Myths and facts of silage production and management

Silage is generally termed as green grass which is starch rich and subjected to a highly compressed and oxygen free environment. There has been a lot of awareness on the nutritional importance of silage by corporate organisations, co-operatives and government sectors.

In order to meet the forage requirements of animals, various state governments have combined with many corporate organisations to provide silage to farmers at a subsidised price.

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Silage making is considered an art and science that requires skilled expertise along with professional interference at certain control points of the process.

Silage production can be broadly divided into seven parts.

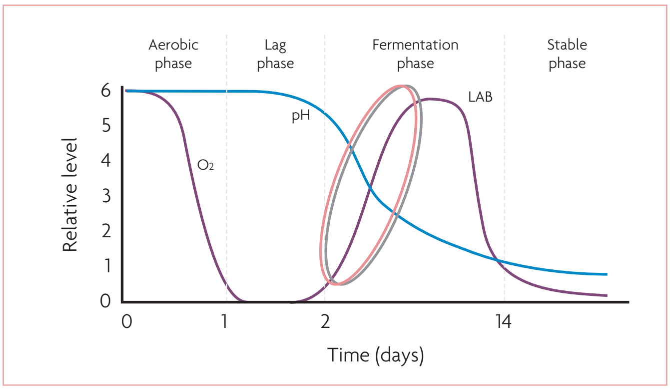

Fig. 1. Various phases of ensiling and the time period for each phase.

Procurement of the green

Corn silage is the majority crop chosen for making silage in India. Procurement is considered as one of the primary and most critical steps for making silage.

Many of the commercial silage makers as well as dairy farmers do not have the privilege of their own land to cultivate enough green for feeding their livestock throughout the year.

They usually depend upon the small and marginal farmers for procurement of the green.

In the majority of cases, dairy owners and silage manufacturers are unaware of the type of seed used for cultivation and other management practices needed for cultivation of the crop.

The irrigation patterns followed by most of the marginal and small-scale farmers are also not in sync with most of the packaging practices, leaving dairy farmers and silage manufacturers with very few options as they cannot procure greens from long distances.

There are basic criteria to follow when selecting the crop:

- Make a practical guess about the dry matter percentage.
- Look at the horizontal section of a few cobs to understand the quality of the crop. Look at a few cobs in a field (at least 10 cobs per acre) for a sample may be a practical approach to decide on the quality of the crop.
- Various steps to be checked on these control points are:
  - Select farmers close to the silage making unit or the dairy farm and provide them with the ideal seeds.
  - Provide training workshops for farmers on the various management practices of cultivating corn crops.
  - Visit the site frequently to check up on the irrigation patterns along with urea and other chemical applications.
- Estimate the right time for the harvest based on regular analysis of the samples for its matter, starch and energy content.
- Ensure the right forage to cob ration during selection of the crop. A rule of thumb rule is 50:50.
- Carry a microwave to know the exact dry matter percentage on the day of harvesting.
- Check the samples for Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Neutral Detergent Fibre Digestibility (NDFD) content before deciding on the crop to be selected.

Table 1. General recommendations for corn silage particle size distributions on the three sieves and bottom pan in the Penn State Particle Size Separator (Corn Silage Production and Management. Penn State Extension. Agronomy Facts 18).

Screen (inches)	(%)
Top (>0.75)	2-8
Second (0.31-0.75)	60-80
Third (0.31-0.46)	20-30
Bottom (<0.46)	1-4

Chopping the green fodder

Corn silage is chopped to improve silo preservation and enhance animal performance. The stage of maturity of the crop, as well as the dry matter of the crop, plays a crucial role during the chopping process.

If the crop is dry and matured, the starch content of the crop would be higher, but is inaccessible to the animals. If the crop has a lot of moisture, then the forage size can be very small.

For proper chop size and proper compression of the green fodder, the dry matter content and the cob maturity are very important.

This holds true even though some manufacturers have kernel processors installed in their facilities. A Penn State Particle Size Separator can be one of the tools to calibrate the chop size accordingly in the chaff cutters.

