Silage production

Silage is forage (e.g. pastures, cereals or legumes) cut at high moisture content (typically 40–70%) and stored in an oxygen free (anaerobic) environment. Anaerobic storage promotes fermentation and the production of lactic acid. A pH of 4.0–4.5 preserves the forage. Poorly fermented silage has lower nutrient value and palatability and produces unpleasant odours.

Principles for good silage

- High nutritive value forage should be used for silage making
- Do not use soil contaminated forage
- Forage should be chopped - pieces no longer than about 2 cm (< 1 inch) in length
- This will facilitate good compaction and reduce the amount of air in the silage.
- Expel the maximum amount of air within the forage before closing the silo, or sealing the bag, to avoid its re-entry and prevent water penetration.
- The silage making processes should be done in the shortest possible time.
- Not more than 16 hrs
- Avoid Re-entry of air during the feeding of the silage
- The area exposed to air should be as small as possible and
- The time between opening and finishing the silo as short as possible

Critical processes for good quality silage include

- Timing of harvest (stage of forage maturity, moisture content).
- Harvesting method (inoculants, grain conditioning, chop length).
- Filling, packing and sealing of silage storage system.
- Storage system management.

Design objectives

Silage storage systems should be designed and constructed to

- ✓ Be located in the controlled drainage area (CDA) of the feedlot and near the feed processing and preparation area.
- ✓ Provide sufficient slope to allow rainfall and silage effluent to drain away from the storage site.
- ✓ Be structurally sound and long lasting.
- ✓ Provide safe access for people and machinery during filing and removal.
- ✓ Provide an airtight storage system as quickly as possible after harvesting and ensiling.
- ✓ Maintain an airtight seal until feeding out starts.
- ✓ Provide sufficient storage capacity for expected feedlot demand, considering seasonal and regional availability and ability to maintain silage quality during storage.
- ✓ Promote sound economic inventory control.

Advantages of Silage Making

1. It makes it possible to increase the livestock carrying capacity of a farm

(a) Yields more total digestible nutrients per Acre than most other forage crops

(b) Has 30 to 50 % higher feeding value as silage then when fed as grain and Stover.

2. It retains a higher proportion of the nutrients of plants than can be accomplished by hay making, even if the weather is satisfactory for the latter, chiefly because shattering and bleaching losses are held to a minimum. Thus, ensiling grass preserves 85 % or more of the feed value of the crop, where as a hay making under the best of conditions will preserve only 80%, and under poor conditions only 50 to 60 %.

3. It is feasible to produce top quality hay crop silage during times of inclement weather when it would normally be impossible to cure the forage crop properly as hay

4. It is the most economical form in which the whole stalk of corn or sorghum can be processed and stored.

5. It requires less storage space per pound of dry matter than dry hay, even when the latter is baled or chopped. A cubic foot of silage or contains about 3 times more dry weight of feed than cubic feet of long hay stored in the mow.

6. It practically eliminates the danger of loss by fire if stored within the recommended moisture range.

7. It is the most satisfactory and economical way in which to preserve a number of by-product feeds.

8. It makes it possible to remove forage crop from the land earlier than would otherwise be possible.

9. It is one of the best methods of controlling the European corn borer since the removal of corn stalks is required in making silage.

10. It helps to control weeds, which are often spread through hay or fodder.

11. It is the cheapest from in which a good succulent winter feed can be provided on most farms.

12. It is a better source of protein and of certain vitamins, especially carotene, and perhaps some of the unknown factors, than dried forage.

13. It is a very palatable feed and slightly laxative in nature.

14. It makes for less waste, the entire plant being consumed, which is an important consideration with coarse, stemmy forages.

15. It may be completely mechanized as a feeding system, thereby eliminating much labor and time.

16. It offer many advantages over pasture, including

- no fencing required
- approximately one-third more forage from the same acreage
- harvesting at optimum maturity
- more uniform quality
- little or no bloat,
- closer observation of animal that are confined to a lot or corral
- reduced damage to the growing sward
- lessened topsoil loss as a result of alleviating the hoof action of grazing animals.

