Animal Production and Technology

Forage and Fodder Conservation

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In a country were there is a strong seasonal rainfall; all year-round animal production is only possible if high quality fodder available in the rainy season can be conserved for use during the dry season.

Benefits of conserved fodders are that they provide

- Bulk roughages even in non growing season
- Roughage of high quality even out of season
- Cheapest form of feed after grazing
- Fodder bank against times of deficient

Conserved Fodder Types

Hay- fodder cut fresh, air dried and normally baled and stacked

Dried fodder- fodder cut fresh, forced dried in a drier and often milled and pelleted

Silage- material produced by fermentation of crop of high moisture content

Silage

Silage is best described as a product of controlled anaerobic fermentation of a crop or fodder plant of high moisture content for the purpose of preserving nutrient value of the plant for livestock. Preserving of nutrients is done by limited respiration a quick formation of correct organic acids to limit fungus and undesirable bacteria. Ensilage is the name given to the process and the container if used is called a silo.

Suitable Crops

The ideal plants for silage making are those that

- High dry matter yields
- Low dry matter content (20 to 35%)
- High soluble carbohydrate to (ensure there is adequate dry matter to ferment
- High nutritive value and palatability
In Zimbabwe the main species used are grasses i.e. maize, sorghum, star grass, Kikuyu, bana grass, rye grass and legume i.e. sun hemp, soyabeans, lablab, cow pea velvet bean and Kenya white clover.

Grass silages tend to have lower protein content that that of legume silages. In order to improve protein content grass-legume mixed silages can be used.

**Silage Formation Process**

The silage crop should be cut and chopped into 12 to 20mm lengths, compressed and sealed. It is important to make sure that the crop is not too wet and is chopped to the right size as this improves silage formation and digestibility.

The most essential condition of the process is to anaerobic conditions necessary for fermentation as quickly as possible and this means excluding air, which contains oxygen from the material. This requires compacting and sealing material immediately and allowing the remaining oxygen to be consumed by plant respiratory enzymes. The end products of respiration are carbon dioxide and water with heat generated in the process. This phase in silage making should be completed as quickly as possible because the substrate for this process is carbohydrate material, which is reduced to its basic elements and lost. If too much heat is generated plant protein will be denatured and lose quality.

As plant respiration ceases microbial activity increases and fermentation of plant sugars get underway. This produces organic acids especially lactic acid, which caused a decline in pH and enhances preservation of nutrients. It is important to get a drop in pH as quickly as possible; this depends largely on plant material, cop length, moisture content and speed of compaction and sealing. It also depends on amount of available sugars. For best results pH should fall to below 4.5. Low pH also inhibits development of harmful bacteria that is also present at ensiling.

The crop should be about 30% dry matter and chopped to about 20mm length. Chopping the crops improves the fermentation releasing sugars in the pant and enables better compaction in the silo with more effective exclusion of air. A clean chop is recommended instead of shredding the crop.

Lower dry matter of the crop results in lower pH required for effective preservation, as harmful bacteria thrive under high moisture conditions while lactic acid bacteria are more tolerant to drier conditions. Proper compaction is necessary to drive out air and reduce the respiration phase. Rapid compaction also reduces development of moulds. Once sealed the silo should sealed with
polythene sheeting and covered with soil. The silo can be left indefinitely provided it is properly sealed and that no rainfall infiltrates into the silo.

Silage should be ready for feeding 4 to 6 weeks after it is made.

