Conservation of Forages for Commercial Livestock Production Operations: Silage and Hay Making

Why Adopt Forage Conservation?

Problems and Solutions: Pakistan Have Periods of

- Seasonal shortages (May-June & Dec - Feb.)
- Fodder surpluses (July-September & March-April) do occur.
  - The surplus fodder can be converted to hay/silage for utilization during feed scarcity periods.
- Silage may be defined as fermented forage plants. It is a very old method of preserving feed. Columbus found that the American Indians used pits or trenches in which to store their grain, and, centuries earlier in the Old world, silos were used as a means of preserving both grain and green forage. The Frenchman, Auguste Goffart, preserved forage in a silo in 1865. The discovery was so highly regarded that the French government awarded him the cross of the legion of Honor. The first tower silo built in the United States by white man is said to have been erected by F. Morris in Maryland in 1876.
- Silage making is one of the 3 common methods of utilizing forage crops, the other 2 methods being grazing and haying. Grazing is the least expensive of the 3 methods, but it is seasonal in nature. In the spring and early summer, forage plants generally grow faster than they can be utilized by normal grazing; and they become dormant in cold weather.
- The surplus forage produced during the growing season may be preserved for feeding during the winter months and other periods of pasture scarcity by haymaking. But weather conditions are not always favorable to haymaking. Ensiling, on the other hand, can be done in inclement weather. Also it has the added virtues of succulence and of preserving a higher proportion of the nutrients of the plant than can be accomplished in haymaking.
- Silage is primarily a beef and dairy feed, where it is used as part or the only roughage in the ration. It is also a good sheep feed. Very little silage is fed to horses.

ECONOMICS/ADVANTAGES/DISADVANTAGES OF SILAGE
Storing feed as silage often makes it possible to get more forage preserved from fewer acres. As a result, there is evidence that silage making in Pakistan is increasing.

Advantages of Silage Making
1. It makes it possible to increase the livestock carrying capacity of a farm or ranch. Thus, corn, the chief U.S. silage crop, (a) yields more total digestible nutrients per Acre than most other forage crops, and (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 haymaking 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 cornstalks 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 (a) no fencing required, (b) approximately one-third more forage from the same acreage, (c) harvesting at optimum maturity, (d) more uniform quality, (e) little or no bloat, (f) closer observation of animal that are confined to a lot or corral, (g) reduced damage to the growing sward, and, (h) 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.
Silage...factors to take into account before considering a silage making program:

- 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.

Silage---Principles for good silage

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Silage---Fodder Crops for Silage

There should be adequate amount of fermentable carbohydrates and more than 65% moisture in fodder selected for silage making. Commonly used fodder for silage making are maize, sorghum, sugarcane tops, mott grass, millet, oat, and sorghum sudan grass. Leguminous fodder crops can also be used for silage making but they contain fewer amounts of carbohydrates hence molasses or mineral have to be sprinkled over them at the time of silage making. Most of the time maize is used for silage making as maize silage is considered the best silage throughout the world.
Silage Making- Step # 1
1. Making a silo
   - Silo is a pit in a ground, trench or tower, bunker, where green fodder is stored as silage. It may be a plastic bag (small or large). The size and type of silo depends on
     - the number of animals,
     - quantity of available feed and
     - the period of feeding

Silos may be classified according to the five basic methods used for processing forages. Each method is associated with the shape and material of the structures, which also influences the efficiency of preserving the silage. Also, the different shaped structures are adapted to different methods of filling and unloading. Within each classification there are many variations of each type depending upon the manufacture. The kind of silo and the choice of construction should be determined primarily by economics and suitability to the particular needs of the farm.

I. Convention upright (tower) silos
II. Gastight (oxygen-limiting) silos
III. Pit silos
IV. Horizontal silos
   1. Trench silos (belowground level)
   2. Bunker silos (aboveground silos)
V. Temporary silos
   1. Enclosed stalk silos
   2. Open stalk silos
   3. Modified trench-stalk silos
   4. Plastic silos

**Conventional upright (tower) silos**
The upright or tower silo, which is sometimes referred to as the “watch tower of prosperity,” is the cylinder built aboveground. Its round shape with stand pressure well and is adapted to good packing.

**Gastight (oxygen-limiting) Silos**
These silos resemble conventional tower silos, but they are more expensive because of their construction.

**Pit silos**
The pit silo is shaped like the tower silo, but inverted into the ground. It resembles a well or cistern. The walls of a pit silo may or may not be lined. Where the water table is low enough that the silo will not fill with water, such as in semiarid areas, the pit silo is very satisfactory.