Some of the disadvantages are:

1. It requires a silo or storage structure and other special equipment, for best results. In comparison with the simpler methods of field curing and storing hay, this may mean higher costs for the small operator.

2. It contains considerably less vitamins D than sun-cured hay.

3. It necessitates that 2 to 3 time as much tonnage be handled as when the same forage is dried for hay, due to the high-water content.

4. It incurs an added expenditure when preservatives are necessary.

5. It lessens the amount of organic material returned to the soil, which is needed in some soil types.

Storage systems (Silo)

Silage can be stored above ground (horizontal or vertical), or in hillside pits (horizontal). The most common methods at a feedlot include hillside pits, above ground bunkers, in ground pits or trenches and stack and bale silage.

Above ground stack (bun)

Silage stacks are for short term storage. The silage is placed on top of the ground, then compacted and covered. As there are no side walls, the height of the stack is limited and the surface area to volume ratio is higher. The greater surface area increases potential spoilage.

Stacks should be located in an area with a slight slope for drainage and away from trees to minimise potential damage from falling limbs and birds. The stack width should fit the size of the plastic cover to be used. For example, a plastic cover of 13 x 33m will allow a pile width of 9–10m to be sealed by burying, or overlapping, the edges of the sheet.

Advantages

- No material construction costs.
- Easily sealed using a grader blade or front-end loader bucket.
- Removing silage from the face minimises loose silage, reducing air penetration into the bun.
- Size of bun can be adjusted to suit rate of feeding.
- Multiple separate buns can promote quality and better inventory control.

Disadvantages

- High surface area to volume ratio, thus larger area to cover and greater chance of surface spoilage.
- Can be a workplace health and safety issue for tractor operators during stack formation and compaction.
- Not suitable for long term storage, unless the cover is protected from sunlight exposure (UV degradation).

Hillside pits

Hillside pits are usually dug into the sides or tops of hills, or high embankments, with the ‘downhill’ end open for drainage and pit access. The surrounding earth provides the side walls of the storage. Earth walls should be sloped to prevent caving in and to enable adequate silage packing. Where soil is unstable, the walls may need to be lined with concrete or untreated timber. A convenient width for unloading with a tractor and front-end loader is 7m (small feedlot) to 15m (large feedlot).

Advantages

- Suitable for long- and short-term storage.
- Lower risk of water entry compared to in ground pits.
- Reduced area to cover compared to above ground storage with no walls.
- Can be replicated by sharing a common wall on either side.

Disadvantages

- Earth walls may become unstable if rocks or loose soil are encountered.
- Location must be planned to avoid problems with water run-off.
- Direct contact with soil generates risks of clostridia and mycotoxins.
- During unloading, any rocks picked up will damage feed mixing equipment

Bunker storage

Bunker storages are permanent structures constructed above ground and are commonly used in flat areas. Above ground walls are constructed using concrete, earth, steel or timber and braced with timber or concrete buttresses.

Timber contacting silage should not be treated with preservatives and silage acids will corrode concrete or steel over time. Round bales lined with plastic have also been used for bunker storage walls, but this is typically a temporary solution.

Bunker storages are rectangular in shape and are open at one or both ends. Most have earth floors, but concrete flooring provides all weather access. Bunker storages must have adequate drainage. The height and width of the structure will depend on the daily silage usage, based on the removal of the required amount of silage per day from the silage face. Generally, about 0.3-0.5m depth of silage needs to be removed from the face each time and the full face of the pit should be traversed every one or two days to minimise spoilage in the exposed face. The height of the silage in the pit should not be higher than the extended bucket of the front-end loader removing the silage in case the loader overturns, or gets buried if the silage face collapses.

Advantages

- Can be built in areas where the soil type is rocky or has a high-water table.
- Is reasonably inexpensive to construct (with earth floors).
- Can be replicated by sharing a common wall on either side.

