.
2. **Duration:** 60 min
3. **Materials required:**
  - Scenario cards
  - Flip-chart paper
  - Markers.
4. **Step-by-step instruction of the task/practical exercise/case study:**
  - The trainer explains tasks and distributes scenarios (10 min): Clarify expected outputs: drying plan, storage plan, timing/harvest adjustment, risk mitigation.
  - Groups analyse their scenario and prepare an action plan (30 min).
  - Group presentations and trainer feedback (20 min).

**References:** See FAO (2021); World Bank (2021); IIAM (2020) in the reference list for more details.

### **3. Mini Field Demo: Evaluating Drying & Storage Options Under Forecast Conditions**

The trainer sets up two simple stations replicating typical Mozambican post-harvest conditions: an open-air drying surface and a covered/solar dryer or sealed storage option (e.g., PICS bags). Learners receive a short “forecast of the week” (real or simulated) and rotate between the stations. At each station, they assess how the expected conditions (high humidity, possible rains, cyclone risk, or cooler temperatures) would affect the quality and safety of products such as cassava chips, maize, beans, or smoked fish. Participants propose quick improvements (e.g., using sealed bags, elevating storage, accelerating drying, relocating stock). A brief plenary discussion connects observations to climate resilience and loss reduction.

1. **Aim of the activity :** Build practical understanding of how forecast information translates into physical adjustments to drying and storage systems.
2. **Duration:** 45–60 min
3. **Materials required:**
  - Open-air drying table
  - Covered/solar dryer
  - Sealed storage bag (PICS)
  - Printed forecast

- Markers.

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

- The trainer explains forecast conditions and demo stations (10 min).
- Participants rotate, inspect setups, and identify risks (20–30 min).
- Group discussion on improvements and link to climate resilience (15–20 min).

**References:** See FAO (2021); INAM (2024); IIAM (2020) in the reference list for more details.