GEAVET TRAINING PROGRAMME FOR CSA

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

MOZAMBIQUE

UNIT I.3 SILAGE AND HAY PRODUCTION

ENGLISH VERSION

GEAVET Project n° 101129027

Open Educational Resources

PART I – LEARNING MATERIAL

1. Introduction

Silage and hay are both methods for preserving forage for animal feed, but differ in moisture content and preservation process. Hay involves cutting and drying forage until it is very dry (10-15% moisture) and then baling it, while silage preserves forage at a higher moisture level (65-70%) by chopping it and storing it anaerobically (without oxygen) to undergo fermentation. Hay requires more sun-drying time, while silage production is often faster and can result in higher nutritional value because the crop is harvested at a less mature stage.

2. Definition and Importance of Hay and Silage Production

Hay and silage are the key components of sustainable livestock farming systems: both are essential methods of preserving animal feed to ensure a reliable supply of nutritious forage throughout the year, in particular when the fresh forage is scarce, such as during dry periods and droughts.

Hay is made by cutting and drying grasses or legumes until their moisture content is low enough to prevent spoilage (less than 15% of moisture) and is stored in well-ventilated and dry environments. In contrast to hay, silage is the product obtained from wet storage - produced by fermenting green forage (such as maize, sorghum, or grasses) in airtight (anaerobic) conditions to retain nutrients and energy (FAO, 2013). Both techniques contribute to climate-smart livestock production by ensuring year-round feed availability, reducing pasture degradation, and minimizing post-harvest losses of fodder (FAO, 2021).

In Mozambique and other Southern African countries, smallholder farmers commonly use maize stalks, Napier grass, or sorghum for silage and Rhodes or star grass for hay. Farmers who adopt these methods can sustain dairy or beef production even during long dry periods, improving income and food security (IIAM, 2020).

3. Role in Sustainable and Climate-Smart Agriculture (CSA)

Hay and silage production play a vital role in **Climate-Smart Agriculture (CSA)** and **Conservation Agriculture** for Livestock Systems, contributing to the three pillars of sustainability.

Environmental sustainability is enhanced because stored forage prevents overgrazing, enabling livestock to rely less on natural pastures during dry seasons and reducing land degradation. Properly prepared silage also lowers greenhouse gas emissions by preventing waste and limiting methane release from decaying plant material. Additionally, using crop residues such as maize stalks or sugarcane tops for silage instead of burning them reduces carbon emissions.

Economic sustainability is strengthened through a stable feed supply that reduces dependence on commercial feeds. Farmers can add value by selling surplus hay or silage to neighbors or cooperatives, while the processes of hay baling and silage packing generate small-scale agribusiness opportunities, particularly for youth.

Social sustainability improves as well: reliable feed leads to healthier livestock, which enhances food security through increased milk and meat production. Women, who often take the lead in fodder collection and processing, gain stronger roles in livestock value chains. Community collaboration also grows through cooperative haymaking groups that promote knowledge sharing.

4. Key Concepts

4.1. Silage

- **Definition:** Fermented, high-moisture feed stored in airtight (anaerobic) conditions.
- **Ideal Moisture Content:** 60–70%.
- **Common Crops:** Maize, sorghum, Napier grass, sugarcane tops, legumes.
- **Storage Methods:** Silos, pits, drums, or sealed plastic bags.
- **Fermentation Period:** 21–30 days.
- **Silage Nutrition**: High in energy (especially maize silage); moderate in protein (depends on the crop); highly digestible; suitable for high-producing animals.
- **Indicators of Good Silage:** Greenish-yellow color, pleasant smell (acidic), no mould.

