Theme 3: Animal Nutrition and Feeding

ESTIMATING FEEDING VALUE OF FODDER AND FEED (Level 3)

Topic	Training & information Content
3.1	Estimating feeding value of fodder & feed on dairy farms
3.2	Sampling feeds & forages/analysis interpretation
3.3	Estimating Dry Matter intake for various breeds/age categories of dairy cattle in the tropics
3.4	Reviewing feed intake, rumen fill, Body Condition Scoring (BCS)
3.5	Life weight estimation of cows
3.6	Rumen fermentation
3.7	Mineral & vitamin requirement, guidelines
3.8	Manure scoring and evaluation
3.9	Guidelines for ration calculations for various breeds, heifers, lactation stage (Rumen8)
3.10	Use of Rumen8 software for ration calculation
3.11	Optimization of ration with Rumen8
3.12	Feeding management guidelines
3.13	Feeding management of dry cows/close up
3.14	Feeding systems
3.15	Metabolic disorders
3.16	Scoring locomotion and hoof condition
3.17	Mycotoxin in dairy cattle nutrition
3.18	Heat stress in dairy cattle nutrition
3.19	Monitoring feeding management, using KPIs (based on Rumen8)

1. You will learn about (learning objectives):

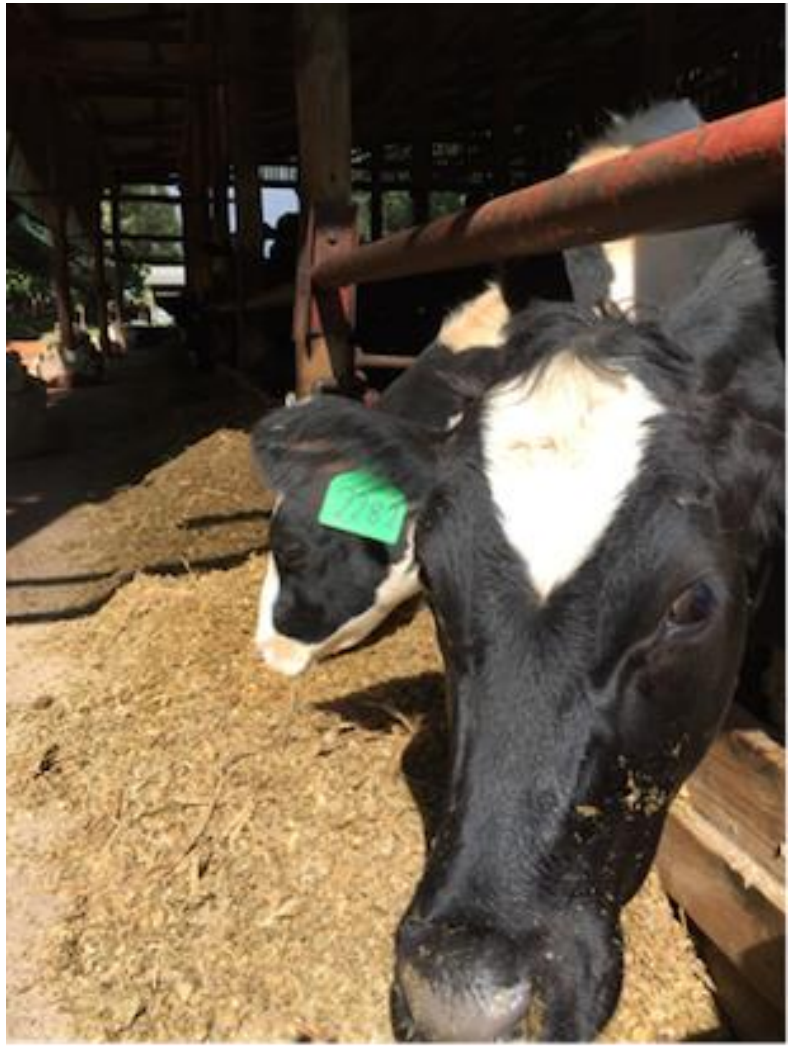
- ❑ Know how to estimate feeding value of fodder and feed in the farm.
- ❑ Know importance of feeding value in meeting animal nutrient requirements.
- ❑ Importance of feeding value in replacing ingredients in a ration.

2. Introduction

- Reducing feeding cost is important for your dairy farm's profitability. However, a balanced ration is needed to feed cows efficiently.
- The nutrient composition in the total ration needs to meet daily nutritional needs of the cows and other animal categories on the farm.
- To accomplish a balanced ration, one needs to have information on the nutrient content of each of the feed ingredients in the ration.
- Tremendous variation exists in nutrient composition within and between different forages.

