Silage Making

- An acid fermentation, sufficient high moisture content are stored under anaerobic conditions
- Contain 20-40% DM and 14-16% CP
- Silage and haylage are attractive to dairy and beef cattle producers because rainfall often hinders hay production, and silage can help reduce total feed costs.

What is silage

- Silage is the green material produced by controlled fermentation of the green fodder crop retaining the high moisture content

Principle of silage

- Anaerobic condition is first and foremost requirement for silage making, as it allows lactic acid bacteria to grow, which convert sugar into lactic acid, a strong organic acid
- As pH declines the degrading action of the plant enzymes and undesirable bacteria are inhibited and at pH 3-4 most degrading enzymes are inhibited and the growth of lactic acid bacteria is also inhibited.
- Resulting fodder is rendered tasty and easily digestible for animals.

- Seasonal productivity of the feed resources and shortage of feed during the dry season
- Animals suffer malnutrition
- Loss of body weight
- Reduction of milk production
- Outbreak of diseases
- Reproduction disorders

- These marked reduction in animal productivity causes mainly the stagnation of income growth in animal farming and becomes a limitation factor for increasing the animal keeping number
- Therefore, it is vital to produce good quality roughage year-round by increasing the cropping area on the basis of those information and proven data

Preparation and storage of silage for the dry season

- General that vigorously grown herbages in the rainy season (high temperature and heavy rain) are produced
- Stored as hay and silage and used in the dry season
- However, it is difficult to make hay due to the climatic condition and cost (According to the country weather)

1. Harvesting and chopping the material herbages at the proper time

- Corn
- Grain sorghum (Milo)
- Bermudagrass
- Stargrass
- Limpograss (Hemarthria)
- Other perennial grasses
- Forage Sorghum
- Sorghum-Sudan hybrids
- Pearl millet
- Small grains and ryegrass

Legumes

- Alfalfa
- Red clover
- Hairy indigo
- Alyceclover
- Aeschynomene
- Rhizoma perennial peanut
- Other crops, such as sugarcane and crop combinations such as grain sorghum and soybeans or ryegrass and red or white clover

Harvesting of crop for silage

- Full-season: produce larger plants and a higher tonnage of silage
- Early-season: May produce as much grain, but on smaller plants
- As a result, therefore, total silage yield is usually lower, but percentage grain in the silage is higher in early-season
- For corn hybrids: full-season (120 plus days), mid-season (115 days), and early-season (110 days)

Adjusting the moisture content

- Optimum moisture level for pit silage is 60 to 65%
- Optimum moisture level for wrapped bale silage is 50 to 55%

- To get the maximum yield of nutrients/acre
- To minimize field and storage losses
- To ensure high palatability and maximum intake by animals


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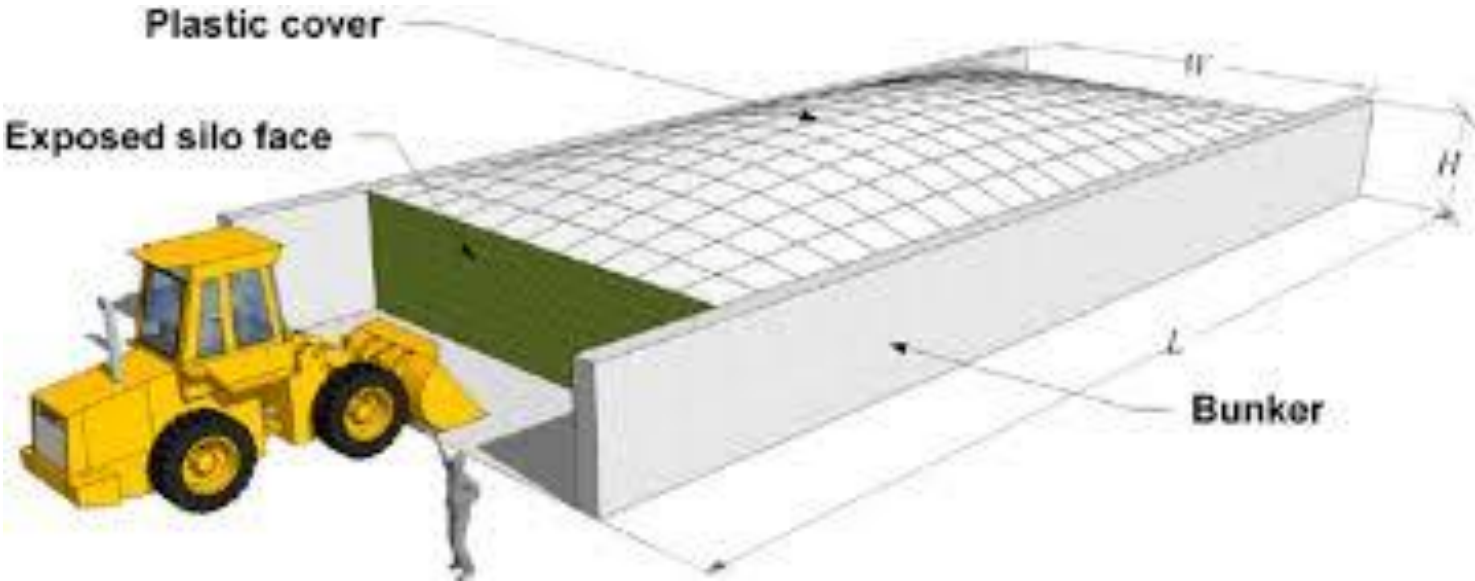
EXIDE