**Horizontal silos**
Only two types of horizontal silos will be discussed herein; trench silos and bunker silos (or horizontal surface silos), both of which may be adapted to self-feeding.

**Trench Silos**
The trench silo is a horizontal, trench like structure that can be built quickly and at low cost. It is most popular in areas where the weather is not too severe and where there is good drainage. The walls of a trench silo may or may not be lined, but for making good silage they should always be smooth; and there may or may not be a floor. A trench silo should be wider at the top than at the bottom, and the bottom should slope away from one end in order that excess juices will drain off if material with too high moisture content is ensiled.

Trench silos have the advantages of (1) low initial cost, (2) low cost of filling machinery, for a blower is not necessary, (3) relative freedom from freezing, and (4) ease of construction. The chief disadvantages of trench silos in comparison with tower silos are the (1) larger area to seal, (2) higher spoilage losses, and (3) inconvenience in feeding during inclement weather.

**Bunker or self – feeder silos**
As a labor saving measure, some operators are now constructing horizontal silos above ground (or slightly recessed) usually with concrete floors, and side walls of wood, concrete, or other materials – and self-feeding silage to cattle by making use of either a feeding fence or an electrified pipe suspended 30 to 48 in, from the floor of the silo.

**Plastic Silos**
Plastic (polyethylene) is now available for use as temporary silos and for use as covers for trench, bunker, and tower silos, and as silo liners. If not punctured, it is nearly airtight. Plastic thicknesses range form 4 to 9 mils. The thicker grades have better tear and puncture resistance, and low permeability by both air and moisture; however, they cost more and are difficult to tie tightly. Thinner grade plastics are less costly, more pliable, and easier to seal.

The two common types of plastic silos are: (1) enclosed plastic bag or tube silos, and (2) round bale plastic covered silage.

**Enclosed Plastic Bag or Tube Silos**
These temporary silos are made of heavy plastic in the form of a tube into which forage is forced by a special machine (much like stuffing sausage). The machine needed to pack the tube is generally rented or owned cooperatively. The filled structure is 8 ft in diameter and about 100 ft long. Preservation of silage is excellent provided the ends are kept sealed and the plastic is not torn or

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damaged by rodents or other animals. To remove or self-feed the silage, the plastic is cut and folded back at one end to expose as much silage as needed each day. The plastic cannot be re-used.

**Round Bale Plastic Covered Silage**

The most common methods for using plastic material to produce round bale silage are:

1. **Individual bags.** Bags come in various lengths, diameters, and thicknesses. A tractor-mounted spear device is needed to lift the bale while applying the bag. Then the bale is placed in storage position before it is tied off. If possible, the bales should be stacked in cordwood fashion to reduce exposed surface area. Then, a plastic cover over the entire stack may reduce storage damage.

2. **Plastic tubes.** These consist of several round bales stuffed by a machine into a long plastic tube which is then sealed at both ends. The filled plastic tube resembles an “Enclosed plastic Bag or Tube Silo” described earlier, except that it consists of a row of round bales covered with plastic rather than long, continuous sausage-type silage material. Plastic tubes can be effective and timesaving, but the multiple bales stored in one package tend to increase the loss if the bag is torn, punctured, or opened for feeding. However, the tube can be easily tied off into one-bale (or more) segments for feeding.

3. **Sheet plastic.** Several round bales can be stacked under two sheets of plastic, with the plastic ends on the ground covered with soil, sand, or other effective sealing procedure. The hazard with this type of storage is that there are more possibilities for air leaks to develop, which may result in a large number of bales being spoiled.

**ADVANTAGES AND DISADVANTAGES OF ROUND BALE PLASTIC COVERED SILAGE**

Round bale silage may serve as a supplement to, rather than a replacement for, other stored forages on most live stock farms. Some advantages are:

1. It doesn’t require silo structures.
2. Hay-making equipment may be used to harvest it.
3. When silo capacity is lacking because of a surplus of forage, round bale silage can offer an effective method of storing excess forages.
4. The round bale silage system can be used to save a mowed field of hay when an anticipated rainstorm or extremely high humidity interfere with proper hay curing.
5. Round bale silage saves about one-third of the harvesting energy plus the fuel required for chopping silage.
6. Round baled silage can be self-fed if properly presented, thereby saving both labor and fuel by not requiring daily silage feeding.

But there are **disadvantages:** among them, the following:

1. Conditions associated with round bale silage are not optimum for fermentation.
2. Extreme care must be taken to eliminate air leaks.
3. The system requires prompt handling and storage of bales.
4. Machines for lifting and moving heavy, high-moisture bales must be available.
5. Plastic bags, storage tubes, or plastic sheets to cover group-stacked bales must be purchased.
6. Plastic is easily damaged, which can result in forage losses greater than in conventional silos.