Disadvantages

- Concrete floor bunkers are expensive to construct.
- Poor compaction, or an uneven surface, can lead to water pooling where the cover meets the side walls.
- Earth walls must have stable slopes.
- Requires regular maintenance (e.g. cleaning walls, weed control and re-surfacing the base).
- Losses or wastage from silage can be caught on walls.

Stretchable bag/bale storage

Stretchable bag/bale storage systems are typically temporary and used for making haylage (wilted forage that is stored at higher dry matter). The forage is compacted, as it is forced into a plastic cover, bag, wrap or tube which is then sealed to exclude oxygen to assist the fermentation process. These heavy weight plastic bags are available in various diameters and lengths and offer a range of storage capacities.

Advantages

- Greatest flexibility with the storage location.
- Low capital requirement.
- Low labour requirement.
- Stronger wrapping achieved, as the bales can be wrapped multiple times.
- Relatively small face is exposed when a bale(s) is retrieved, which reduces aerobic spoilage.

Disadvantages

- Specialised wrapping machine is required.
- Spoilage can be large if care is not taken to adequately seal out oxygen during the wrapping process and during storage.
- Not suitable for long term storage, unless the cover is protected from sunlight exposure (UV degradation) and predator damage.
- Disposal of used plastic may present problems.
- Preparation costs are high due to the cost of the plastic required to seal the forage.

Determining the size to build a silo

The size of silo to build should be determined by needs. With tower type and pit silos, this means

(1) The diameter should be determined by quantity of silage to be fed daily

(2) The height (depth in a pit silo) should be determined by the length of the silage feeding period. Similar consideration should be accorded trench silos.

I. The packing density of green fodder is 10-20 Kg/cubic feet depending on moisture and fibre content

II. ONE cubic feet area is for about 20 kg fodder storage (moisture >65%)

I. 40x10x5 ft silo is for 40 tonnes (40,000kg)

How to make good silage?

In addition to using a sound silo of proper size, those who make goo silage generally harvest at the proper stage of maturity, cut to proper length, control the moisture content, add an additive or preservative when needed, fill rapidly, distribute forage uniformly in the silo, and seal or top-off the silo.

Harvest at Proper Stage of Maturity

Harvesting at the proper stage of maturity assures the maximum yield and nutrient content. The black layer test can be applied quickly and easily to determine when to harvest corn for maximum yield and nutrient quality. Sorghum should be cut for silage when the seeds are hard. Grass silage forages (grasses, legumes, and cereal crops) should be cut at the same stage at which they would make the best hay.

Cut to Proper Length

The length of the cut sections affects the packing and hence, the quality of the silage. Also, the proper length of cut varies with the crop and the moisture content. Thus, for corn and sorghum crops, forage harvesters should be set to make a theoretical cut of ¼ to 3/8 inch. If the knives are sharp and set up to the cutter bar, this will result in about 15% of the particles being 1 ½ in, and over, 25% of the particles being ¾ to 1 ½ inch, and 60% being 1/8 to ¾ inch in length. Such a combination of particle size is necessary for high-quality feed. Grass silages should be more finely chopped than corn or sorghum silage. Also, wilted and dry forage and forage with hollow stems should be chopped more finely than forage of high moisture content, thus permitting more thorough packing and eliminating most air pockets.

Control the Moisture Content

Moisture content is one of the most important factors in determining quality of silage. Experimental work and practical experience have indicated that 60 to 67% is the best moisture content for most crops to be ensiled.

However, low-moisture silage of 40 to 60% moisture is now being preserved successfully in either oxygen-limiting silos, or tall conventional silos that are properly topped off with heavy, wet forage or sealed with a plastic cover.