- Early complete sealing and application of heavy weights

FeedFresh® Silage Covers Maximize Feed Quality Throughout The Pile by Lowering the OTR.

One-Step Cover Installation ▶

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- Addition of molasses, or sugars and by-products (in case of delayed harvesting and poor condition for silage condition)
- Practicing complete silo management (measures against damages by birds, field mice, etc.)
- Short working time for adjustment at each silo. It is also important to introduce and use simple and inexpensive silos which can be easily procured or made in the region

The first stage

- The packed raw materials are still respiring immediately after chopped and consumes oxygen
- The temperature will rise to about 32ºC around 4 days after packing

The second stage

- Acetic acid production begins by fermentation with acetic acid bacteria during the respiration in the first stage
- The silage pH slowly changes from about 6.0 to about 4.0.

The third stage

- Lactic acid fermentation begins by lactic acid bacteria about 3d after packing chopped materials
- Acetic acid fermentation by acetic acid bacteria decreases, and then acetic acid production declines.

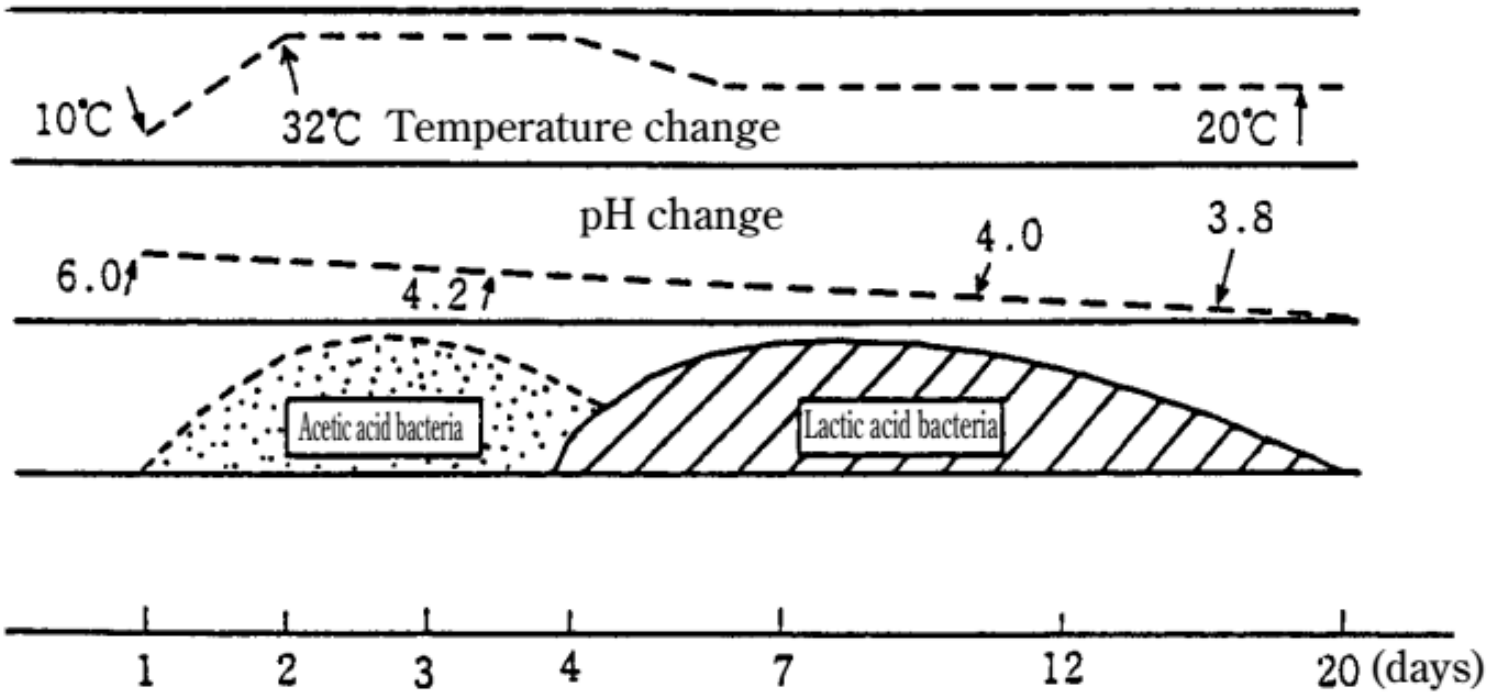
The fourth stage

- Lactic acid production continues for about 2 weeks
- The temperature goes down slowly to about the normal atmospheric temperature
- The pH decreases to about 4.0, and the activity of the various bacteria ceases.

The fifth stage

- If the reaction proceeds smoothly up to the fourth stage, it enters a stable phase with a low pH condition, and high quality silage is made
- The lactic acid fermentation completes in about 20 days, and the silage product is finished
- If the lactic acid production is insufficient, butyric acid fermentation begins and quality deterioration occurs.

Figure 2. Diagram showing the fermentation process of silage



Selection of fodders for silage making

- Silage can be made from all winters and summer fodders but usually maize, oats , sorghum etc. are considered best for silage making.
- Normally fodders with
  - Broad leaves
  - Thick stems
- Leguminous fodders have less carbohydrates , they are usually mixed with non leguminous fodders like maize and sorghum to make the best and nutritious silage.

- Pasture grasses: Elephant grass, Rhodes grass, Sudan grass, Ruzi grass etc.
- Pasture legumes: Stylo
- Fodder tree: Leucaena
- Straws: rice straw, wheat straw, soybean chaff, peanut hulls etc.
- Corn, Sorghum
- Farm by-products