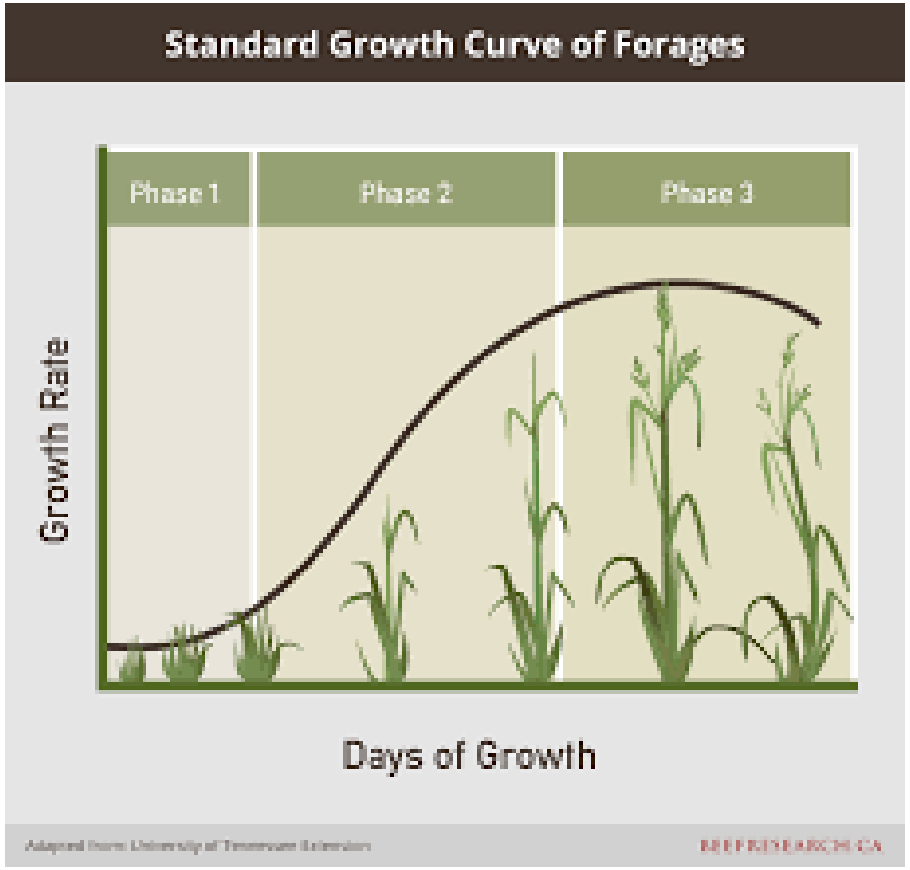
2.1 Introduction Cont'd…

- Feed nutritive value refers to the content of available energy (total digestible nutrients "TDN") and crude protein in forages.
- Total digestible nutrients (TDN) is an indicator of concentration of available energy.
- TDN measures digestible proteins, fiber, carbohydrates and fats/lipids in a feedstuff.
- Forage quality entails forage intake as well as its nutritive.
- Forage quality influences animal performance directly.



3. Importance of knowing forage quality

- Low quality forages such as overgrown (mature) grasses, often in the generative (seeding) stage have low levels of nutrients.
- The low nutrients can only be compensated with supplements, which are often expensive when formulating a balanced ration.
- Supplemental feed ingredients include agro-industrial by products such as; maize bran, brewers waste, cotton seed meal etc. Sometimes whole grains may be used for supplementation.
- Imbalanced rations with low quality forages cannot meet the expected animal performance (milk production, growth rate and health).

