Theme 2: Forage conservation

FERMENTATION PROCESS IN SILAGE

Level 1 – Part I

Topic	Training & information Content
2.1	Fodder conservation and storage
2.2	Estimating ideal time of harvesting
2.3	Guideline for silage making
2.4	Fermentation process in silage
2.5	Treatment of straw with Urea
2.6	Making of urea/molasses/mineral lick
2.7	Management of silage pit (feed out)
2.8	Estimating fodder supplies for dry season feeding & planning of feeding management

1. You will learn about (learning objectives):

- ❑ The trainee understand the different processes which influence the silage making

IMPORTANT

This module has two parts; this is part I – download Part II to continue to END.

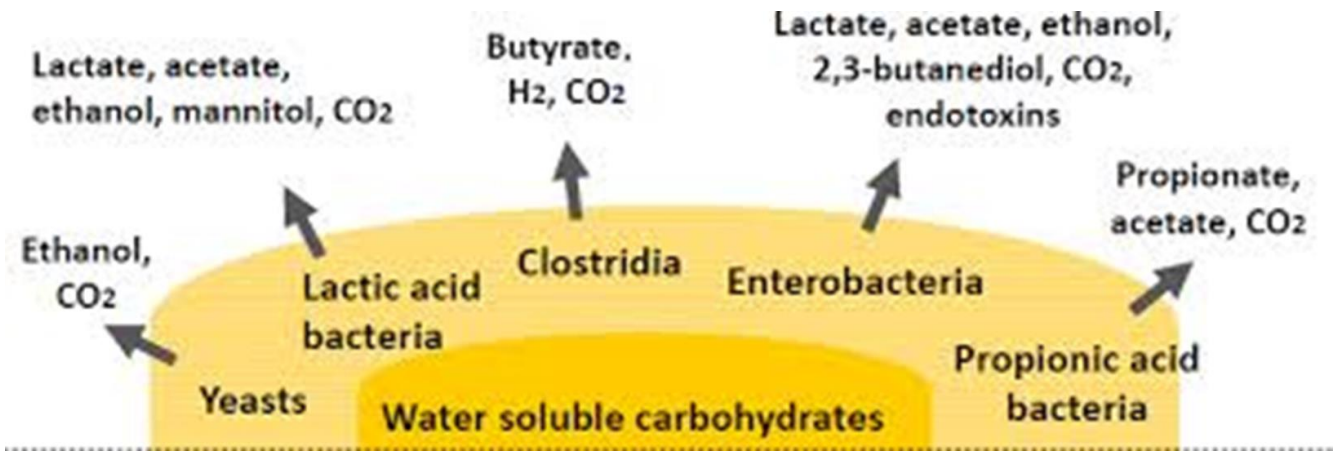
2. What is Silage

- Silage is an end product where chopped forage material of high moisture content is fermented under no oxygen.
- Silage is made to retain the nutrients present in fresh forage (for dairy cows).

3. Fermentation

Fermentation = Sugar → (volatile) organic acids + alcohol

1. Fermentation does not require oxygen.
2. It does not occur within the living cells. It requires only enzymes and substrate (forage material).
3. Different substrates oxidize to form alcohol or organic acids.