Site selection for construction of silo

- Site should be easily approachable from fields as well as dairy farm
- The area should not be low lying because such type of areas are prone to water logging
- The chaffing shed should be adjacent to the site
- It should be away form residential area
- Tractor should easily reach the site
- It should be 60 meters away from water pond etc.
- Trees should not be around

Steps for silage making

- Selection of fodder
- Check moisture
- Harvesting and Chopping of Fodder
- Filling of silo
- Mixing of additives
- Sealing of silo
- Storage

Selection of fodder

- 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, 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

Maize

Millet

Oat

Sorghum

Sorghum Sudan Grass

Moisture checking

“Grab test” is used to measure the moisture concentration in fodder. To check the moisture, take a hand full of fodder and press it in hand for few seconds. On opening of hand, there will be a ball of fodder:

- If this ball suddenly opens, it means moisture content is too low
- If this ball remains it shape, it means moisture content is too high
- If this ball opens slowly, it means moisture content in fodder is suitable to be ensiled.

Oven test

- This test consists of following steps:
- Take fresh fodder (not more than 50 grams)
- Note down the weight of this fodder
- Place it in oven for few seconds and again weigh it
- Again place in oven and weigh it. Repeat this step again and again until no change occurs in weight of fodder. No change in weight shows that moisture is no more in fodder and only dry matter is left
- Now note down the weight of this dried fodder
- Find moisture content in fodder with the help of this formula
- $\% \text{ Moisture} = \frac{\text{Weight of fresh fodder - Weight of dry fodder}}{\text{Weight of fresh fodder}} \times 100$

Harvesting and Chopping of Fodder

- Chopping of fodder to short length (1-3cm), so that the packing density is kept higher, lactic acid fermentation takes place in good condition
- Crop should be harvested at the stage when there are maximum nutrients present in crop and 65-70% moisture content.
- In case of maize moisture reaches this level when:
- Color of Lower leaves of plant starts changing to light green
- Husk's color is from green to light green
- Kernel has visible dent
- There is 40-50% moisture in grain
- Kernel Milk line is 50%

- Use maize chopper for harvesting and chopping of fodder.
- If maize chopper is not available then harvest it and chop it upto size of 1-3 cm.