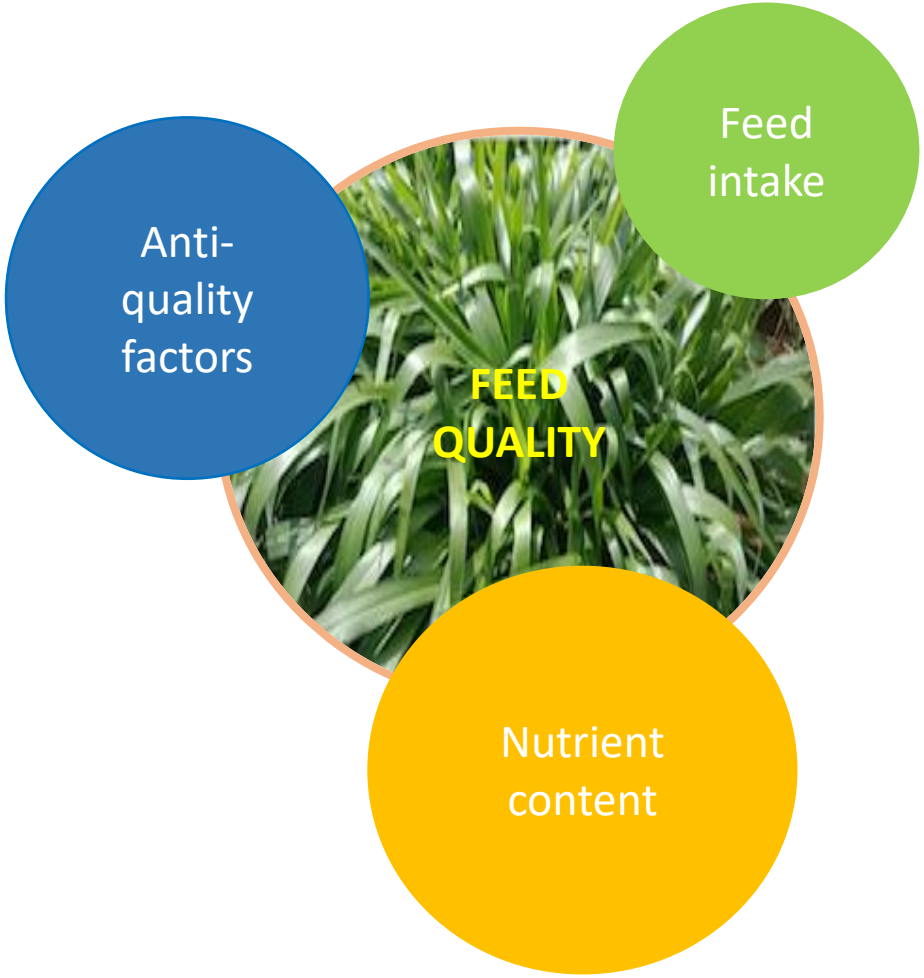


4. Determinants of quality forage

- Forage quality includes;
  i. Feed intake
  ii. Anti-quality factors
  iii. Nutrient content/value e.g.:
    - Dry matter content
    - Digestibility
    - Fiber content
    - Crude protein (CP)

- Forage fiber content determines how much of the forage the animal can take in.

- The availability of nutrients is directly related to the total feed intake.



5. Factors affecting forage quality

- Forage quality and feeding value vary much with;
  i. Varieties/species
  ii. Age/maturity of forage
  iii. Nutrient and water supply (soil fertility)
  iv. Temperature
  v. Harvesting stage/cutting interval
  vi. Storage technology
  vii. Parts of the plants used

- These factors also have direct impact on the nutritive value of forages.

5.1 Forage varieties/species

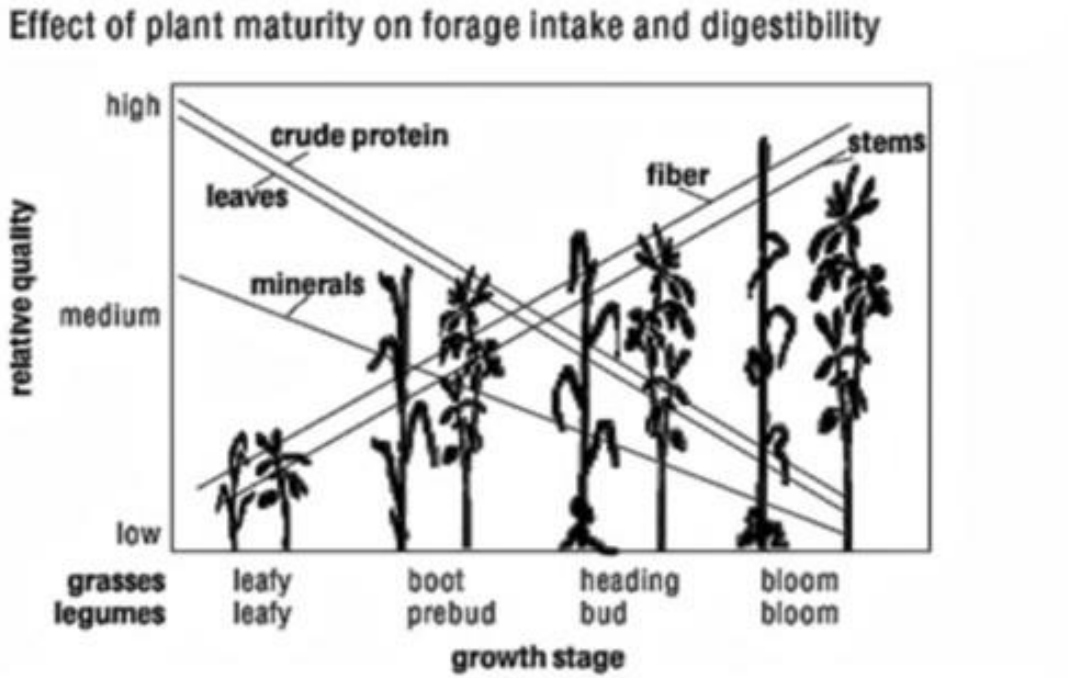
- Forage species should be carefully selected for their intended farming/feeding systems, whether;
  - Cut and carry varieties
  - Grazing varieties
  - Dual purpose varieties

- Legumes generally produce higher quality forage than grasses because the fiber content is lower. This low fiber favours feed intake.