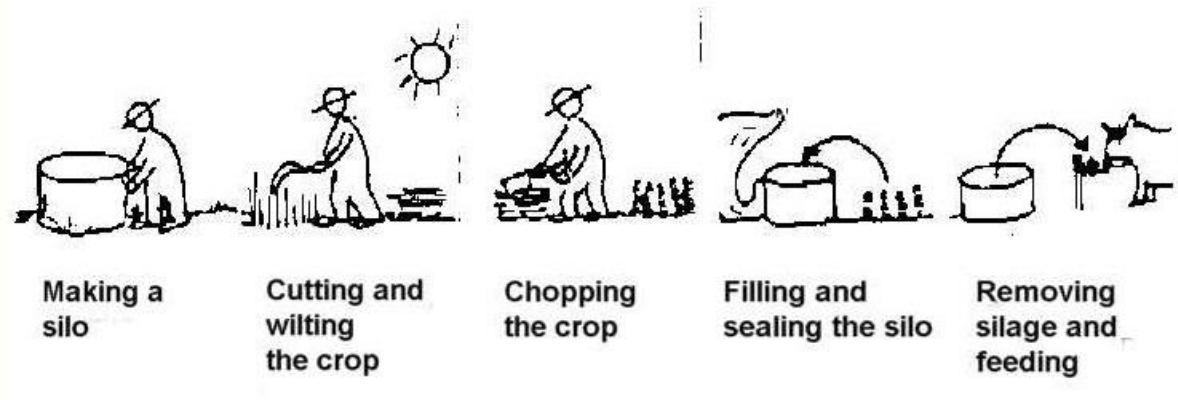

Figure 2. Small scale Silage making (FAO, n.d.)

4.2. Hay

- **Definition:** Dried grass or legume forage preserved by lowering moisture content.

- **Ideal Moisture Content:** Below 15%.
- **Common Crops:** Rhodes grass, star grass, lucerne, cowpea haulms.
- **Storage:** Stacked or baled in dry, ventilated sheds on raised platforms.
- **Hay Nutrition**: Lower in energy than silage; variable protein (lucerne high; grass hay low); good fiber source; safer for digestive systems
- **Indicators of Good Hay:** Green color, leafy, pleasant aroma, no dust or mould.

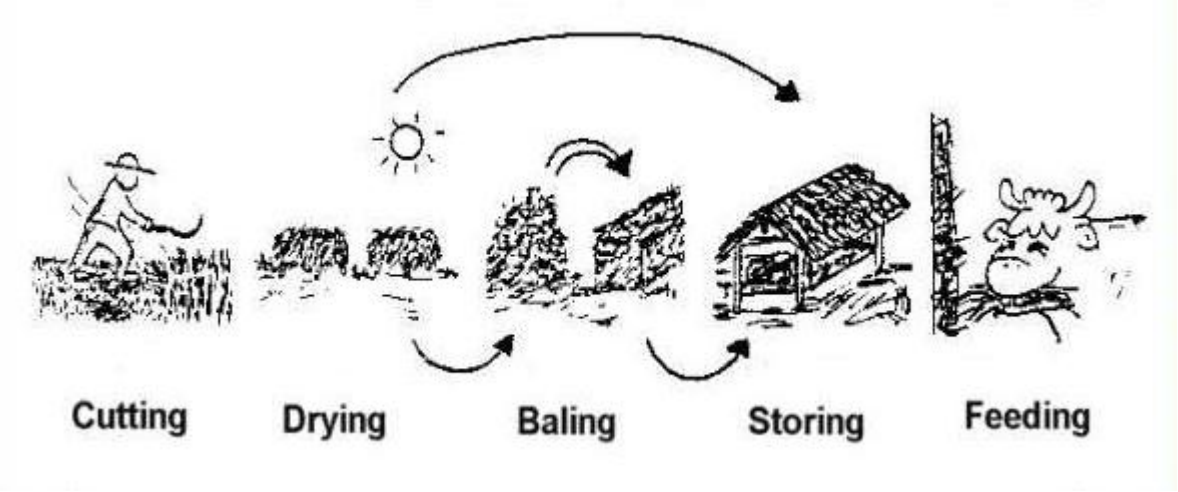

Figure 3. Small scale hay making (FAO, n.d.)

5. Differences Between Silage and Hay

Feature	Silage	Hay
Moisture	60–70% (High)	10–15% (Low)
Storage Condition	Airtight (anaerobic)	Dry and ventilated
Season of Use	Wet or dry season	Mostly dry season
Nutrient Retention	High energy; sugars preserved	Slight nutrient loss possible
Main Risk	Spoilage if air enters	Mould if not fully dried
Common Crops	Maize, Napier, sorghum	Rhodes grass, lucerne

6. Tools needed for Hay vs Tools needed for Silage Production

Hay and silage production require different tools at each stage of the process due to differences in moisture content and preservation methods.

In hay production, cutting is done using a mower or mower-conditioner, after which the forage must be dried in the field using tools such as a tedder and rake. The dried

forage is then gathered with a rake, processed using a baler, transported in wagons or trailers, and finally stored in a barn.

In contrast, silage production involves cutting forage at a higher moisture content, using either a mower or a forage harvester header. Drying is not required, as the forage is preserved through fermentation. The forage harvester both gathers and chops the material during processing. Chopped forage is transported using silage wagons or trucks and stored in airtight systems such as bunkers, bags, or silos to ensure proper fermentation and preservation.

