

SAMPLING FEEDS & FORAGES/ANALYSIS

INTERPRETATION (Level 2)

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)



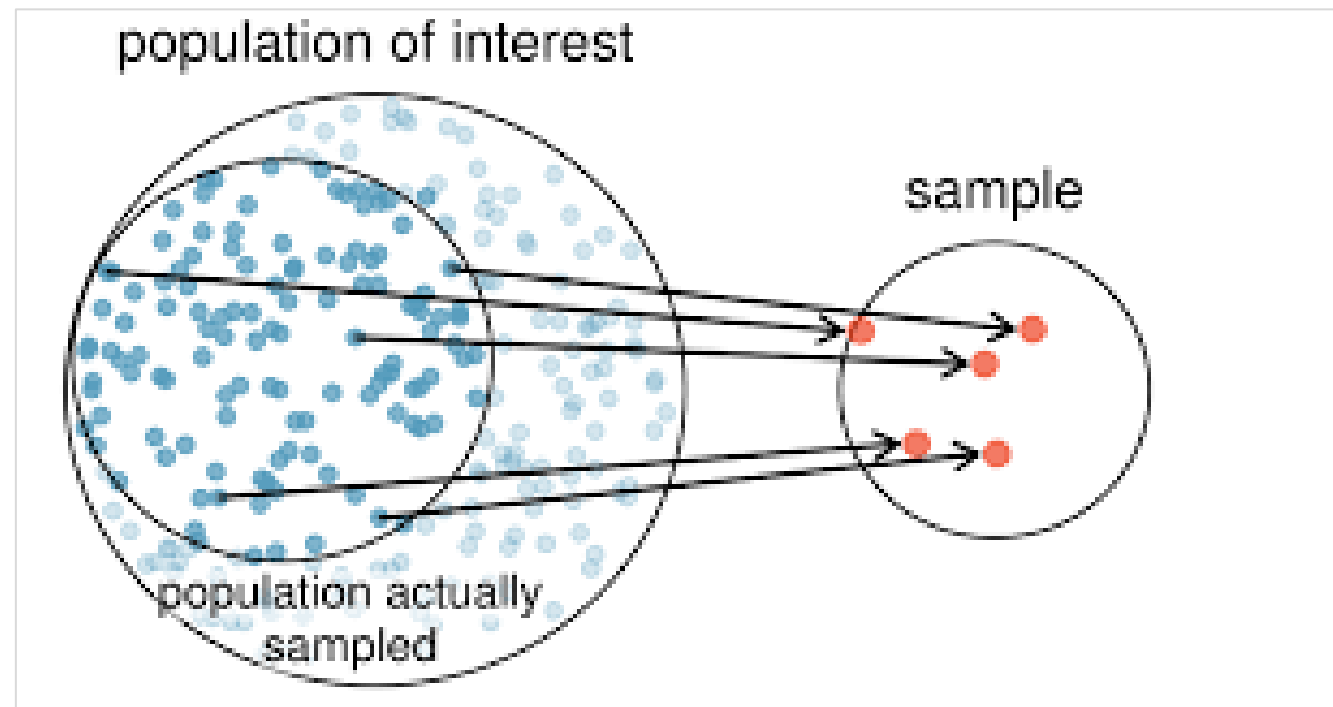
1. You will learn about (learning objectives):

- Importance of feed sampling.
- How to carry out sampling in a farm.
- Tests made on feed & forage samples.
- How to interpret feed & forage analysis results.



2. Background

- Sampling involves collecting a predetermined number of observations from a large population, for example collecting a representative sample of grass from various spots in a field.
- Analysis gives detailed explanation of the structure of a sample.
- Sampling & analysis is mostly done to confirm quality of feed and forage for the dairy cows.



3. Importance of forage sampling & analysis

- i. Helps identify the nutritive value and mineral composition of feeds and forages.
- ii. Identifies contamination in feeds and forages such as: mycotoxins, chemical residues, heavy metals etc.
- iii. Knowing the chemical composition of feeds and forages in relation to cost of these ration ingredients can assist to reduce/minimize total feed cost in a farm.
- iv. Helps to formulate and balance rations for different animal categories.



4. Guidelines for sampling feed/forages

- Identify feeds and forages to be tested.
- Samples need to be taken from different batches of feeds; representative of the total batch.
- Take many small portions from various places of the batch.
- Before sending the samples to the laboratory, package appropriately, label and record.
- Deliver samples to the laboratory as fast as possible preferably within 24hrs.