The Penn State Particle Size Separator can be used to estimate the particle size distributions for harvested corn silage. If the chopping size of the forage as well as the grain is optimal, then the chances for sorting are minimised.

Packing of the forage

This step in the process decides the fate of the silage after it is ensiled. The most desirable method of packing bunker silos is the progressive wedge method, where silage is continually packed on a 30-40% grade. This minimises the surface area exposed to the air that can result in dry matter and forage quality losses.

If this is not possible, the silos should be packed by spreading relatively thin layers of silage (six inches deep) and packing it well. If packed well, the silage density is usually 10-12kg per cubic feet as such and around 6.5kg per cubic feet in terms of dry matter.

The compression procedure must be made rapidly and accurately to prevent the formation of air pockets in the bunkers. The corners of the bunkers always need special attention as they are the major sources of nutrient losses in the silage.

It is always advised to pack a bunker within a day, however in certain cases where the bunkers are big and can be closed to prevent air entering the silage, it may be possible to extend past a day.

Inoculants and preservatives

Ensiling can be categorised into four stages:

- Pre seal.
- Active fermentation.
- Stable phase.
- Feed out.

Each stage is important and must be controlled properly for a certain period of time. In a case extension

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in a phase, the end product quality would be at stake.

During the pre-seal phase there is respiration by the plant material as well as microbes and this utilises most of the sugars and starch in the forages. Measures have to be taken to curb this stage early as it can lead to nutrient losses, less sugar availability for the microbes and increase the mould and yeast growths.

Proper packing and care must be taken to prevent oxygen from entering into the bunker. This process can increase the temperature of the bunkers from 45 to 48˚C which causes a reduction in digestibility. To avoid these losses, the silage making must be done at a faster rate and the silos must be closed within a day or preferably two.

The second step is the active fermentation. During this stage, plant enzymes and acetate producing bacteria compete with lactic acid bacteria inside the bunker where inoculants or preservatives play a major role. When a preservative is added to the forage, the pH declines rapidly giving the lactic acid bacteria a greater chance to multiply and produce good amount of lactic acid.

Inoculants are another set of products that can be added to enhance the anaerobic fermentation process. A combination of hetero-fermentative and homo-fermentative microbes could be used to improve silage quality. Initially, the hetero-fermentative lactobacillus bacteria are predominant.

These organisms remain active until the pH of the ensiled material drops below 5.0. As the pH of the ensiled forage reaches 5.0, the homo-fermentative lactobacillus become predominant. These bacteria are extremely acid tolerant and grow quickly. Since they produce only lactic acid, the silage pH drops more rapidly. The bacteria remain active until the silage reaches a stable pH of 4.0 or below, or until the fermentation sugars are depleted. So, when the natural population of lactobacillus is very low, acetic acid bacteria may proliferate. These bacteria are less desirable than lactobacillus

When lactic acid bacteria have used up all the sugar in the crop or when pH gets low enough to stop their growth (4.0-4.2 or lower), the stable phase begins. As long as the silo remains sealed and anaerobic, little biological activity occurs during this period. However, as oxygen slowly enters through silo walls and covers, this may cause the growth of yeasts, moulds, and aerobic bacteria at the exposed surfaces of silos. During this period, harmful bacteria such as listeria may develop in the silage which can be harmful to dairy animals.

The target values for corn silage are shown in Table 2.

Nutrient	Target value (%)	Reason
Dry matter (DM)	30-40	Excess or less can cause spoilage.
Crude protein (CP)	7-9	Indicates total amount of nitrogen in the silage. High protein is desirable.
Neutral detergent fibre (NDF)	35-55	NDF values are usually high for low grain silage and may depress dry matter intake.
Acid detergent fibre (ADF)	20-33	High ADF content indicates reduced digestibility.
Lignin	2.8-4.1	Lignin increases as the plant maturity increases the NDF content.
Non-fibrous carbohydrate (NFC)	23-43	High levels can reduce fibre digestion.
Starch	>28	Higher starch contents are always beneficial.
Sugar	8	The higher the sugar content, the greater the volatile fatty acids and greater reduction in pH.
Crude fat	2.8-3.8	Energy source.
TDN	67-74	Denotes the energy value.
ASH	<6%	Greater level of ash indicates presence of soil.
Lactic acid	>4%	The higher the lactic acid content, the better the fermentation.
Acetic acid	<3%	High levels indicate silage was not packed rapidly enough.
Butyric acid	<0.13	High values indicate high clostridial fermentation.
Lactic acid to acetic acid ratio	1.5-4	High ratio indicates effective fermentation.
Volatile fatty acid score	>8.0	High scores indicate beneficial aids predominant and adverse effects.