7. Which Animals can eat Hay and which Silage?

Animal	**Silage**	**Hay**
Cattle	Excellent (most common users)	Excellent
Sheep	Good (can eat silage but must be high-quality and not mouldy)	Excellent
Goats	Moderate (must be clean)	Excellent
Horses	Not recommended (sensitive to botulism and mould; silage risk is higher than hay)	Best (hay is the safest and most common roughage)
Donkeys	Avoid (prone to colic; avoid silage)	Best
Rabbits	Very limited only (only limited amounts, very good quality – not common in practice)	Essential (hay is essential to their digestion and dental health)
Poultry	No (cannot digest it well)	Not useful
Pigs	Limited (can eat *some* silage (esp. maize silage) but it's not ideal as a major ration)	Not useful

8. Practical Examples

8.1. Example of Drum or Pit Silage Production

Materials:

- Freshly chopped maize, Napier, or sorghum
- Plastic drum or lined pit
- Molasses (1 L molasses in 10 L water per 100 kg forage)
- Stones or sandbags for sealing

Steps:

1. Chop forage into 3–5 cm pieces.
2. Fill the drum/pit in layers, sprinkling molasses solution.
3. Compact each layer to exclude air.
4. Seal tightly with plastic and soil.
5. Store for 21–30 days before opening.

Best Areas: Central and Northern Mozambique (Manica, Nampula).

8.2. Example of Traditional Haymaking

Materials:

- Mature grass (before flowering)
- Rakes or sticks
- Twine or baling wire
- Raised storage platform or shed

Steps:

1. Cut grass early morning after dew dries.
2. Spread evenly for 2–3 days under sun.
3. Turn grass regularly for uniform drying.
4. Bale or bundle manually.
5. Store off the ground under cover.

Best Areas: Southern provinces (Gaza, Inhambane).

9. Benefits of Hay and Silage Production

Both hay and silage offer significant benefits. **Agronomically and environmentally**, they reduce feed waste and post-harvest losses, improve nutrient recycling and soil fertility through use of crop residues, and prevent land degradation by easing pressure on grazing lands (Adesogan et al., 2025). **Economically**, they ensure continuous

livestock production throughout the year, stimulate local feed enterprises such as hay baling and silage bagging, and reduce expenditure on commercial feeds (FAO, 2019). **Socially**, hay and silage production support greater participation of women and youth in livestock value chains and encourage community cooperation through shared forage banks (Notenbaert et al., 2021).

10. Challenges and Solutions

Hay and silage production can face several challenges, but practical solutions can help reduce losses and improve feed quality.

Poor sealing or improper moisture management often leads to spoilage and nutrient loss; this challenge can be addressed through farmer training on airtight storage techniques and the use of moisture testing before storage (FAO, n.d.).

A lack of chopping tools limits efficient silage production, particularly for smallholder farmers. This can be overcome by introducing cooperative models or service providers that enable shared access to equipment such as balers and choppers, or by promoting the use of low-cost manual cutting tools (FAO, 2011).

Mould contamination is another common problem and can be minimized by ensuring proper drying during hay making and effective sealing during silage storage to support anaerobic fermentation.

Limited technical knowledge among farmers can be addressed through TVET demonstrations, mobile-based training videos, farmer field schools, and demonstration plots, which enhance skills transfer and adoption of best practices (FAO, 2014).

Additionally, unpredictable weather conditions can be managed by using official weather forecasts and alerts to guide optimal harvest timing and reduce weather-related losses (World Meteorological Organization (WMO), 2018).

11. References/Sources

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Food and Agriculture Organization of the United Nations (FAO). (2011). *Guide to good dairy farming practice*. FAO Animal Production and Health Guidelines.

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Food and Agriculture Organization of the United Nations (FAO). (2019). Developing sustainable value chains for small-scale livestock producers. edited by G. Leroy & M. Fernando. *FAO Animal Production and Health Guidelines no. 21*. Rome.

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Virginia Tech Cooperative Extension. (2025). Determining forage moisture concentration (Publication 442-106). *Virginia Polytechnic Institute and State University*. (https://www.pubs.ext.vt.edu/442/442-106/442-106.html)

World Meteorological Organization. (2018). *Guide to agricultural meteorological practices*. WMO.