Mixing of Additives

- Different feed additives may be mixed to stimulate or inhibit the microbial activities in silage. Silage additives should

1. Increase nutrient recovery
2. Improve animal performance
3. Decrease heating and molding during storage and feed out

- These additives may include:
- **Inorganic chemical** - Calcium carbonate, magnesium carbonate, ammonium sulphate, sodium sulphate, zinc sulphate, copper

Feed stuffs - Used as silage additives are wheat bran, crushed maize, starch, dextrose, molasses, whey and yeast etc.

Fermentation products and microorganism - A few enzymes, extract of fungi and several species of microorganism like Lactobacillus acidophilus, Turolopsis species, Bacillus subtilis etc.

Direct acidifiers

- Inorganic or organic acids- decrease pH
- E.g. Sulphuric and formic acid

Fermentation inhibitors

- Immediately decreases pH
- Sterilents to inhibit micro flora
- E .g. formaldehyde, Max grass, sorbic acid salts

Fermentation stimulants

- Provide substrate for fermentation e.g. molasses
- Enzymes speed up fermentation e.g. cellulose
- Inoculants- microbial cultures
- E.g. homo fermentative lacto bacille

NPNs

- Urea and anhydrous ammonia can be added silages to increase their crude protein content

Minerals: such as calcium, phosphorus, sulfur and magnesium can be added to silage

Silage Inoculants

- The primary purpose for adding bacterial inoculants is to increase the number of lactic acid producing bacteria. Most commercial inoculants for silage include
- Homo fermentative lactic acid bacteria

  e.g. *lactobacillus plantarum, Enterococcus faecium, and Pediococcus spp*.
- Hetero fermentative LAB include *L. buchneri*

Intake (kg day^{-1})	Uninoculated	Inoculated
Dry matter	8.82^{b}	8.82^{a}
Crude protein	1.10^{b}	11.04^{a}
Neutral detergent fiber	5.63^{b}	1.40^{a}
Non fiber carbohydrate	2.56^{b}	5.18^{a}
Ether extract	0.55^{b}	0.65^{a}
Ash	0.26^{b}	0.33^{a}
Digestibility (%)		
Dry matter	75.03^{b}	79.91^{a}
Crude protein	72.30^{b}	76.35^{a}
Neutral detergent fiber	62.50^{b}	70.56^{a}
Non fiber carbohydrate	85.66^{b}	89.68^{a}
Ether extract	66.71^{b}	83.26^{a}
Ash	48.08^{b}	65.37^{a}

Filling of Silo

- After chopping and adding additives silo is filled.
- Inside silo chopped fodder should be compressed with tractor or some other means so that it is packed tightly and there is no air left.
- If air left anaerobic condition will not be created.
- In case of baled silage, silage baler makes bale in well compacted form.

Sealing of Silo

- The air tight sealing is necessary to avoid the entrance of air in the silo.
- So after filling of silo, cover it with polythene sheet and put tires or sand filled bags over it or cover it with mud (Lepai).
- It is better to cut tires in small circular pieces for maximum usage.
- In case of baled silage baler automatically wrap the bale with wrapper

Process of Ensiling

- The whole process may be divided into four different phases.
- **Phase I** – The phase I immediately starts after sealing the tightly filled silo. The plant cells continue to respire till the oxygen trapped is exhausted. The carbon dioxide production makes the silo anaerobic. This favors the growth of anaerobic bacteria.
- **Phase II** - At the initial stage clostridia and coliform bacteria are active, causing degradation of protein and amino acid and production of amine and acetic acid. Lactic acid producing bacteria are also increased.
- **Phase III** - The lactic acid producing bacteria dominate and cause increase in lactic acid production and reduction in pH of ensiled material. The presence of readily available carbohydrate enhanced the growth of such types of desired bacteria producing lactic acid and reducing the pH.
- **Phase lV** - This phase is quite variable and dependent on phase III. If pH is reduced to around 4 silage is stable and no further degradation occurs. If sufficient acid is not produced to bring down the pH round 4 microbial activities still continues. High moisture contents favours this undesirable fermentation.