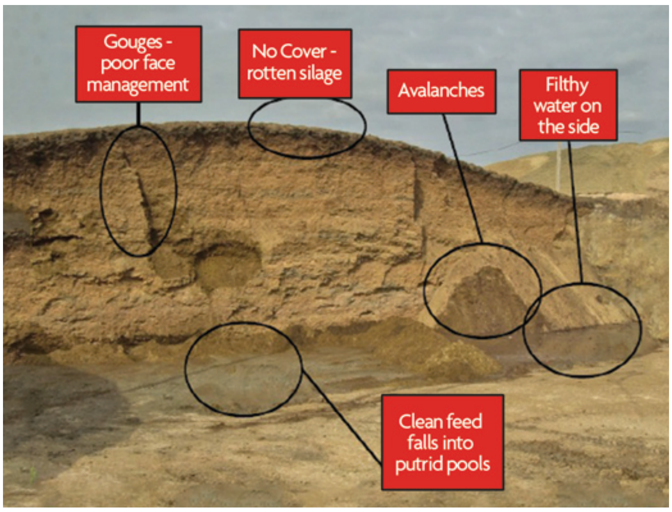
Table 2. Target values for corn silage (Mireille Chahine, Tianna E. Fife, Glenn Shewmaker).

Opening the bunker at the right time

Bunkers must be opened when the pH and temperature are optimal. There are chances of improper fermentation and rise in temperature when the bunkers are opened at an early stage, which makes the silage less palatable to the animals resulting in drastic digestibility reduction.

Feed out is very important in preventing nutrient losses and in maintaining the aerobic stability of the silage. Face management can help in improving the aerobic stability of the silage. It is advised to take out only the quantity of silage that is needed for a day and then close the bunker properly to prevent oxygen from entering the bunker. If face management is not properly followed, the pH of the exposed silage can go up to 7.0 with a lot of contamination from yeasts and moulds. It would be better to remove four to six inches of silage every day for feeding.

Fig. 2. Various flaws that can happen due to improper face management (Dr Whitney Rounds).



Aerobic stability and face management of silage

Aerobic stability can be defined as the amount of time that the silage remains cool and does not get rotten after exposing to air.

When proper precautions are used during silage making, there may be an improvement in the aerobic stability of the silage. Use of preservatives and inoculants can also help to improve aerobic stability by reducing the growth of yeast and other harmful bacteria in the silage.

Most importantly, the way we manage to remove the silage during feed out is a critical parameter for improving the aerobic stability of the silage. Face management of the silage bunkers is an extremely important step to prevent air entering the bunkers.

Silage must be sliced properly in the form of layers and the bunkers must be sealed every time the work is done. Use of appropriate equipment for taking out silage from bunkers is very essential.

Fig. 2 helps us understand the various mistakes commonly encountered due to improper face management of silage.

Summary

In recent times silage making has been considered an essential practice in many commercial farms with a herd size of more than 200 animals. Various small farmers are also being catered for by different silage manufacturers.

If the ensiling process is not proper, it may result in nutrient loss and economic loss to the farmers.

If silage is the major feed forage, care needs to be taken to improve the digestibility of the silage. Adding inoculants and preservatives is always beneficial for improving the overall quality of the silage through controlled fermentation.

Based on data from various studies it is always better to have an inoculant or a combination of organic acids added to silage to enhance the digestibility and reduce nutrient losses which can, in turn, provide a return on investment. ■

References are available from the author on request