Forage conservation techniques: hay production and utilization

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Uganda Vision 2040 identified the dairy enterprise as one of the strategic agricultural commodities for the country that is to receive increased investment levels for accelerated production. The Ugandan dairy sector has developed rapidly during the last 10 years. The dairy enterprise is dominated by small-scale farmers owning more than 70 percent of the national cattle population and producing over 60% of the milk needed for the life of animals and humans in Uganda.

Small-scale dairy cattle production system plays a crucial role in food and income security in Uganda. More than 90 percent of the small-scale dairy cattle farmers in Uganda keep 1-10 cows but have little or no access to grazing land and they rely mainly on crop residues and natural or planted forages. This results into dairy cattle receiving sub-optimal level of nutrition especially during the dry periods.

**Fodder conservation**

Forages and crop residues are conserved in order to ensure continuous regular feed for livestock, either to sustain growth, fattening or milk production, or to continue production in difficult periods when market prices are highest. Conserved forages can take the form of *hay, haylage* and *silage*. On the demand side, it can be noted that there is a large demand for hay, silage and haylage by progressive smallholders and medium scale dairy farmers (10-30 cows). These farmers are engaged in commercial dairy production but are usually unable to grow and preserve sufficient quantities on-farm, due to lack of land size, skills and/or capital for mechanization. In general, commercial fodder production is growing – and it has potential to grow further with enhanced management skills and proper mechanization. The demand for hay, silage and haylage is high due to a commercializing and growing dairy sector in Uganda, but also due to land shortage, high costs of dairy meals and raw materials/feed ingredients imported from neighbouring countries. Sales prices of conserved forages are equally high, especially if considering the generally low quality of the products.

Farmers and large arable government farms could therefore produce hay, silage or haylage as a cash crop, while not keeping livestock themselves. Hay making as a service delivery is also an opportunity for investments by unemployed rural youth who loathe agriculture as a direct employment option. The youth need technical and entrepreneurial skills in the service provision.

**Commerciale pasture grass and/or legume hay production**

This article describes methods used to produce pasture grass and legume hay. A second article will describe methods used to produce haylage and silage cash crop enterprises. It is important, to keep this fact in mind “*At best, conserved forages can rarely match the nutritive value of fresh forage because some losses of highly digestible nutrients (sugar, protein, and fat) are unavoidable during conservation and storage*”. 
Important definitions

**Pastures** are grasses and legumes that are either native or introduced for cut and carry, grazing, and hay or silage crops. Pastures are the most important and cheapest source of feed for ruminant animals such as sheep, goats, cattle and goats.

**Forage** is a plant material eaten by grazing livestock. Forages are major source of fiber which cows need to stay healthy. Forages, especially legumes, provide lots of protein to livestock.

**Pasture legumes** are plants that form seeds in pods, like peas. They have broad leaves and colourful, prominent flowers. They ‘fix’ or make their own ‘fertilizer’ from nitrogen in the air. Generally, they are higher in protein than grasses. Examples of forage legumes are lablab and alfalfa.

**Pasture grass** plants typically have narrow leaves; hollow, jointed stems; and flowers at the top of the plant that become seed heads. Grasses are an excellent source of fiber for dairy cows.

**Hay** is “pasture grass or/and legume, or other herbaceous plants that have been cut, dried, and stored for use as animal fodder”. Farmers cut grasses and legumes in the field, let them dry, and then bale them for feeding at a later date. Hay production is the cheapest method of conserving forages to ensure year-round feed supply.

**Haylage** is simply forage that is baled at a higher moisture content than dry hay and then stored in a sealed plastic wrap. Because of the high moisture level and air-tight environment, the forage ferments and is preserved by acid production during fermentation.

**Silage** Farmers cut grasses and legumes, chop them while still moist, and put them in silos to ferment so they can be preserved (like the canned foods we eat).

When selecting a pasture conservation method, a farmer should consider the following:
- suitability of the forage for a given method,
- storage capability,
- weather conditions,
- the intended use of the conserved forage and,
- the selected conservation technique should maximize nutrient conservation
- efficiency and minimize production costs.

Impact of fodder conservation

(a) **Positive environmental impact**

- Grass-cutting generally promotes the maintenance of permanent grasses and forage legumes (elimination of refuse and some weeds). It improves the composition of pasture vegetation.
- Cutting grass reduces the possible risk of fire. It can be practiced on fire-breaks.
(b) **Negative environmental impact**

- Repeated cutting can make the pastures uniform and lead to reduction of botanic diversity.
- Removal of forage harvests entails a transfer of nutrients and decreases soil fertility if there is no compensation by the use of fertilizers.
- Intensive annual forage crops have the same environmental impacts as other intensive crops: risk of erosion, reduced retention of organic matter in the soil, leaching of fertilizing elements leading to water pollution.
- Cutting annual pastures promotes seasonal stripping of the soil and can promote wind erosion.