**How to Determine the Size Silo to Build**

The size of silo to build should be determined by needs. With tower type and pit silos, this means (1) that the diameter should be determined by quantity of silage to be fed daily, and (2) that 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. Below data Table 1 is for bunker silo.
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%)

III. 40x10x5 ft silo is for 40 tonnes (40,000kg or 1000 mons)

<table>
<thead>
<tr>
<th>Fodder</th>
<th>Production/Acer (Tons)</th>
<th>Size of Bunker</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Length (ft.)</td>
</tr>
<tr>
<td>Maize</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Oat</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Sorghum</td>
<td>25</td>
<td>20</td>
</tr>
</tbody>
</table>

**Table 1**

**Table 2 EFFECT OF KIND OF SILAGE ON WEIGHT**

<table>
<thead>
<tr>
<th>Kind of Silage</th>
<th>Changes To be made in The Number of Tons Shown in Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. For corn silage ensiled when less mature than usual...</td>
<td>Add 5-10%</td>
</tr>
<tr>
<td>2. For corn ensiled when dry or overripe ..................</td>
<td>Deduct 5-10%</td>
</tr>
<tr>
<td>3. For corn very rich in grain ..............................</td>
<td>Add 5-10%</td>
</tr>
<tr>
<td>4. For corn with very little grain ...........................</td>
<td>Deduct 5-10%</td>
</tr>
<tr>
<td>5. For sorghum silage ...........................................</td>
<td>Use the same weights as used for corn silage of comparable grain and maturity.</td>
</tr>
<tr>
<td>6. For sunflower silage ..........................................</td>
<td>Add 5-10%</td>
</tr>
<tr>
<td>7. For grass silage ..............................................</td>
<td>Add 5-15%</td>
</tr>
</tbody>
</table>

For this reason, a stronger structure is necessary where grass silage is stored.

The following example will serve to illustrate how to determine the size tower silo to build:

Over a period of years, a farmer plans to feed cows on a ration of corn silage and protein supplement. There is a 60 – day wintering period. No increase in the herd is planned. What size bunker silo should be built?

No of animal: 100, Days to Fed: 60 days. Required Silage per day: 27 kg per animal

Per cubic ft storage is 20 kg of Silage (Shrinkage loss not added)

<table>
<thead>
<tr>
<th>2700</th>
<th>162000</th>
<th>20</th>
<th>8,100</th>
<th>1</th>
<th>70</th>
<th>30</th>
<th>5</th>
<th>10,500</th>
<th>20</th>
<th>210,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total daily S Req</td>
<td>Total Req. for 60 days</td>
<td>precubic ft</td>
<td>cubic ft</td>
<td>L</td>
<td>W</td>
<td>H</td>
<td>Area (Cft)</td>
<td>stored qty of fodder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
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<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>10</td>
<td>5</td>
<td>2,500</td>
<td>20</td>
<td>50,000</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>360,000</td>
<td></td>
</tr>
</tbody>
</table>

**SILAGE STORAGE LOSSES**

Tight structures, good distribution and packing, and the proper use of plastic covers minimize silage storage losses. Silage losses also vary widely between kinds of silos, as shown in Table 3. Losses in trench and open stack silos are also influenced by depth; less surface is exposed in deeper silos.
TABLE 3
ESTIMATED (1) AVERAGE, AND (2) RANGE OF SILAGE STORAGE LOSSES

<table>
<thead>
<tr>
<th>Type of Silo</th>
<th>Percent of Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>Gastight upright</td>
<td>5</td>
</tr>
<tr>
<td>Conventional upright</td>
<td>6</td>
</tr>
<tr>
<td>Horizontal (trench)</td>
<td>15</td>
</tr>
<tr>
<td>Open stack</td>
<td>20</td>
</tr>
</tbody>
</table>

Losses in the silo are of four types: (1) surface or top spoilage, (2) seepage, (3) gaseous, and (4) heating (browning reaction and spontaneous combustion).

Surface or top spoilage losses of 20% or more may occur in stack silos and in any uncovered bunk, trench, or pit silo. These losses can be reduced by the use of suitable protection, such as a plastic cover.

Seepage losses can be high in high-moisture silage stored in upright silos. The higher the silo, the greater the pressure and the higher the losses through seepage. The seepage carries soluble feed nutrients with it. Horizontal silos have less seepage loss than upright (tower) silos because of lower vertical pressure. Seepage losses can be reduced by wilting forages to less than 65% moisture before ensiling.