- Plant breeding is aimed at improving quality of forages.
  - Use varieties/species with balance in quality and quantity (biomass).
  - Use varieties/species resistant to extreme weather conditions (drought).

5.2 Age/maturity of forage plants

- As the plant matures, the protein level in the plant decreases as a result of reduced digestibility.
- As the plant matures fiber content increases.
- Forage quality is highest at initial stage of plant tissue growth.
- Cut forage at early vegetative to early reproductive growth stage.
- As the plant matures the biomass per acre increases, resulting in an increase of the dry matter (DM) yield.
- It is best to harvest the crop when digestibility and DM yield are balanced.



Source: *Adapted from Blaser, R., R.C. Hammes, Jr., J.P. Fontenot, H.T. Bryant, C.E. Polan, D.D. Wolf, F.S. McClaugherty, R.G. Klein, and J.S. Moore. 1986. Forage–animal management systems. Virginia Polytechnic Institute, Bulletin 86-7.*

5.3 Soil nutrient and water supply to forage crops

Soil nutrient

- Forage crops absorb nutrients from the soil.
- Fertilization is therefore important to maintain soil fertility, because nutrients are important for the growth of these crops.
- Low soil fertility affects the nutritive value of the forage crop.
- Supply of nitrogenous fertilizers increases the yield and crude protein content in forage crops, particularly grasses.

Water

- Adequate water supply is needed for the forage crop to grow.
- Some forages do not do well on poorly drained soils.
- Excess water supply contributes to leaching of minerals needed for plant growth.

5.4 Temperature

- Higher temperature increases growth of forage crops up to a certain point.
- After this point an increase of the environmental temperature will reduces the quality of the forage crop.
- Under dry conditions, crude protein and phosphorus content decrease while fiber and calcium content increases.
- During conservation of forages, the temperature assists to preserve the quality of forages e.g. hay making.

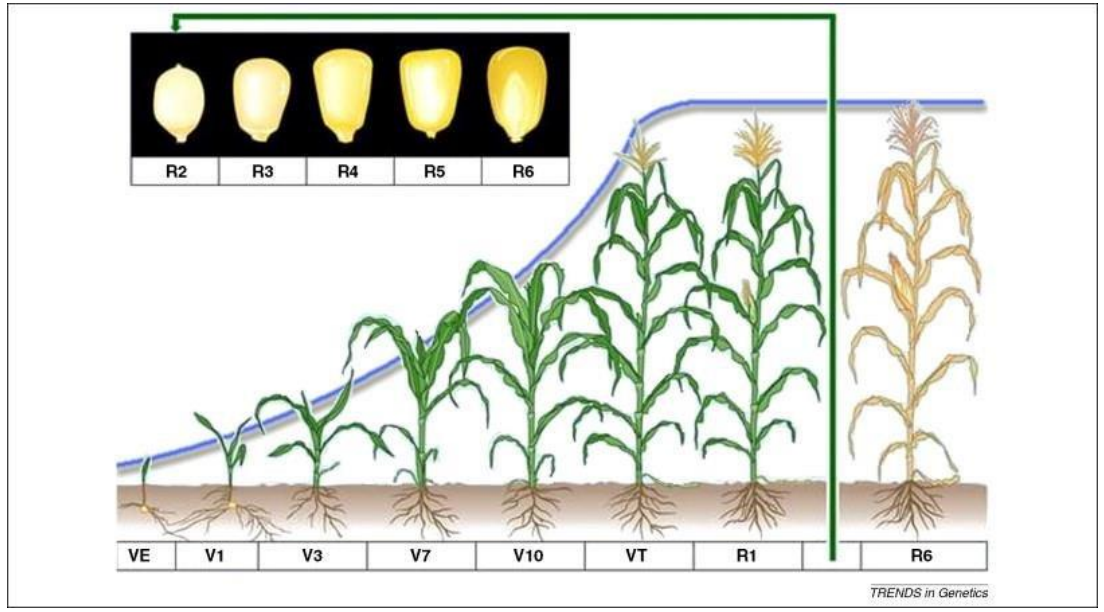
5.5 Harvesting stage/Cutting interval:

Grasses

- Harvesting grass once it has started flowering and producing seeds is a common practice, such as in Rhodes grass.
- Whereas harvesting mature grasses gives a higher biomass, the quality is reduced.
- It is best to harvest grass when there is balance between biomass yield (quantity) and quality. For example, booting stage for Rhodes grass for hay.
- Harvest grass for hay making when dry weather is predicted/expected.
- Allow the grass to wilt/dry until the dry matter content is more than 82%.