**Phases of silage fermentation**

- After cutting, the fresh material is chopped into pieces of length 1-3cm, compacted and well sealed

**Phase 1 - Aerobic phase**

- Begins from the time of harvesting the crop to the time oxygen is depleted from the sealed silo
- Phase is short (only a few hrs ideally)
- Key to minimum nutrient loss in this phase include: Harvesting at the correct plant maturity, chopping to the right particle length, packing the silo tightly, and sealing within short period of harvesting

**Aerobic phase – practical aspects**

- Harvesting at the correct plant maturity: Ideally, 30-35% DM for horizontal silos, 32 – 37% DM for conventional tower silos, 40 - 45%DM for limited-oxygen silo, and 35% for silo bags
- Chop material as short as possible (1-3cm)
- Fill storage within 1-2 days
- Compact container well, fingers cannot be inserted in compacted material and seal container airtight
- Weight top of stack to maintain airtight seal between cover and compacted forage
- Sealing should be done as soon as possible after harvesting is complete

**Biological activity in phase 1**

- Nutrient losses due to degradation of plant proteins & conversion of sugars into CO2 & H2O by enzymes & aerobic bacteria & continued respiration
- Generated heat increases silage temp by 8 to 10 degrees
The phase progresses until oxygen is depleted

Phase 2 – Fermentation phase

- Starts when anaerobic bacteria begin to ferment plant sugars into organic acids, alcohols, carbon dioxide, and nitrogenous compounds
- Ends when all sugar is fermented
- Depending on properties of ensiled crop, the phase last from 3 days to 4 weeks
- The organic acids (due to activity of LAB) lower silage pH from above 6 to about between 3.5 and 4.5

Phase 2 – Practical aspects

- Lower pH is achieved with unwilted material, higher with wilted material
- Mix molasses (at 3 – 5% as is); molasses is a substrate for bacteria to encourage lactic acid fermentation
- If possible, forage should be wilted to about 30% DM - If silage pH drops slowly and the moisture concentration is high due to harvesting too early, clostridial bacteria may grow

Negative effects of Clostridial bacteria

- Degrade sugars and convert lactic acid to butyric acid, releasing strong offensive odours.
- Break down protein to non-protein nitrogen and undesirable end products like amines.
- Dry matter is lost and palatability and quality of the silage is reduced due to above mentioned changes

Phase 3 – stable phase

- Once pH has dropped, air and water is not permitted to enter storage, most microbes of phase 3 decrease in number, the growth of undesirable microbes is prevented and silage becomes stable
- Some acid-tolerant bacteria and some spore-forming Clostridia and Bacillus spp can survive

Phase 3 - Practical aspects

- Maintain airtight seal around silage
- Repair holes as soon as they are noticed
Phase 4 – Feed out phase or aerobic spoilage phase

- Phase begins after aerobic conditions are restored
- This happens when holes are made by mice, birds, other agents or the pit is uncovered for feeding out
- Rate of spoilage is highly dependent on numbers and activity of spoilage organisms

The two stages of phase 4

- After air penetration, yeasts & molds that were dormant during the fermentation are revived: Phase 4 occurs in 2 stages:
  - 1st stage involves rise in pH due to degradation of preserving organic acids by yeasts and occasionally, acetic acid bacteria
  - 2nd stage is associated with increase in temperature and activity by spoilage microbes such as bacilli, moulds and enterobacteria

Phase 4 - practical aspects

- Maintain airtight seal
- Feed out to ensure 20-30cm removal from entire silage face each day
- Whenever silage gets hot, increase rate of feeding the silage
- If silage heating occurs, consider making a smaller stack face during next harvest

Using maize for silage

- The presence of a dark colored layer at the base of the maize grain can be good indicator for the appropriate time of harvest for silage production.
- Once the first grains with dark layer are noticed, wait for 3-4 weeks more before harvesting, at this time the average dry matter contents of the maize plant is 30-35%

Harvesting maize for silage

- The whole maize plant should be harvested by cutting it 10 - 12 cm from the ground

Optimal length for cutting maize
Silo

Any container that can be properly sealed will serve as a silo. Traditionally silage is made in trenches, bunkers, plastic bags,

The site should be well drained and accessible. The sides should be smooth and sloped inwards to aid compaction. The floor should be smooth and slope slightly to allow drainage. The structure should be big enough to allow access to tractor and trailer.