Phases of silage conservation

Pre-ensiling

- Aerobic
- Plant respiration
- Protease activity
- Epiphytic organisms
- pH 5.5-6.5

Ensiling

- Anaerobic
- Sugar fermentation
- LAB dominance
- Lactate & VFA formation
- pH 3.8 -5 Feed out

Feed out

- Aerobic
- Fungal resurgence
- Acetic bacteria, yeasts, molds
- pH 6 –9
- <47% DM loss

Advantages of Silage Making

- Surplus green fodder abundantly available can be preserved as silage for feeding during lean season
- The organic acids produced in the silage are similar to those normally produced in the digestive tract of the ruminants; so digestibility of fodder increases
- It eliminates wastage of the less favoured parts of the fresh fodder like stem because the animals consume entire plant.
- It is highly palatable
- It provides succulent feed particularly during dry periods, when the vegetation growth is dormant . It is more economical as compared to cut-and-carry prevailing system

Quality of Silage

- **Good silage** should have a milk, pleasant aroma, an acid taste and a slightly greenish color. It should be free from sliminess and mold and have sufficient acid to prevent further action of microorganisms.
- **Causes of Poor Silage:**

  These are different factors which may lower the quality of silage:

  Acid Production:

  If during silage making acid is not produced in sufficient quantity, it will stop the fermentation, and there will be putrefaction due to undesirable bacteria. Such bacteria will produce enzymes that will cause the breakdown of protein causing an off flavor and slimy silage. On the other hand if there is production of acid in high quantity due to high proportion of sugar content, it will result in sour unpalatable silage. Such silage is not only unpalatable, but when fed in large quantity causes cattle to scour.

- Moisture content:

When there is high moisture content in fodder, the silage will not be packed well and more air will be left in it. This will result in moldy silage. High moisture content causes undesirable fermentation to take place. In case of less moisture content there will be no proper fermentation

Kinds of silo

- **Silo**:

The specialized device or container used for preparation of silage is called silo. The silo are:

- **Pile Silo**:

In this type of silo there is no need of construction. Only a pile of chopped fodder is made on a ground and it is pressed with the help of tractor. This type of silo is recommended for short term preservation of fodder.

- **Long Silage Bag:**

This type of silo consists of long stretchable bag. After proper filling and compaction, the end of bag is closed.

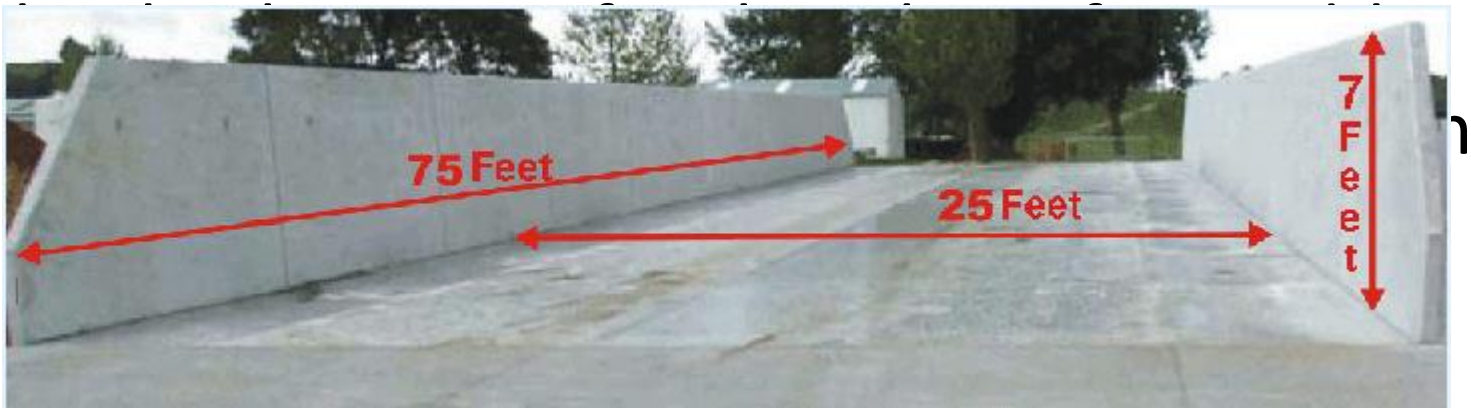
Tower silo

- These are long vertical silo of steel or concrete typically 10-90ft. in diameter and 30-270ft. In height.