5.6 Harvesting stage Cont'd: Forage maize

- It is advisable to harvest forage maize at dough stage (See module on Estimating ideal time of harvesting).
- Aim at 30-35% dry matter (DM) level of the whole crop to maximize starch and Metabolizable Energy (ME) levels.
- Corn maturity correlate directly with dry matter.
- It is advisable to harvest and store forage maize (ensile) within the shortest time possible, same day if possible.



Source: https://www.researchgate.net/profile/Jerry-Dlamini/publication/280084904/figure/fig2/AS:714961869344769@1547471601396/Growth-and-development-of-a-maize-plant.jpg

5.7 Storage technology: Silage

- Poorly stored feeds are more likely to rot and contain toxic substances that affect the health of the dairy cow.
- Poor storage of silage e.g. air entry into the silo due to poor covering increases growth of mould, leading to rise in aflatoxin level in feed/silage.

Further reading: See module on mycotoxins in dairy cattle nutrition.

5.8 Storage of dry feed

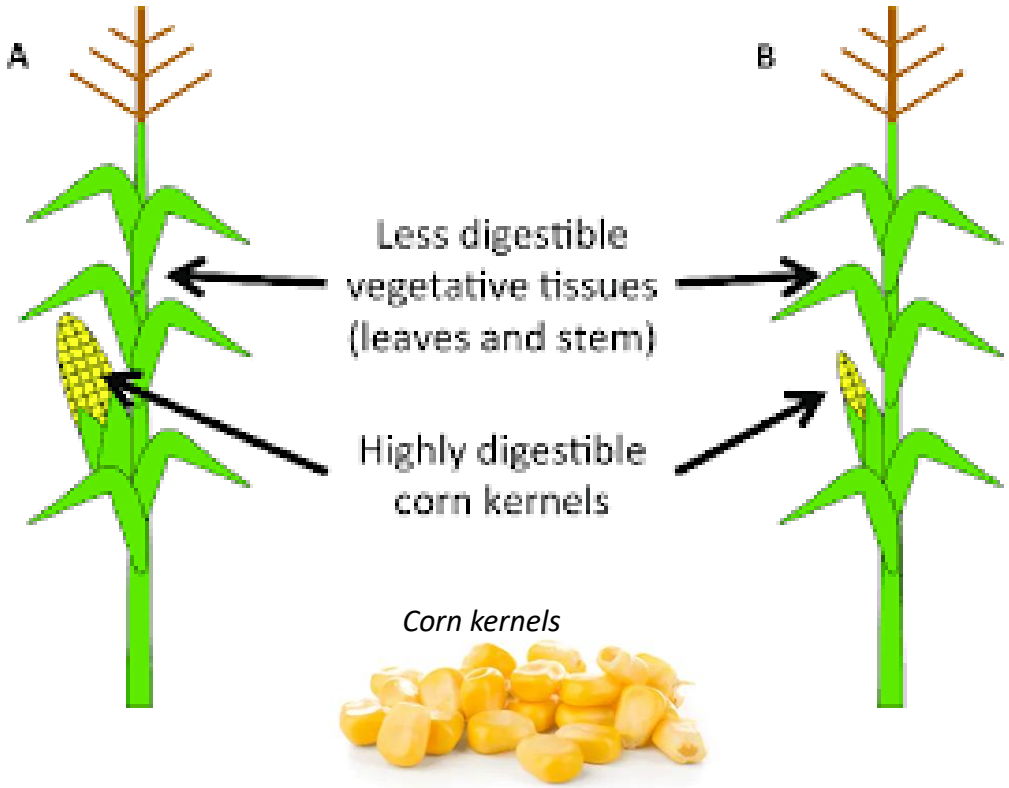
- Storage of feed should be done after proper wilting, sun drying and artificial drying (pelleting).
- Avoid congesting hay at storage site by providing adequate space for ventilation to reduce heating up.
- Poor curing, during harvesting may lead to combustion due to heating up and reduce forage quality. This increases incidences of hay fires.
- Hay stored under poorly sheltered storage area increases possibilities of rotting and growth of mould.
- Well protected storage/shelter against rain is advised.

5.9 Parts of a forage plant/crop

- Leaves have more nutritive elements than stems.
- Leaves contain more sugars, protein and less fiber.
- As plant matures, the leaf-stem ratio declines. Stems become more lignified and palatability reduces.
- Stems contain more fiber less sugar and less protein.

Parts of Maize forage plant/crop

- For silage making, the maize cob is an important consideration.
- The grains of maize plant contains a large proportion of starch.
- Grains also contribute to yield/biomass hence nutritional quality of the forage.
- The cob and kernel maturity contributes to the dry matter of the whole plant.
- More leaf ears also contribute to greater dry matter yield.
- The cob should be included when making silage and should be properly chopped and crushed.