SAMPLE

Mat _____

Lot No _____

PN _____

Amt _____ Date _____

By _____

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5. Tools and equipment for sampling



Forage probe



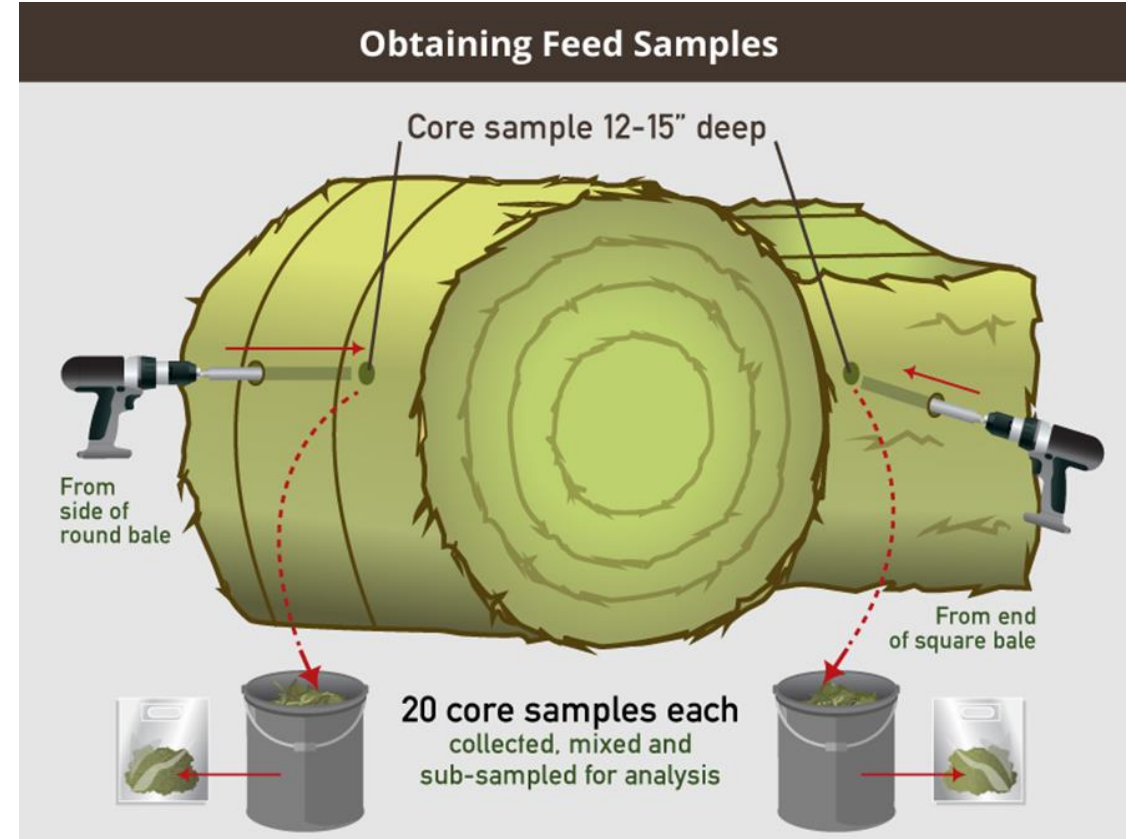
Grain probe



Bag with zip lock

6. Actual sampling

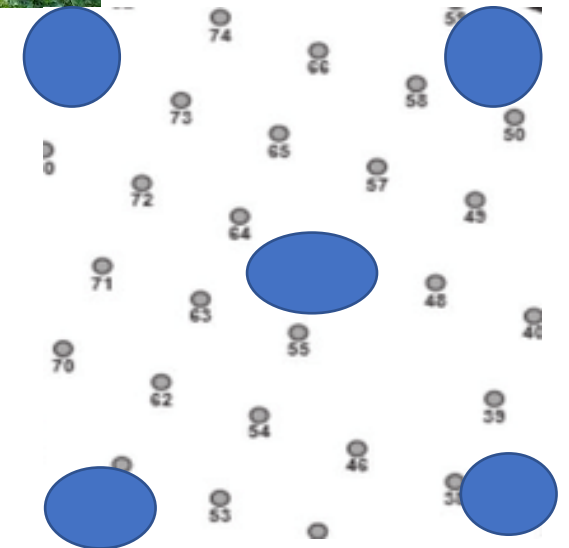
- The first step of chemical evaluation or analysis of fodder & feed is taking samples.
- Appropriate sampling needs to be done to get accurate results on the feed analysis report.
- Suitable and appropriate sample equipment needs to be used.
- Most samples are taken during loading and offloading or while in storage for example: silage silo/clamp, hay stack.
- Sampling procedure varies depending on the type of feed/forage.



7. Collecting samples of fresh pasture grass

- Cut one meter square sampling area at random in the plot to be harvested.
- Weigh all the grass within the meter square that is cut.
- Repeat the same procedure from various places going through the pasture in an 'X' or 'Z' pattern.
- Take a total grass samples of about 1kg from various areas and package.
- Samples after packaging needs to be well sealed, labelled and recorded before sending to the lab.

Meter square sample area



8. Collecting samples from bagged feeds

- Pick sub-samples of the feed from different bags in the batch.
- Mix the different sub-samples thoroughly for example in a clean bucket.
- Collect approximately 1kg of the mixed sub-samples for analysis.
- Put the 1 kg sample in a paper bag/plastic bag (if the sample is dry). If the sample is moist, a plastic zip-lock bag is preferred.
- The sample after packing needs to be well sealed, labelled and recorded before sending it to the laboratory for analysis.