PART 2 – CURRICULUM

Learning Objectives:

KNOWLEDGE	SKILLS	ATTITUDES
Student is able to: ● Define and differentiate between hay and silage. ● Identify suitable crops and conditions for hay/silage production. ● Explain the benefits of forage conservation in sustainable livestock systems.	*Student is able to:* ● Prepare silage using local materials (e.g., plastic drum). ● Prepare and dry hay correctly to prevent spoilage. ● Use mobile apps for harvest and feeding decisions.	*Student is able to:* ● Be responsible for reducing feed waste and protecting natural resources. ● Cooperate and be open to innovation in livestock feeding. ● Show Resilience and adaptability to climate variability.
TRANSVERSAL SKILLS INTEGRATED: ● **Critical Thinking:** Evaluation of crop moisture levels and decision on preservation methods. ● **Collaboration:** Work in teams during forage harvesting and preservation. ● **Problem Solving:** Identification of causes of spoilage and proposing corrective actions.		
DIGITAL SKILLS INTEGRATED: ● **ICT4Ag:** Use of digital tools for weather and feed planning. ● **Data Management:** Recording moisture content, feed volumes, and storage conditions. ● **Mobile-Based Advisory:** Use of mobile phones/tablets and available apps for agriculture/weather conditions		
GREEN SKILLS INTEGRATED: ● **Sustainable Resource Management:** Reduction of waste of crop residues. ● **Circular Economy Thinking:** Turning by-products (maize stalks) into valuable feed and reducing livestock feed imports		

- **Climate Adaptation:** Building drought resilience through stored feed reserves.

Implementation plan of pedagogical activities - Scheme of work

Duration: 3 hours				
Target: VET learners and smallholder livestock farmers				
No. of Activity	**Duration**	**Training Methods / Activity**	**What the trainers do**	**What the participants do**
1.	50 min	Interactive lecture + video + Q&A	● Explain core hay/silage principles ● Show short demo videos.	● Listen ● Discuss local practices ● Complete short quiz.
2.	55 min	Group planning and simulation	● Guide groups to design hay/silage preparation plans using mobile tools.	● Work in groups to plan, sketch, and record moisture targets.
3.	75 min	Practical demo + reflection	● Demonstrate drum silage and hay drying ● Guide reflection.	● Practice techniques ● Observe results ● Take photos ● Share lessons.

Materials (What trainers need to have prepared): ● Projector ● Video ● Flip-chart ● Markers ● Forage samples (grass, maize) ● Plastic drum ● Plastic sheet ● Twine ● Smartphone apps.
Other notes: ● If field is not available, use photo or video simulations.

PART 3 – ACTIVITY GUIDE

DESCRIPTION OF THE ACTIVITIES

1. Understanding Hay and Silage

Trainer introduces hay and silage concepts (check Learning material), showing a 3–4 min video ("Differences Between Hay and Silage in Animal Production (Livestock Feeding) - https://www.youtube.com/watch?v=yyfNG8LZhHI). Learners discuss local fodder practices and identify challenges. A short mobile quiz (Mentimeter) checks understanding.

1. **Aim of the activity:** Build foundational knowledge and differentiate between hay and silage systems.
2. **Duration:** 50 min
3. **Material required:**
    - Projector
    - Video - https://www.youtube.com/watch?v=yyfNG8LZhHI
    - Flip-chart
    - Markers
    - Mobile quiz
4. **Step-by-step instruction of the task/practical exercise/case study:**

➢ Introduction and key terms (10 min)

➢ Play video and highlight points (10 min)

- ➢ Guided discussion (20 min)
    - Ask: “What happens to your animals during dry seasons?”
    - Guide discussion toward *feed shortage* and *preservation solutions* (silage and hay).
- ➢ Quick quiz and summary (10 min)
    - Ask questions such as: What are the main differences between silage and hay?; Name suitable crops for silage and hay.; Why must silage be airtight?; Describe signs of good-quality hay.; How can poor storage affect feed quality? Which animals eat hay and which silage? Which tools are needed for hay and silage production?
    - A Mentimeter (https://www.mentimeter.com/) can be used as a tool for the short mobile quiz.

References/Sources/Further materials:

Video “Differences Between Hay and Silage in Animal Production [Livestock Feeding]” (https://www.youtube.com/watch?v=yyfNG8LZhHI)

Mentimeter (for quiz) - https://www.mentimeter.com/

2. Plan Your Forage Preservation System

Learners work in groups to design a forage preservation plan (either hay or silage) based on a given farm scenario—for example ”A smallholder farmer in Nampula owns 1 hectare of Napier grass and 2 dairy cows.” They decide when to harvest (based on crop growth and weather conditions), how to process (silage or hay; using locally available resources), and how to store the feed (using available materials, to ensure feed quality and minimize losses). Learners use weather apps or online climate tools (such as AccuWeather or The Weather Channel) to guide their decision-making, promoting data-driven planning.