6. Primary evaluation of forages/feed

Color

- Gives a sense of the condition of the feed i.e. maturity.
- Dark green color in forages is a sign of high protein, low fiber and high digestibility. The dark green color is caused by higher nitrogen content.
- Yellow to brown color shows low nitrogen content in forage.

Smell

- Gives an indication of the type of fermentation or whether the feed is contaminated.
- Cows are sensitive to bad smell. This can reduce feed intake.

6.1 Primary evaluation of forages/feed Cont'd: Touch/feel

- One can identify moisture content in the feed by touching or squeezing.
- Crops with rough stems, usually deep yellow to brown in colour, with few dead leaves are a sign that they have high fibre content due to high stem ratio to leaves.

6.2 Primary evaluation of forages/feed
Cont'd: Homogeneity

- Homogeneity refers to uniformity in composition. It checks the pureness of a feed ingredient.
- In pastures, manage weeds to avoid them competing with main crop for nutrients and avoid adding them to the ration.
- Moulds reduce feed intake and also cause health problems to cows, affecting their performance.

6.3 Primary evaluation of forages/feed Cont'd: Size

Grasses

- Size of forage & feed gives information on growth.
- Overgrown forage tend to have more stems than leaves hence low nutritive content and high fiber content.
- Chopping forage reduces selection by cows while feeding while encouraging feed intake.

Silage

- Maize grain should be crushed to make it available to cows for better utilization and reduce wastage.

7. Assessing quality of forage at the farm: Tropical grasses

- Fresh grass is a cheap source of feed for farmers and has high crude protein if cut/grazed at the right stage. Examples are Kikuyu grass, Brachiaria grass, Napier grass etc.
- Fresh mowed grass have a fresh-grass odor when cut.
- Tall variety grasses get mature when they reach knee-height.
- Fresh forages are of high quality than conserved forages provided they are managed and cut for feeding at right stage.

7.1 Assessing quality of forage at the farm Cont'd: Pastures

- Mixed pastures (containing legumes and grass) are more nutritive than monocultures. This is due to nitrogen fixation by legume forages from the atmosphere.
- Pasture regeneration is influenced by climatic conditions.
- In dry periods pasture regeneration is low, increasing period taken for grasses to mature. This affects forage quality.
- Poorly managed pastures are prone to selection by cows, reducing forage utilization compared to cut and carry forages.

7.2 Assessing quality of forage at the farm Cont'd: Hay

- Overgrown forage tend to have more stems than leaves hence low nutritive content and high fiber content.
- It is not advisable to cut grass for hay at flowering stage as nutritive value will be low.
- Aim at a maximizing quality and quantity of grasses.
- Low quality hay has a musty or mouldy odor. If identified, mouldy parts should be discarded (not fed to cows).

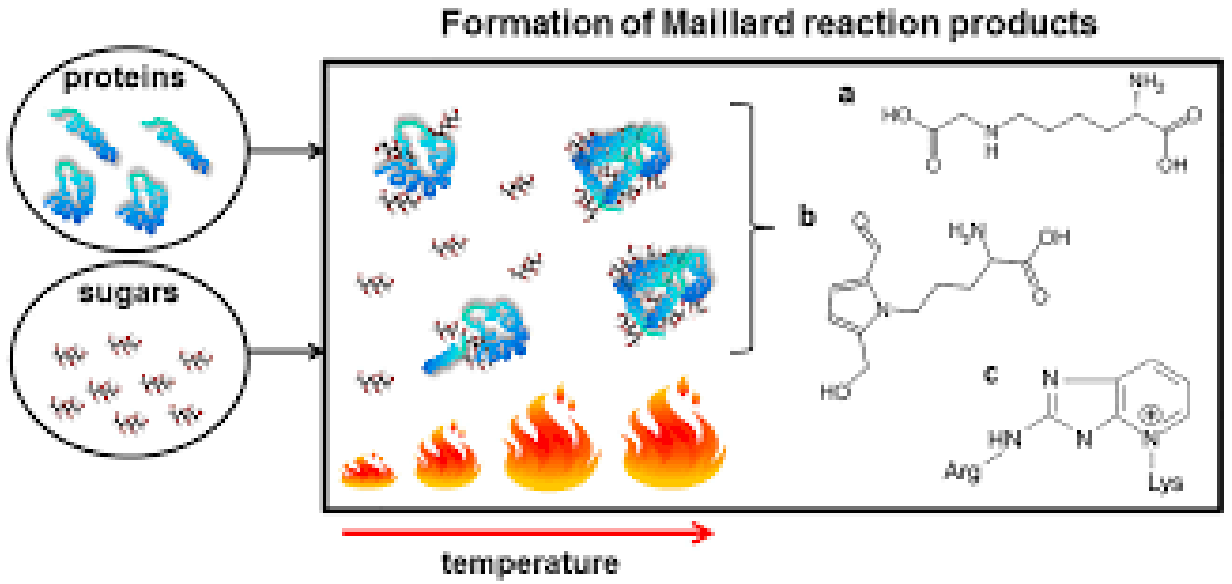
8. Evaluating quality of ensiled forages