(c) **Impact on herd productivity (milk, reproduction, meat, health, etc.)**

- Improvement of meat production (hay), milk (silage), out of season, the season when prices are highest.
- Reduction of productivity loss (increase in birth-rate and reduction in mortality rate).

**Key steps in hay production**

1. **Visual assessment**

   Pasture grass or legume for hay production is cut when about 10% of the crop is flowering. At this stage, the plant has high energy, protein and sugars. Plants must have a high leaf-to-stem ratio. The more leaves the better because they are packed with nutrients.

2. **Cutting**

   Use sharp blades, like a sickle or a hand shear to cut the plants at least 1 cm above the ground. Cutting too low will affect the plant’s ability to regenerate.

A field of Rhodes grass (*Chloris gayana*) after cutting the fodder
3. **Drying**

Leave the harvested material in the field to dry for 2 to 3 days depending on the forage species. Hay production must therefore be done during the dry season to allow the forage to dry properly. Drying stops the plants’ chemical and biological activity and reduces the possibility of the hay going mouldy. The harvested forage can be hung in a well-ventilated moisture free structure to ensure quick drying in the absence of sufficient sunshine.

4. **Raking**

The dry grass or legume is raked into heaps. This helps to stop the dry grass from blowing around the field and means it is all lined up and ready for baling.

5. **Baling hay**

- Equipment used to bale hay

Care must be taken to ensure the leaves and stems remain intact and that the moisture in the hay is just right. If the grass has not dried out enough, it will turn into a hot compost heap that could start a fire. Baling can be done using:

(a) a simple modified manual hay baler;
(b) wooden bottomless hay baler for small quantities of hay
(c) tractor mounted with a baler.

(a) Simple modified manual hay baler

The simple modified manual hay baler was developed by the National Agricultural Research Organization (NARO) under the support of the World Bank.
Simple modified manual hay baler

Specifications

- The bailer box requires largely flat pieces of timber of 1 inch thick, but of varying lengths
- The box measures 0.6 x 0.6 metres, with a depth of 48cm
- Lever arm is 1.5 metres.
- Bolts are required - one for the pivot pin and the other to attach lever arm to the timber extending from the tamp
- Distance between the tramp and lever arm is 48cm

How a simple modified hay baler works

- Cut narrow slots in the middle of the top edge of each wall
• Insert twine into the notches and run the twine across the ground and out through the notch on the opposite side, leaving enough twine hanging out for cinching and tying once the bale has been compressed.
• Fill the box with hay that has been cut and dried
• Compress the hay using the lever and tramp
• Continue to refill the box and compress the hay until the bale is at desired tightness
• Lift up the tramp and tie off bale with the overhanging twine

(b) Wooden bottomless hay baler

A wooden bottomless hay baler has practical application whenever resource-poor farmers bale, transport, store and stall-feed bulky dry forages (grass and legume hays, fibrous crop residues such as maize and sorghum stove and; cereal straws), and bean haulms. The measurements for the wooden bottomless box are: 75 x 50 x 40 cm.

(c) Tractor mounted hay baler

Large scale commercial hay production can be done using tractor mounted hay balers.
Baling hay using a wooden baling box

This facility is available at the National Livestock Resources Research Institute (NaLIRRI) located in Busukuma sub-county, Wakiso district.

Baling hay

(a) Lay four sisal strings of about 10ft long at the bottom of the box with two strings across each facing side of the box meant for tying up the packed material.

(b) The dried fodder is placed in the hay bailing box. When the box is full, the fodder is thoroughly compacted until when no more dry fodder can be added into the box.
The hay is compacted in a hay baling box

(c) Tie grass hay with the sisal strings.

Farmers in Apac district tying hay during one of the farmer workshops

(d) Remove the bales from the baling box
The bales are removed from the baling box

(e) Transfer the bales into a hay barn where it’s kept until it’s utilized for livestock feeding

6. Storage of hay

Barn-stored and outdoor-stored hay are two ways to store hay bales for later use. Both have their advantages and disadvantages.

Advantages of indoor storage

- the hay usually has a higher nutritional value and a reduced percentage of spoilage compared to outside stored hay and, soil moisture and hay contact are reduced, as well as precipitation, to decrease spoilage.

Disadvantages for indoor storage

- storage space becomes limited, and
- careful storage of bales must be managed to prevent the bales' falling or exerting too much pressure on the sides of barns.

Advantages of storing hay bales outside

- increases the amount of storage space available.