1. **Aim of the activity**: Develop planning and decision-making skills using digital tools.
2. **Duration:** 55 min
3. **Material required:**

- Flip charts
- Markers
- Smartphone apps
- Moisture-meter (optional)

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

- The trainer explains the task (10 min)
    - Introduction (5 min): The trainer explains the purpose of the activity—planning forage preservation to ensure year-round feed supply. They review key decision points:
        - When to harvest (growth stage, weather conditions)
        - How to process (drying, chopping, use of molasses, etc.)
        - How and where to store (drums, pits, bales, sheds)
    - Scenario Assignment (5 min): The trainer presents 2–3 example scenarios (varying by crop type, herd size, or region). Each group selects or is assigned one scenario to plan for.
- Groups design plan (30 min): Learners work in groups of 4–6 to develop a forage preservation plan based on their scenario. Group tasks include:
    - Assessing forage type and yield (for example: estimating biomass from 1 ha of Napier).
    - Checking local weather data using smartphone apps such as AccuWeather or The Weather Channel to determine optimal harvest window (for example:, dry spell for hay or cooler period for silage).
    - Selecting preservation method (hay or silage) and justifying the choice.
    - Designing a step-by-step process for harvest, processing, and storage using local tools and materials.
    - Creating a simple sketch or flow chart on flip chart paper showing: timeline (harvest to storage), materials and equipment needed, key quality control points (moisture, compaction, sealing, etc.)
    - Estimating potential feed quantity and duration (for example: how many months of feed for 2 dairy cows).

  Trainer moves among groups, offering guidance, prompts, and feedback where needed.
- Presentation + peer review (15 min): Each group presents their forage preservation plan (3–4 minutes per group) using their flip chart. Peers provide feedback on:
    - Feasibility and realism of the plan.
    - Integration of weather data and local resources.
    - Sustainability and potential improvements.

  Trainer facilitates a short wrap-up discussion highlighting good practices and lessons learned.

References/Sources/Further materials:

AccuWeather (https://www.accuweather.com/)

The Weather Channel (https://weather.com/pt-MZ/clima/hoje/l/MZXX0003:1:MZ)

3. Practical Demonstration and Reflection

Trainer sets up two stations:

a) **Station A:** Silage making using a plastic drum.
b) **Station B:** Hay drying and baling using local grass.

Learners participate in both processes, take photos/videos, and reflect on feed preservation benefits.

1. **Aim of the activity:** Reinforce practical skills and promote reflection on sustainability.
2. **Duration:** 55 min
3. **Material required:**

- Fresh forage
- Drum/pit
- Molasses
- Twine
- Rake
- Shed or shade area.

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

➢ Trainer demonstrates process (15 min)

- Introduction: Trainer explains the importance of feed preservation—linking to seasonal feed shortages and sustainability benefits.
- Silage Demonstration:
  - Show chopping of green forage into small pieces.
  - Mix chopped forage with diluted molasses.
  - Compact and seal the forage tightly in the plastic drum to exclude air.
  - Explain the fermentation process and expected results.
- Hay Demonstration:
  - Show how to spread grass evenly in the sun or under shade.
  - Demonstrate turning with a rake to ensure uniform drying.

        - Once sufficiently dry, demonstrate simple hand baling and tying with twine.
        - Explain proper storage and moisture control.

- ➢ Group practical participation (30 min): Learners are divided into two groups, rotating between the two stations after 15 minutes.
    - At Station A (Silage Making):
        - Chop forage and mix with molasses.
        - Pack, press, and seal in the drum.
        - Label the drum and record observations (smell, texture, color)
    - At Station B (Hay Drying and Baling):
        - Spread and rake grass to promote drying.
        - Check dryness by touch and sound.
        - Form small hand bales and tie with twine.
        - Stack under the shade for curing.

  During both tasks, learners take photos or short clips to document steps and teamwork.
- ➢ Reflection discussion (15 min): Learners regroup with the trainer. Guided Reflection Questions:
    - What were the main differences between silage and hay in terms of process and preservation?
    - What challenges did you face in each method, and how might you solve them on-farm?
    - How do these practices support sustainability and climate resilience?
    - What did you learn about teamwork and resource use?

  Trainer summarizes key lessons and emphasizes feed preservation's role in ensuring year-round livestock productivity.

References/Sources/Further materials:

No specific references or further materials are required.