- Forage nutritive content should be checked in the field before ensiling.
- If forages are not properly ensiled nutritional value depreciates.
- When evaluating ensiled forages one should look at;
    i. Dry matter content
    ii. Fermentation process of forage – how well the material fermented (smell, lactic acid, acetic acid, butyric acid).
    iii. Nutrient content (fiber, starch and crude protein).
    iv. Temperature
    v. Spoilage

8.1 Evaluating quality of ensiled forages Cont'd: Temperature

Effects of heat damage on feed to protein

- Excessive exposure of feeds to heat exposes feeds to damage.
- Damage often occurs during processing/harvesting and storage periods.
- When feeds are exposed to heat a process called "browning" or "maillard reaction" occurs.
- The reaction occurs during heating as protein portion of the feed is bonded to the fiber portion of the feed. This reaction causes proteins to be wholly or partially unavailable for digestion by the cow.



8.2 Evaluating quality of Maize Silage

- Harvest silage at dough stage.
- Use plant varieties recommended for silage making.
- Maize grain should be included during ensiling and be crushed for proper utilization by the cow.
- Maize silage should have to dry matter content of 30-35%.
- Good quality silage should be golden yellow in color.
- Silage should be well compacted and covered within the shortest time to prevent air entry that cause growth of mould.

8.3 Evaluating quality of Grass Silage

- Make grass silage when the crop has more protein content.
- Wilt the grass to approximately 30-35% Dry matter (DM). High DM indicates high fiber content that will make compaction hard.
- Ideally chop the forage into pieces of 1-3 cm for better (compaction) ensiling.
- Closing pit soonest reduce air entry that increase mold growth.
- Avoid soil contamination, which occurs mostly when DM is low and when cutting height is low.
- Good quality grass silage should be green-yellow in color and have a slightly acidic fruity smell.

9. Stovers and straws

- This refers to crop residues of food crops. Examples include wheat straws, maize stovers, beans stovers and sorghum stovers.
- Stovers and straws are low in feeding/nutritive value.
- This forages can however be used to enhance rumen activity due to their high roughage content e.g wheat straws.

10. Factors affecting feed intake

Failure to give animals quality feed as per the different needs results in reduced performance (growth, milk or meat production) hence reduced income. Factors include:

- Feed selection: feed selection by animals occur when there is presence of irritating smell, feel and taste; all which influences palatability.
- Rate of nutrient digestion: leafy and easily digested forages have high passage rate compared to fibrous forages that take a long period in the rumen - they are slowly digested and have low nutritive value.

10.1 Factors affecting feed intake Cont'd…

- Chopping size: influences dry matter intake; the small particle sizes (0.8-1 cm minimum chopping size) eases intake by the animal.
- Contamination: such as moulds and rotten feeds decreases the animal feed intake.
- Anti-nutritive factors: are commonly related to leguminous trees & shrubs. Farmers should identify presence of any of these factors and limit amount to feed a cow.

11. Secondary evaluation of forages/feed

Chemical testing

- Chemical evaluation of feeds require testing in laboratories.
- Such tests can be undertaken by government or private sectors laboratories.
- Laboratory tests offer an in-depth evaluation of forages compared to primary evaluations.
- Unlike physical evaluation, chemical evaluation are not done by a farmer independently.

Sampling feed for laboratory analysis

11.1 Basic components of secondary feed analysis

- Farmers should understand the major components of feed analysis to interpret analysis reports.
- Components of feed analysis include;
    i. Dry matter
    ii. Energy
    iii. Crude protein
    iv. Crude fiber
    v. Fat
    vi. Crude Ash
    vii. Carbohydrates (sugar and starch)
    viii. Neutral detergent fiber (NDF)
    ix. Acid detergent fiber (ADF)
    x. Digestibility

Further reading: See module on 'Sampling feeds & forages/analysis interpretation.'

Sample Name : Maize silage

Parameter		Unit	Result
Energy	E	MJ/Kg	7.60
Protein	Protein	%	8.18
Fibre	Fibre	%	21.9
Fat	Fat	%	1.19
Total Ash	Ash	%	6.74
Starch	Starch	%	17.6
Acid detergent fibre	ADF	%	26.5
Neutral Detergent Fibre	NDF	%	49.3
Sugar	Sugar	%	< 0.50
Digestibility (NCGD)	NCGD	%	52.0
Dry matter	DM	%	33.6
Aflatoxin (Total B1, B2, G1, G2)	Aflatoxin(Total)	ppb	3.00

12. Secondary feed testing: Dry matter (DM)

- Dry matter in forage refers to what remains after removal of water from a feed.
- Hay/maize grain for example has a higher DM content as compared to fresh grass due to higher water content present in fresh grass.
- DM is measured in percentage and all nutrients in feeds are found in the dry matter portion.