Disadvantages of storing hay bales outside

- potential spoilage,
- excessive heat exposure,
- decreased nutritional value,
- bales stored outdoors should be placed on gravel or pallets,
• the outdoor sites should be in areas where there are no floodplains or standing water, as little shade as possible, and an open breeze. This allows for proper drainage, sunlight penetration, and airflow between the rows to facilitate drying.
• stacking of bales outside should be avoided unless the bales are covered securely.
• leaving hay bales uncovered will decrease the nutritional value of hay due to heat, moisture, and higher risk of spoilage.
• uncovered hay can lose 520% of its original weight to waste in just nine months.
• by elevating bales on gravel or pallets to reduce soil moisture/hay contact, loss can be reduced by 315%.
• If covered and elevated, the loss could be up to 24%, which is similar to barnstormed hay.
• enclosed barn hay losses are usually less than 2%

A simple rack constructed below the roof of a zero-grazing unit

The barn must be well ventilated to aid in further drying of the bales as well as to prevent accumulation of moisture that could lead to mould development on hay. The floor of the barn should consist of a raised perforated surface to allow air circulation under the bales.

Characteristics of good-quality hay

Good-quality hay should have the following characteristics:
• leafy and greenish in colour,
• has no foreign material mixed with it and,
• has no bad smell.

How do you feed grass hay to dairy cow?

1. Chop grass hay on a canvas or tarpaulin.
2. Mix chopped grass hay with 30 percent leguminous forages such as Gliricidia or Calliandra leaf hay to improve the protein content of the feed.
3. Mix molasses and water in a ratio 1:3 (molasses: water).
4. Sprinkle diluted molasses on chopped grass hay. Molasses improves palatability and acceptability of the feed by the animals. Salty water can be sprinkled in the absence of molasses.
5. Supplement the hay with a source of energy such as dairy meal or dairy pellets depending on their availability.
6. Intake of grass hay depends on the liveweight of the cow, quality of hay and whether or not grass hay is the only constituent in the diet. As a guideline, excluding wastage, the daily requirement of hay is about 3 percent of the animal’s body weight with at least 30% of the total intake being legume hay.
7. It is best to feed outside-stored bales within nine months after harvesting. An important key to reducing the weathering of a round bale is the tightness of the outer layer. The looser the outer layer, the more likely it is that the inner layer will become spoiled.
8. An easy way to check whether the outer layer is loose is to press the palm of the hand against the outside layer. If it moves more than half an inch, then the outer layer is too loose, and significant loss can be expected.

**Estimated cost of small-scale commercial grass hay production**

It is no secret that feed costs are a huge addition to dairy farm expenditures, and if you feed hay one of the main concerns is finding quality hay at a fair price. Is it more expensive to buy hay from another farmer, or to harvest your own off of your land? Many farmers in Uganda have adopted commercial forage conservation as a very profitable enterprise. What should be considered when calculating the cost to produce a bale of hay? To know what homegrown, harvested forage costs, a farmer needs to calculate the unit cost of production for the farm’s hay enterprise.

**Inputs in the cost of hay**

There are four basic concepts to remember when pricing a product or service:

1. The cost of production---this includes all inputs involving your production.
2. The prevailing market price-----ask around how is the other producer’s hay priced and what is the quality?
3. Produce what your customer wants-----make sure you produce the quality of hay your customer is looking for.
4. Sell quality products at reasonable prices and with quality service----what is the quality of the harvested hay? Does it have a good nutrient analysis, or does it contain too many undesirable weeds?

It can be a challenge to produce good quality hay as a cash crop and meet the four concepts when weather, pests, and other obstacles cause a reduction in quality, quantity, or both. When calculating the true cost of hay, it is important to add all farm expenditures related to hay production. This includes land, whether owned or rented. Any costs for establishing and maintaining a forage crop such as seed, fertilizer equipment, and labour are important. Maintenance machinery can be costly in itself. “Machinery costs can often account for as much as 50% of the annual cost of producing and harvesting a forage crop.” (Own or Custom Hire Hay Harvesting and Hauling).
The following inputs should be included when determining cost of producing hay:

1. Equipment (tractors):
   (a) Current market value and machinery depreciation
   (b) Annual repair costs
   (c) Management, labour, and fuel
   (d) Miscellaneous costs (hay wrap, twine, wire, etc)

2. Land preparation
   (a) Removing tree stumps, slashing and ploughing and disc harrowing.
   (b) Fertilizer application:
      (b) Soil analysis of fields; cost of fertilizers, fuel and labour to apply fertilizer
   (c) Planting and management:
      a. Cost of pasture (grass and legume) seeds; labour to plant, weed and harvest and dry the grass, and fuel to transport inputs
   (d) Harvesting and baling
      a. Cost of hay balers and sisal strings
      b. Labour to cut/harvest pastures, rake and dry pasture in the field and bale the hay.
      c. Labour and fuel to transport hay bales from the field for baling
   (e) Sample analysis
      a. Analysing hay samples for nutrient quality
      b. Cost of labelling hay
      c. Cost of production information material on the utilization of hay
   (f) Storage:
      a. Construction and repair of hay barn