Construction of Silage Bunker:

For construction of bunker, concrete floor is constructed which is kept 1 ft high in middle giving slope on both sides. On both sides of this floor, walls are constructed. For construction of wall 1.5 feet high base is constructed; width of first step of this base is kept 36 inches, width of second step is kept 30 inches and width of remaining step is kept 27 inches. On this base, construction of wall is started. Width of the end of wall attached is kept 27 inches and after this width is started reducing until it reaches 13 inches. Height of wall should be 6-7 inches. The width of bunker should be at least double

than the width of tractor. From front and back sides bunker should be open. Out of front and back side, concrete floor is constructed up to 15 feet.

Benefits to keep both sides open are:

- ✓ Due to slops on both sides, there is no danger of falling of tractor
- ✓ Due to lack of fear, driver is comfortable and compress fodder at corners
- ✓ Silage can be utilized from both sides
- ✓ When half of the bunker becomes empty, this space can be again filled for silage making, while prepared silage can be utilized from opposite side
- ✓ Expenditures of construction are reduced

Regarding the dimensions of bunker one formula should be kept in mind that one cubic fit space will be filled by 18-20 Kg fresh fodder i.e. bunker having 1 feet length, 1 feet width and 1 feet height will carry 18-20 feet fresh fodder. On this base we can say that a bunker having 75 feet length, 25 feet width and 7 feet height will carry 235-265-ton fresh fodder and silage prepared from this will be sufficient for 40-50 animals for 6 months.

The Ensiling Process

The ensiling process refers to the changes which take place when forage or feed with sufficient moisture to cause fermentation is stored in a silo in the absence of air. Many different kinds of pants and plant products can be preserved in this way. Sauerkraut, for example, is the silage form of cabbage. The ensiling process is governed by the interaction of three factors: (1) the chemical composition of the plant material placed in the silo, (2) the amount of air entrapped or allowed to enter the mass, and (3) the activity of the bacterial population.

The entire ensiling process requires 2 to 3 weeks, during which time the following phases of varying intensity occur:

- **Aerobic phase (with air)**: This is the respiration phase. In this phase, the living plant cells of the forage continue to respire, or take up oxygen, and the plant enzymes and aerobic bacteria use the readily available carbohydrates to produce heat, water, and carbon dioxide. The oxygen supply is usually exhausted in 4 to 5 hours, but carbon dioxide continues to accumulate for about 48 hours; the temperature of the ensiled material increases over a period of about 15 days, but seldom exceeds 85 to 90-degree F, and then decreases gradually. At this point, anaerobic conditions prevail.

• **Anaerobic phase (without air):** This is the “picking” phase. When the available oxygen of the entrapped air has been consumed, anaerobic bacteria – chiefly acid-forming and proteolytic – multiply at a prodigious rate. Simultaneously, the moulds and the yeasts die, but continue in a minor way to provide enzyme system which produce alcohol and other end products.

The combined anaerobic activity produces the following changes:

(a) The complex carbohydrates and sugars (especially the sugars) are broken down into lactic acid (the acid in sour milk), some acetic acid (the acid in vinegar), and a small amount of other acids and alcohols

(b) small quantities of the proteins are broken down into ammonia, amino acids, amines, and amides

(c) the acidity finally reaches a point when the bacteria themselves are killed, and the silage – making process in completed. At this stage, ideally the lactic acid concentration is equivalent to 4 to 10% of the dry matter.

• **Stable phase:** When a pH of 4.2 or less is reached3 silage is stable and may be kept for years if air is excluded. Drier silages stabilize at a higher pH.

• **Browning reaction/Maillard reaction:** lowering of the moisture content without excluding air may lead to undesirable effects on silage. It may cause high temperature in the silo and damage the protein and energy value of low-moisture silage as a result of the nonenzymatic browning reaction, also termed the Maillard reaction, convinced by a tobacco-brown or black colour and a caramelized or tobacco order. In this reaction, heat causes by carbohydrates to combine with protein to produce an insoluble product, decreasing the digestibility of both protein and energy sources. The loss of feeding value depends on the degree of the heat damage to protein can be assessed by determining the residual insoluble N in acid detergent fibre