Different micro organisms use forage material to form alcohol or organic acids

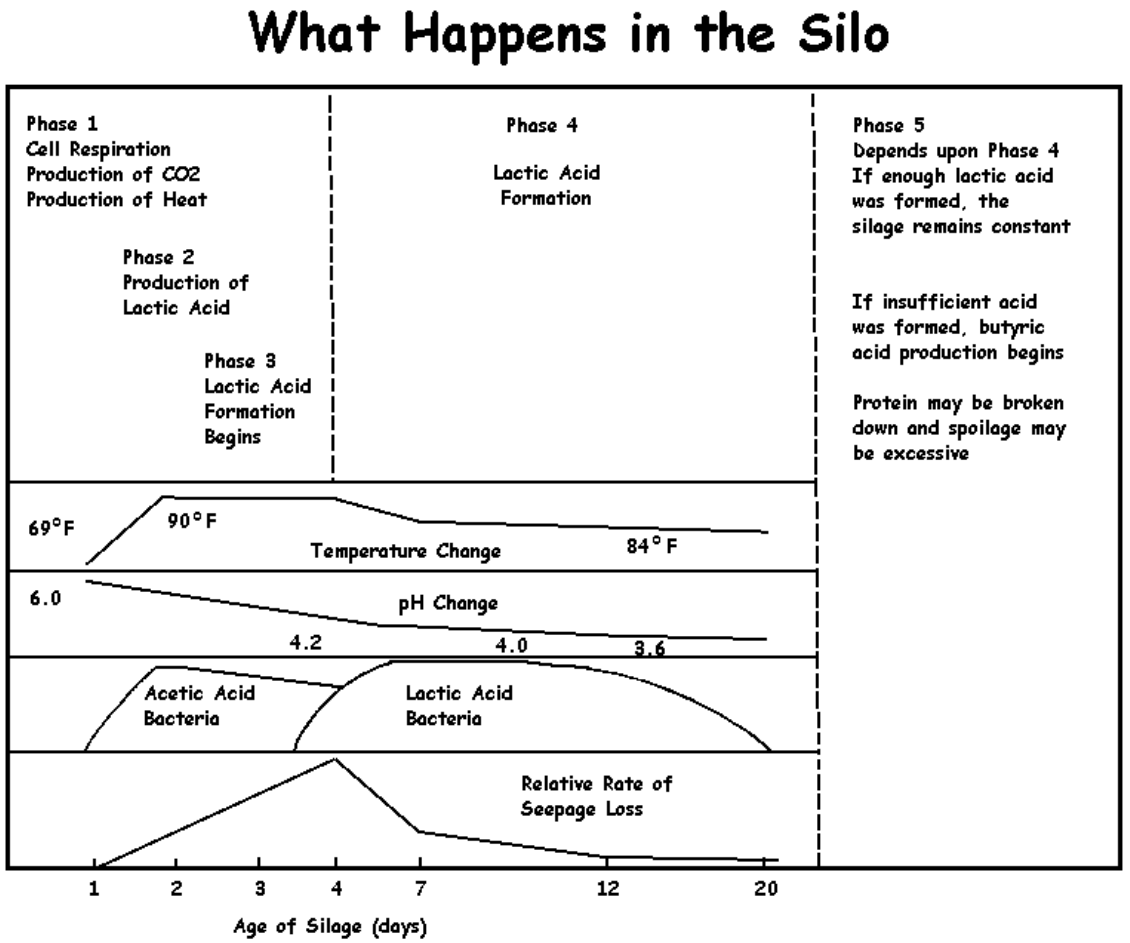
4. Why efficient fermentation is needed

- To preserve nutrients in order to optimize livestock (including dairy cows) intake and performance.
- To optimize intake and performance of dairy cows.
- To minimize forage dry matter lost during the fermentation process and spoilage at feed out.

