Silage Production for Smallholder Livestock Farmers in South Africa

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1. Introduction

Forages lose their nutrients during the dry season or winter months and there will be less or no available forage for the grazing livestock during this period.

The price of commercial feed sources is quite high and mostly affordable to smallholder farmers. Hence, it is important to preserve forages for feeding of ruminants during the dry periods. The preservation of forages assists to improve fodder flow planning of the farm.

Common forage preservation methods include drying (such as hay making) and fermentation (such as silage making). Hay making is the most common method of forage preservation in South Africa. Although, silage making has long been practiced by the larger or commercial livestock producers with high producing animals such as dairy cows and beef cattle in a feedlot operation, it not widely practised in smallholder livestock production. It is therefore important to promote silage production as an additional and valuable feed source for smallholder livestock production.

This guideline provides a practical guide was co-developed through insights from on-farm participatory research and learning workshops on silage making with selected smallholders livestock farmers in South Africa.

2. Silage Production

2.1. What is Silage?

- Silage is an acid fermented feed that is produced under anaerobic conditions.
- The production of silage starts by harvesting a forage/crop that contains moisture of more than 60 %.
- The forage is chopped to particle size of less than 10 mm and put in a pit/bunker/container for compaction. The compaction is done to reduce space for the ingression of oxygen.
- After compaction, then the pit/bunker/container is tightly sealed to avoid the ingression of oxygen.

- The anaerobic condition in the pit/bunker/container will activate lactic acid bacteria (LAB) to consume water-soluble carbohydrates (WSC) in the forage and lactic acid will be produced.
- The presence of lactic acid in the forage will reduce the pH to lower than 4 depending on the type of forage ensiled.

2.2. Silage versus Hay

- In **hay making**, forages nutrients (e.g. protein) should be conserved before they decline in the plant. However, the forage is often too wet to dry successfully, and forage crops such as cereals (e.g. maize and sorghum) are too thick-stemmed to dry successfully and special machinery equipment are needed for making hay. Sometimes sun-drying of the forage can be employed to make hay, but this system is weather dependent. This makes hay making costly and may not be affordable to some farmers.
- However, in **silage making,** forage crops can be cut early and must have at least 30% dry matter to be ensiled successfully. There is no need to dry out the plant material any more than that, so wet weather is not such a constraint as it is with making hay. In this regard, silage is considered the better way to conserve forage crops.

2.3. Why is Silage Production Important for Smallholder Livestock Farmers?

Studies have documented that a good and well-prepared silage is very palatable and can be fed to livestock at any time. It can keep its nutrients for three to five years without deteriorating.

3. Ensiling Forages

3.1. Types of Forages that can be Ensiled

- Whole crop cereal grains (maize and sorghum): these forages are rich in water-soluble carbohydrates (WSC) and can be ensiled without additives.
- Legumous crops (e.g. lucerne, soybeans, etc): they contain low WSC and have high buffering capacity making it difficult to reduce silage pH to below 4. Sugarcane molasses can be added to increase the WSC and a microbial additive can be added

- High moisture agro-industrial by-products (e.g. food wastes, oil cakes, etc):

  These forages are by-products from food processing (e.g. potato wastes), fruit processors (e.g. juice or wine production) and oil extraction (e.g. oil cakes) which are high (> 60 %) moisture. Some of these forages (e.g. food wastes and oil cakes) are low in WSC content while those from the fruit processors are rich in WSC.

Figure1. Demonstration on shredding forage for ensiling

3.2. Forage Requirements for Ensiling

- Silage is made from low dry matter (< 30 %) forages. We don't ensile dry forages!
  - Must contain at least 6 to 12 % soluble sugar. Sugarcane molasses can be added at 3 – 5 % of the total mass
  - low buffering capacity. Legumes (e.g. lucerne) difficult to ensile
  - 5 – 10 mm chop length
- Fodder with high sugar content, will conserve well; whilst fodder with low sugar content is more likely to rot than ferment.
- Many crop residues lose much of their soluble carbohydrates during the final stages of grain ripening, and while the residue is left to dry in the field.
- The drier the silage, the more dry matter is packed into a given volume but the more susceptible is to air movement and dry matter losses;
- Densities also tend to decrease as particle size increases.

Figure2. Farmers filling the silage bag with forage

3.3. Using a Plastic Bag for Silage Making

- Emerging livestock farmers are lacking with space to dig bunkers/pit for making silage, hence the plastic bags are preferred to make silage. A well graded and well drained ground surface is all that is necessary to place the plastic bags.

- The quality of bags used is important. Select a strong, high density plastic bags (900mm x 1200mm; 240 L capacity; 18 microns) with a capacity from 5 - 15 kg of fresh chopped green fodder. High rather than low-density plastic reduces the potential for tearing.

- Bags with no obvious holes can be purchased in packs from ten to hundred. If holes are present along the seal, sticky tape or tar/mastic may be used to repair seals as the bags are tied. The seal must be without holes and this may relate to factory practice.
- Inner bags (if more bags are used) also tend to get damaged, but thicker bags are always less damaged to the extent that two rather than three layers of bags are sufficient.
- Plastic fertilizer bags make very good silos. The fertilizer bag will last for at last three seasons.