Gaseous losses are unavoidable so long as the plant material respires and there is subsequent fermentation. However, these losses can be minimized by avoiding entry of air into the silo, by having the pH decline rapidly, and by encouraging favorable fermentations.

Lowering the moisture without excluding the air may lead to heat damage, known as the browning reaction or Maillard reaction.

Spontaneous ignitions sometimes occur in low-moisture silage (haylage). For such losses to occur, there must be a build-up of temperature to the combustion point in the silo mass, combined with a low transfer of heat. These fires are very difficult, and usually impossible, to extinguish. The addition of water may build up pressure and lead to an explosion. Most silo fires should be allowed to burn.

KINDS OF SILAGE
A great variety of crops can be and are made into silage. Generally speaking, crops that are palatable and nutritious to animals as pasture, as green chop, or as dry forage also make palatable and nutritious silage. Likewise, crops that are unpalatable and unnutritious as pasture, as green chop, or as dry forage make unpalatable and unnutritious silage.

COMPOSITION OF VARIOUS SILAGES

<table>
<thead>
<tr>
<th>Type of Silage</th>
<th>Analyses on A Dry Matter Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Crude protein (%)</td>
</tr>
<tr>
<td>Corn</td>
<td>8.3</td>
</tr>
<tr>
<td>Grain sorghum</td>
<td>7.9</td>
</tr>
<tr>
<td>Forage sorghum</td>
<td>9.2</td>
</tr>
<tr>
<td>Oats</td>
<td>10.0</td>
</tr>
</tbody>
</table>
Alfalfa ................................. 17.4 59.0 1.75 0.27

Corn and Sorghum Silage
For the United States as a whole, corn ranks first in importance as a silage crop. Generally more total digestible nutrients can be obtained from an acre of corn as silage – which will yield from 5 to 25 tons of forage per acre, with an average of about 14 tons – than can be obtained from an acre of any other crop. Also, corn ensiles easily without the aid of a preservative, and keeps almost indefinitely in a good silo, is highly palatable, is well adapted to mechanized feeding, and may be fed with little waste.

There are four kinds of corn silage; namely,

1. The whole corn plant.
2. Ear corn silage.
3. Corn Stover silage.

The sorghums are more dependable and higher yielding than corn in certain areas, particularly in unirrigated, and relatively dry areas, of western and southwestern United States. Sorghum for silage is harvested with the same equipment as is used for corn silage. It should not be harvested for silage until the heads are soft to medium dough stage. Harvesting at this stage provides the highest yields of total feed material, enhances preservation, and makes silage that has good palatability.

On a dry-matter basis, corn silage contains an average of 8.3% crude protein, 68.0% total digestible nutrients, 0.31% Ca, and 0.27% P. grain sorghum silage contains less protein and TDN than corn silage. Grass/legume silages contain more protein and less TDN than corn silage. The carotene content of corn silage is variable, but on the low side.

GRASS/LEGUME (HAY CROP) SILAGE
Grass/legume (hay crop) silage refers to silage made from any of the green crops which might otherwise be grazed or dried and made into hay. This includes grasses (such as timothy or fescues), legumes (such as alfalfa or clovers), grass legume mixtures, and cereal grains (such as oats).

Grass-legume silage can be produced in areas where the climate is too cool and the growing season too short for corn or sorghum silage.

The interest in hay crops for silage increased as a result of farmers (1) becoming aware of the field losses that occur in hay making, (2) being provided with the information necessary to make high quality silage from the grasses and legumes, and (3) having access to field choppers, which facilitated making silage from the crops.

Grass/legume silages are of three kinds based on moisture level:

1. Direct-cut silage 70% moisture or above.
2. Wilted silage, 60 to 70% moisture.
3. Low-moisture silage (or haylage), 40 to 60 moisture.

2. Harvesting of crops

- The crops should contain about 30-35% dry matter at the time of ensiling.
- The quality of silage depends upon the stage of harvesting.
  - In general, grasses should be harvested just before flowering. If moisture content is high, first wilt the crop to 30-35% dry matter content.
3. Chopping the crop
  • Chop the crop into small pieces.
  • Forage should be chopped - pieces no longer than about 2 cm (< 1 inch) in length
  • Chopping make it easy to compact the silage and to remove the air.

4. Filling the silo
  • Fill the material into the container/bunker layer by layer.
  • Compact the crop all the time by continuous treading.
  • This remove the air inside the silo.
  • Try to fill silo continuously in one day.
  • Seal the silo quickly.
  • This will improve and speed up the fermentation process.

5. Feeding the silage to livestock
  • Silage can be fed as a source of roughage either on its own or with other feed sources.
  • After a period of 35-40 days the silage is ready for feeding.
  • Max can be fed upto 27 kg