5. Fermentation is not always perfect

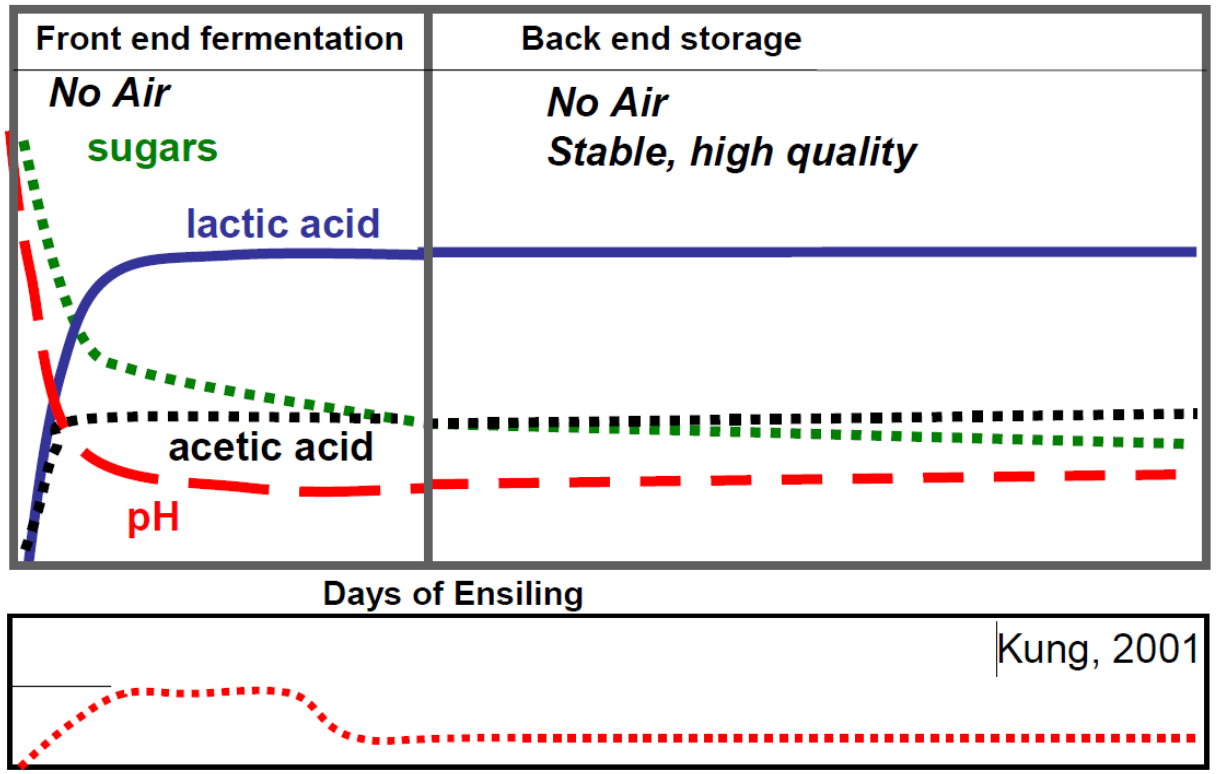
- Silage results from a biological processes; the silage making process doesn't always work perfectly.

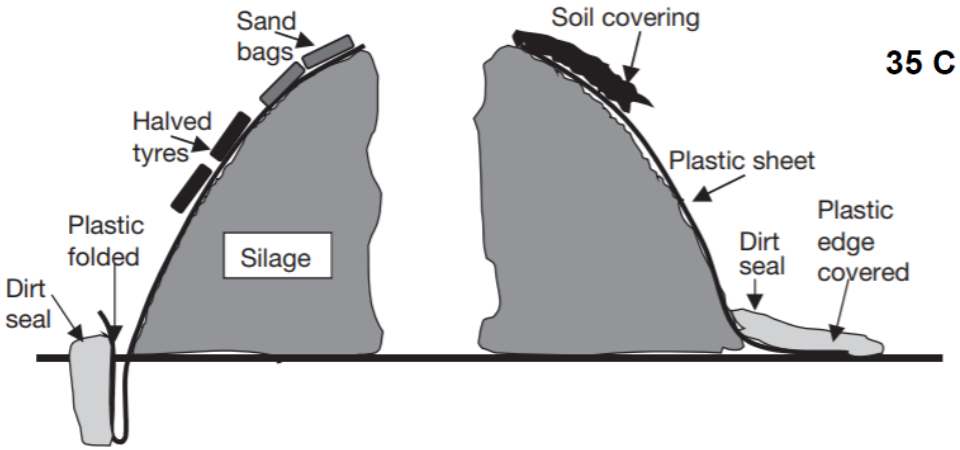
- During an anaerobic silage fermentation, micro-organisms feed on sugars and other water soluble carbohydrates in the forage material to produce organic acids, such as lactic acid and acetic acid. This lowers the pH and creates an environment where the resulting silage is preserved.



6. Anaerobic fermentation

- In the absence of air, lactic acid bacteria ferments sugar in the biomass to lactic acid which acidifies the forage material (this results in a drop in pH).