3.4. Filling the Plastic Bag during Silage Making

- Do not allow the feed to become contaminated with dirt;
- Ensile at proper maturity and moisture (58% - 68%); If moisture levels are higher, reduce the packing pressure to avoid creating mushy, silage, or better yet, wait until the forage is drier; If moisture levels slip below 65%, increasing the packing pressure can help;

Figure 3.: Silage Plastic Bags

- Pack the bag immediately after filling: this will limit chances of ingression by oxygen.
- Fill rapidly and pack uniformly. Each bag should be filled in one or two hours at maximum. This is needed to maintain forage consistency.
- The silage must be packed as densely as possible, to avoid air pockets that can interfere with proper fermentation. Air pockets can develop more frequently when longer chop lengths are used.
- Monitor particle length. A shorter chop length of 3/8-cm will pack better but may not retain enough physical fibre for the ration.

- The fodder can be hand chopped or chopped through a cutter. 10 – 80 kg of chopped green fodder is carefully packed into a bag,
- To avoid making any holes in the bag; the bag is gently but firmly squeezed by hand to expel air, and while compressed, the bag is closed.
- Packing the silage bag correctly is the most important factor that will affect silage quality. Therefore, the following recommendations should be followed when selecting the packing materials.

3.5. Sealing the Plastic Bag during Silage Making

- If bags are used, leaning heavily on the forage material in the bag then tying the remaining plastic as close to the material as possible and as tightly as possible, will compact the silage and then seal it from air. Make sure there is enough plastic to tie, up, so that it does not come free from the twine.
- Tobacco twine or hay baling twine is best for tying up the bag and it should be twined around the top of the bag several times to ensure the bag is completely sealed. Remember to seal tightly. Several methods can be used to seal the bags:
- For larger bags. Stretch the remaining plastic as far as it will reach, then place a wooden board on the plastic and wrap it around the board back toward the bag, like re-sealing a bag of potato chips; for smaller bags, the neck of the bag was twisted then turned over and tied with twine.
- You can also practice nailing of wooden boards to the one used to wrap the end of the plastic bag. Just roll the board and plastic two or three times and place a second board on the top. Nail the two boards together slightly alternating the angle of the nails.

Figure 4.: Compaction of forage in drums

- Sometimes the plastic bag can be filled in 210L drums. The drums help to prevent rodents from damaging the bags
- Things to avoid when making silage:
  - Don’t take a break to fill a bunker during compaction
  - Using leaking bunkers
  - Contaminated tools

3.6. Advantages of Using Plastic Bags for Silage Making

- Plastics silage bags are an economical alternative to traditional silage storage systems, such as pits and silos when related, harvest and storage losses are considered.
- It is an effective way for preserving feed with minimum nutrient loss. The anaerobic environment that is created eliminates spoilage from the growth of yeasts, molds and adverse bacteria while maintaining essential proteins and allows farmers to store silage anywhere they need it.
- The silage is completely sealed in the bag. This means that all the acid is retained in the silage, unlike that in pit silage when it seeps out through the bottom of the pit as effluent. This compensates for the longer pieces of forage and poorer compaction than that found with silage machinery, so that the quality of the silage is just as good.
- Ensiling in a bag avoids the hard work of having to remove silage, as it has to be from a pit, when it has to be dug out every day. The bag is easily stored and easily portable so that any member of the family can carry it to the feed trough for the cow.
- Because the whole bag is fed out to the animal, it means the rest of the silage which is in the other bags is not exposed to air at removal and is therefore unspoiled.
- Much of the silage in bunkers has been found to be spoiled due to poor sealing and exposure to air every day when the silage is removed for feeding.

4. Making Silage from Grasses Mowed/harvested at Stadium/Agri-parks

- Mowed/harvested grasses from stadium/agri-parks contain valuable nutrients (protein, fibre, minerals, etc) that can benefit animal production.
- These grasses are fertilized and irrigated, making them good protein sources.

Figure 5.: Mowing grass at the park

- These grasses have a high buffering capacity, which prevent a fast reduction of pH during ensiling Mowing these grasses with a lawn mower result in grasses of smaller particles (less than 3 cm), which is good for compaction.

Figure 6.: Loaded mowed grass

- Freshly mowed grass can be wilted for 24hrs to achieve DM of 30-40 %
- These grasses are low in soluble sugars for efficient fermentation during ensiling.
- The addition of sugar cane molasses at 3 to 5% of the biomass is recommended.
- Molasses syrup can be mixed with water at 1:3

5. Making Silage from Maize Stalks

- Maize stalk is the standing crop which is available after the harvest of maize cobs
- This crop contains dry matter of less than 30 % and low in soluble sugars, rich in fibre and low in energy and crude protein
- Should be chopped with a cutter to smaller particle size
- Sugarcane molasses can be added for ensiling maize.

Figure 7.: Chopping maize stalks

Figure 8.: Compaction of maize stalks

6. Advantages and Disadvantages of Silage Production

6.1. Advantages:

- Stabile composition of the feed (silage) for a longer period (up to 5 years).

- Plants can be harvested at optimal phase of development and are efficiently used by livestock.
- Reduction of nutrient loses which in standard hay production may amount to 30% of the dry matter (in silage is usually below 10%).
- More economical use of plants with high yield of green mass.
- Better use of the land with 2-3 crops annually.
- Silage is produced in both cold and cloudy weather.
- The fermentation in silage reduces harmful nitrates accumulated in plants during droughts and in over-fertilized crops.
- Allows by-products (from sugar beet processing, maize straw, etc.) to be optimally used.
- Requires 10 times less storage space compared to hay.
- Maize silage has 30-50% higher nutritive value compared to maize grain and maize straw.
- 2 kg of silage (70% moisture) has the equal nutritive value of 1 kg of hay.

6.2. Disadvantages

- Silage is not interesting for marketing as its value is difficult to be determined.
- It does not allow longer transportation.
- The weight increases manipulation costs.
- Has considerably lower vitamin D content compared to hay.