Examples:

- Sweet potato vines <20% DM (=80% moisture).
- Grasses <25% DM (75% moisture).
- Hay > 85% (=15% moisture).
- Silage 30- 40% DM (= 70-60% moisture).

12.1 Testing Dry matter (DM)

- Test can be carried out using a microwave, fan-forced oven or other recommended instrument. This can be done by the farmer.

Procedure

- Weight and record empty container/paper plate.
- Place feed in the container.
- Weigh and record total weight (container & feed).
- Determine weight of feed by subtracting weight of container from total weight and record it.
- Dry the feed, under recommended conditions depending on equipment being used.
- After drying, get the total weight and later, weight of the container when emptied and record.

12.2 Calculating Dry matter (DM)

- From the total weights recorded, one can derive the weight of dry sample and fresh sample for calculation.

DM (%) = Dry weight of sample / Fresh weight of the sample × 100

- Calculation of dry matter can be done at farm level easily using various heating equipment's i.e. microwave, dryer & electronic methods.
- When using the various equipment’s one should follow instructions to avoid tampering with the sample.

13. Secondary feed testing: Crude Protein (CP)

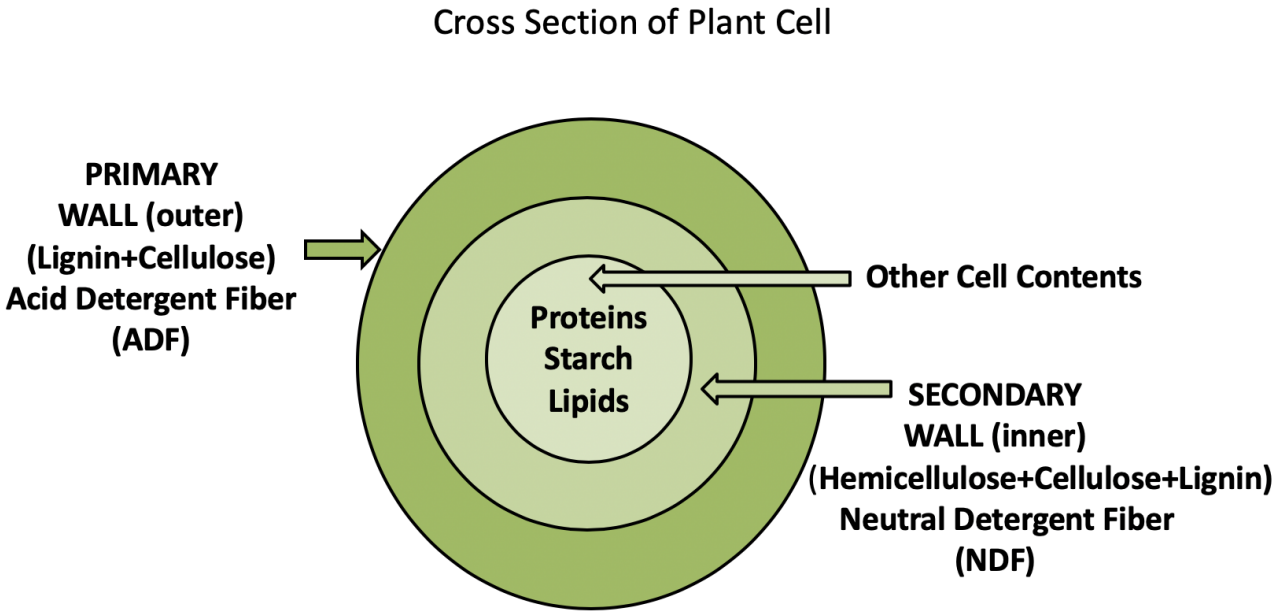
- Measures the protein content in feeds.
- CP is measured in percentage (%).
- Measure of protein in feed is based on the nitrogen, which is a component of protein.
- Calculated by multiplying the %nitrogen with 6.25.

$$\%CP = \%N \times 6.25$$

Note: It is assumed that proteins contain an average of 16%N hence the conversion rate of 6.25 (100/16).

14. Secondary feed testing: Crude Fibre (CF)

- Measures the fiber content in plants.
- Crude fiber is a residue obtained when forage is treated to acid hydrolysis followed by alkaline hydrolysis during chemical testing in a laboratory.
- Crude fiber residue contains;
  - True cellulose
  - Insoluble lignin



"Crude Fiber" = Neutral Detergent Fiber + Acid Detergent Fiber

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