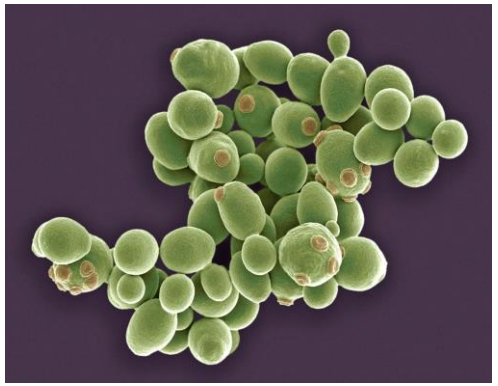




6.1 Fermentation is micro-organisms at work

Good organisms

- Lactic acid bacteria
  - heterofermentative
  - homofermentative



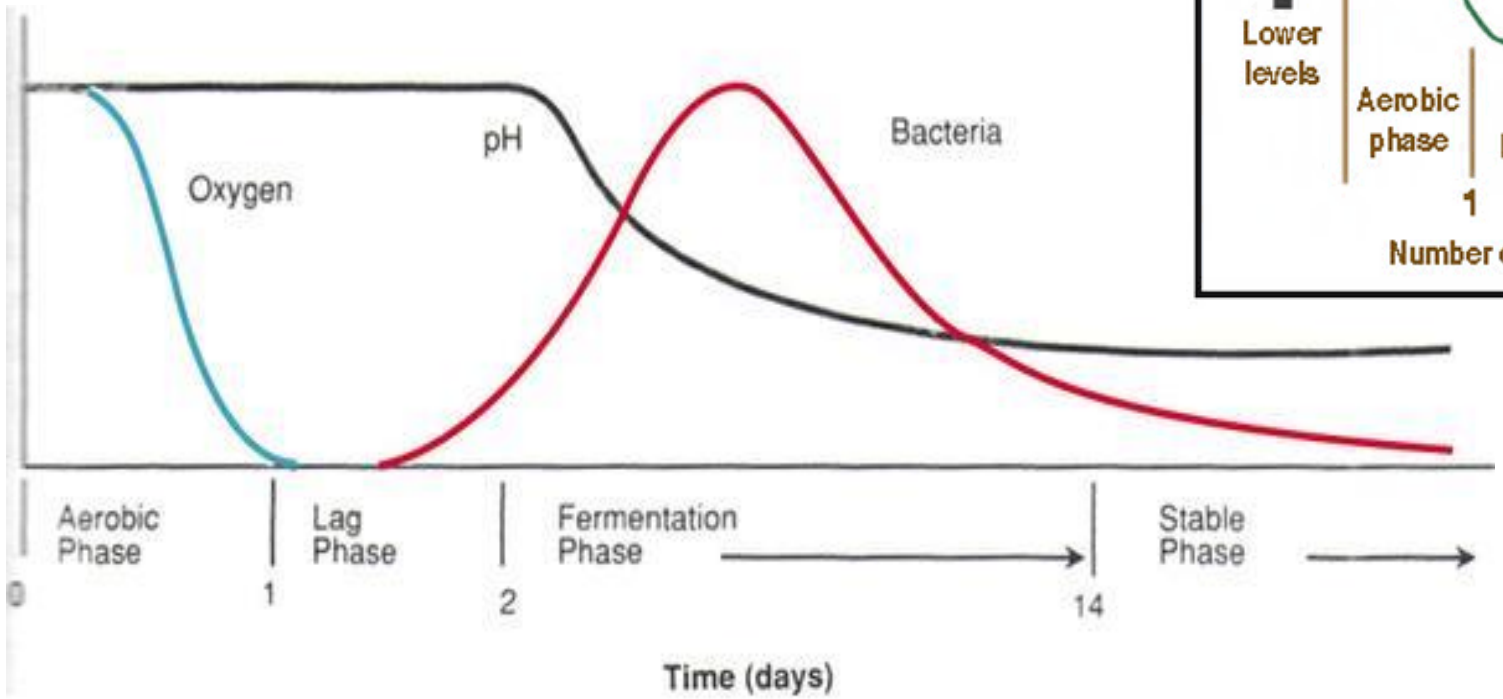
Bad organisms

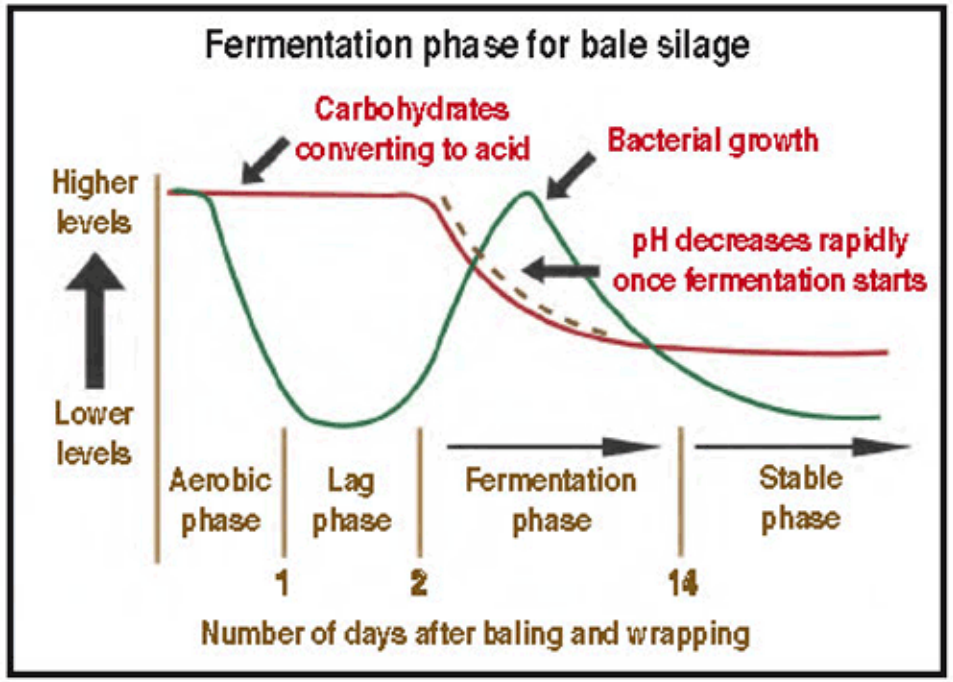
- Yeasts
- Moulds
- Clostridia
- Enterobacteria

7. Water soluble carbohydrates in forage material/biomass

- Availability of water soluble carbohydrates (sugar) in forage material or biomass depends on:
  - Species
  - Variety
  - Stage of maturity
  - Time of day
  - Climate
  - Drought
  - Nitrogen (N) fertilization
  - Rainfall
  - Lower under poor wilting conditions
  - Management

8. Fermentation phases in silage





Source: Pitt et Sniffen, 1985

8.1 Fermentation process phase I: Aerobic phase

Aerobic phase: Phase I (1-2 days)

- The (chopped) plants continue their respiration and as a result of this activity, CO_2 is produced.
- Inside the silage mass, the temperature starts to rise above 20°C and the pH is around 6-6.5.

8.2 Fermentation phase II: Lag phase

Lag phase or hetero-fermentative phase: Phase II (1-3 days)

- Anaerobic fermentation starts; organic acids (acetic acid, lactic acid) and ethanol are produced.
- Temperature reaches 30-32°C.
- The pH decreases gradually to 5°C and lactic acid bacteria start flourishing.

* Colony Forming Units/ gram

8.3 Fermentation phase III: Homo-fermentative phase

Fermentation phase or homo-fermentative phase: Phase III (3-5 days)

- The fermentation is almost exclusively lactic acid.
- pH drops to 4.
- By the end of this phase silage mass starts to cool down.
- Under tropical climate, it is important to achieve pH 4-5 early in order to prevent hot fermentation in silage, which makes it favourable for mould and yeast to grow within the silage mass.

8.4 Fermentation phase IV: Stable phase

Stable phase: Phase IV (15-21 days)

- All kind of fermentations are almost shut down.
- pH is stabilized at around 4.
- The temperature inside the silage mass should be more or less the same as the environment (outside - night) temperature.

9. Factors influencing fermentation

- DM content: ideal 30-35% DM.
- Chopping length: ideal 0.28-1.25 cm.
- Compaction increases density (600 kg/m^3)
- Sealing closes off the biomass from oxygen.
- Covering ensures any air still inside is removed.

10. Important note

This module is continued in Part II…

- PROCEED TO PART II -