Bunker silo

- Silage Bunker is most commonly used type of silo.
- This is rectangular structure which is open from one side or both sides.
- On both sides of walls of wood, steel, concrete are constructed.
- Dimensions of bunker depends upon the amount of fodder to be stored.

- 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



- **Temporary Bunker :**

Temporary bunker consists of two frames of steel or iron which are covered by sheets of steel, iron or wood.

- The function of these frame is same as that of the wall of bunker but difference is that these are portable and can be easily transferred from one place to other place.
- Wherever fodder is to be preserved, these frames are fixed with the help of stands on both sides and space is filled with fodder.
- After compaction of fodder these frames are removed and can be used somewhere else. Hay bales can also be used in place of frames for this purpose.

Pit/Trench silo

- In this type of silo, a pit is constructed in ground. It may be rectangular or cylindrical.
- A trench silo can be built by simply digging the ground, but it is better to place plastic sheets inside to prevent loss.
- A trench silo whose interior is coated with concrete can be used for a long time.

Baled silo

- This is the most modern way of silage making in which fodder is preserved in the form of bale.
- Fodder is converted into bale via machine called silage baler and this bale is then tightly wrapped with polyethylene sheet with the help of wrapper.
- This bale can be easily transported.

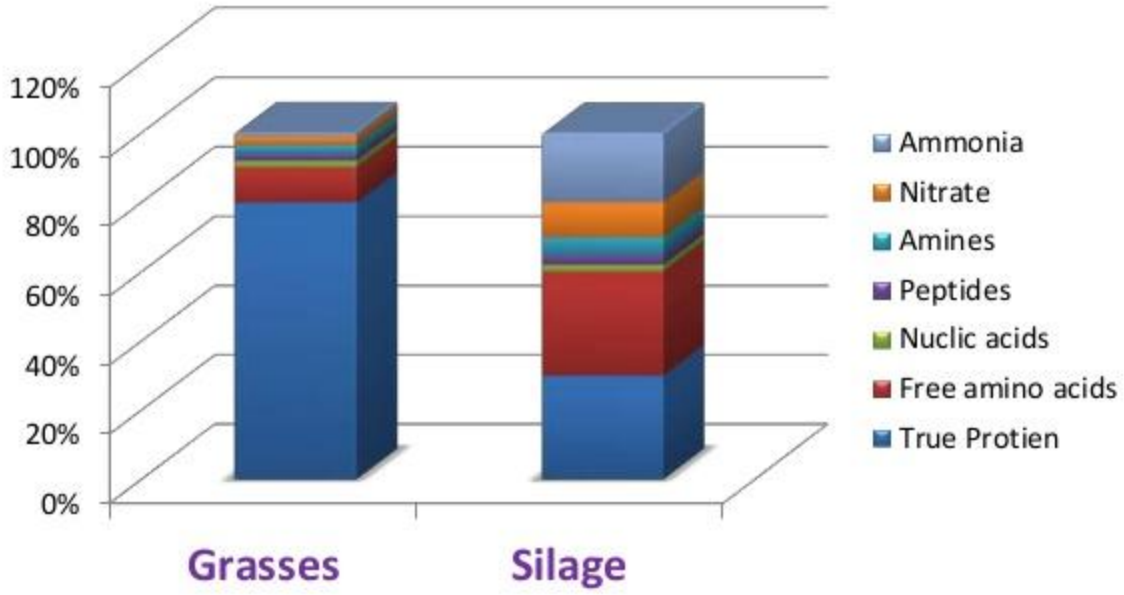
Feeding of silage

2 - 3 year old cattle	11-13 kg
3 - 8 year old cattle	13-22 kg
sheep	1-1.5 kg per 45 kg. live wt.
goats	1-1.5 kg per 45 kg. live wt.

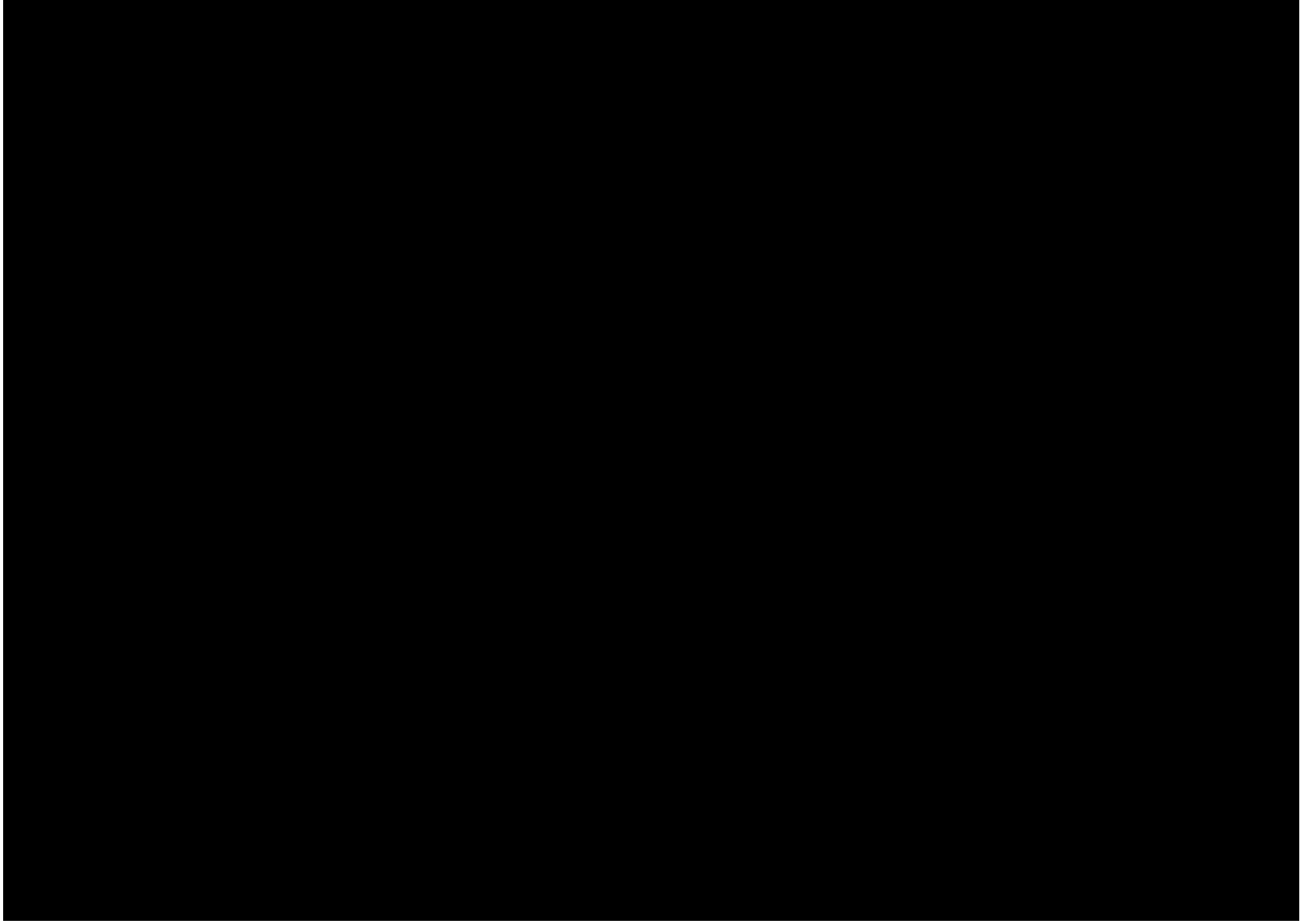
Energy losses in silage and causative factors

Process	Classification	Approximate loss (%)	Causative factors
Residual respiration	Unavoidable	1-2	Plant enzymes
Fermentation	Unavoidable	2- 4	Microorganisms
Effluent	Mutually	5 -7	Dry matter content is too low
Wilting losses	unavoidable	2- 5	Weather, technique, crop
Secondary fermentation	Avoidable	0 - 5	Buffering capacity, Dry matter content is too low
Aerobic deterioration during storage	Avoidable	0 -10	Delayed filling and compaction, sealing, crop susceptibility
Aerobic deterioration after unloading	Avoidable	0 -15	As above, DM content, season, unloading technique and rate
Total		**7- 40**	

Grass & silage protein fractions



- References
- http://www.pakdairyinfo.com/ummb.htm



Aerobic