9. Collecting samples of silage from a silo

- Take samples from different sites on the silage silo/clamp. Use forage probe or pick a handful.
- Sites picked need to be representative of the silage silo.
- Sample needs to be taken below 30 cm at all sides.
- Collect all the sub-samples and mix them in a clean empty bucket.
- Mix the different sub-samples thoroughly in the bucket.
- Take a 1kg sample from the mixture and put it in a plastic zip lock bag.
- After packing seal, label and record before sending it to the laboratory for analysis.
- Send the sample the same day or store it refrigerated (but not deep frozen).



10. Collecting samples from hay bales

- Using a hay probe, pick a sample from the center of one face of the bale.
- Face picked hay should have good distribution of leaves and stems.
- Follow the same procedure for a number of bales to get representative sub-samples of the whole batch.
- Take the different sub-samples and mix evenly in a clean empty bucket and collect approximately 1kg of the mixed sub-samples for analysis.
- The sample after packing needs to be well sealed, labelled and recorded before sending to the laboratory for analysis.



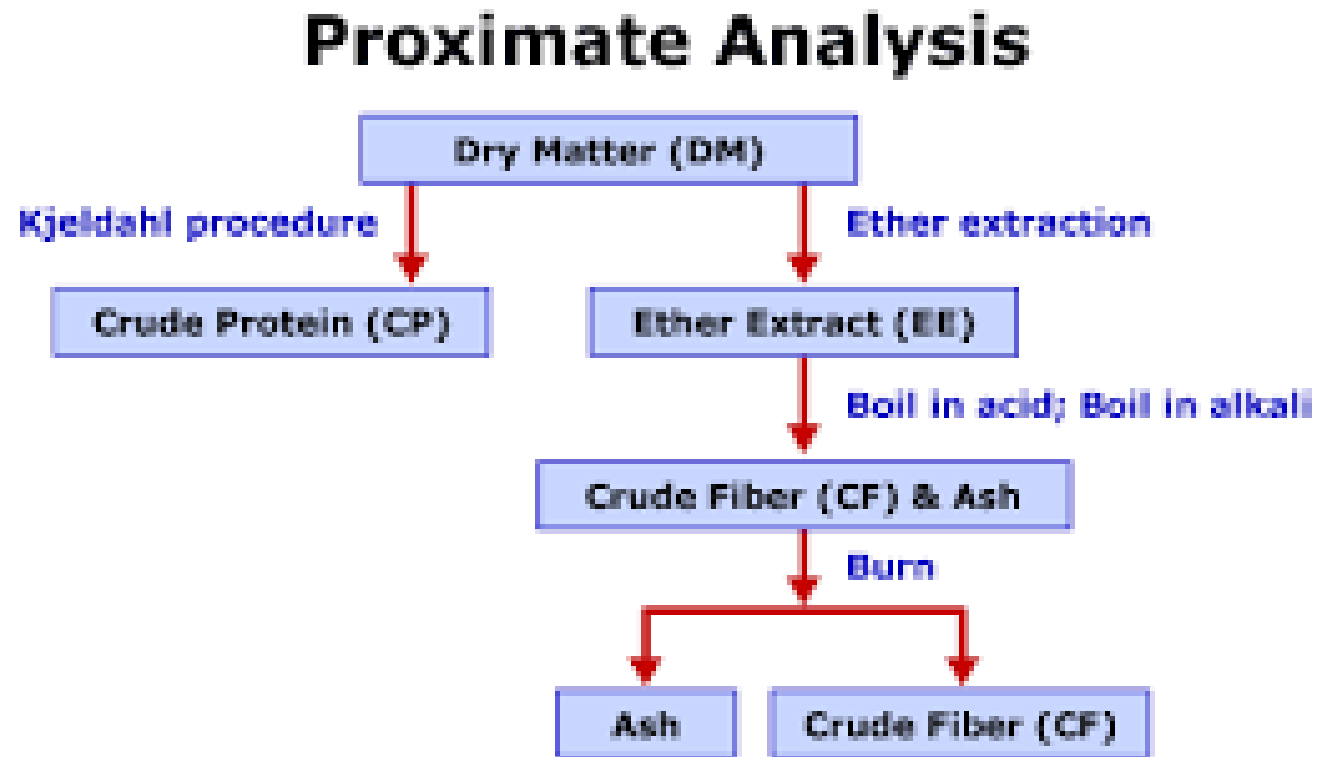
11. Types of tests in feed analysis

- There are two common tests used in a laboratory;
 - i. Chemical tests
 - ii. Near infra red (NIR) spectroscopy
- Modern tests involve both chemical procedures in the lab and Near infra-red (NRI) tests.
- Chemical tests, also called wet chemistry is a method that was used in the past and used a series of chemical procedures.
- Near infra-red (NIR) spectroscopy is a new technology that uses light, suitable to determine harvest time and quality at storage.



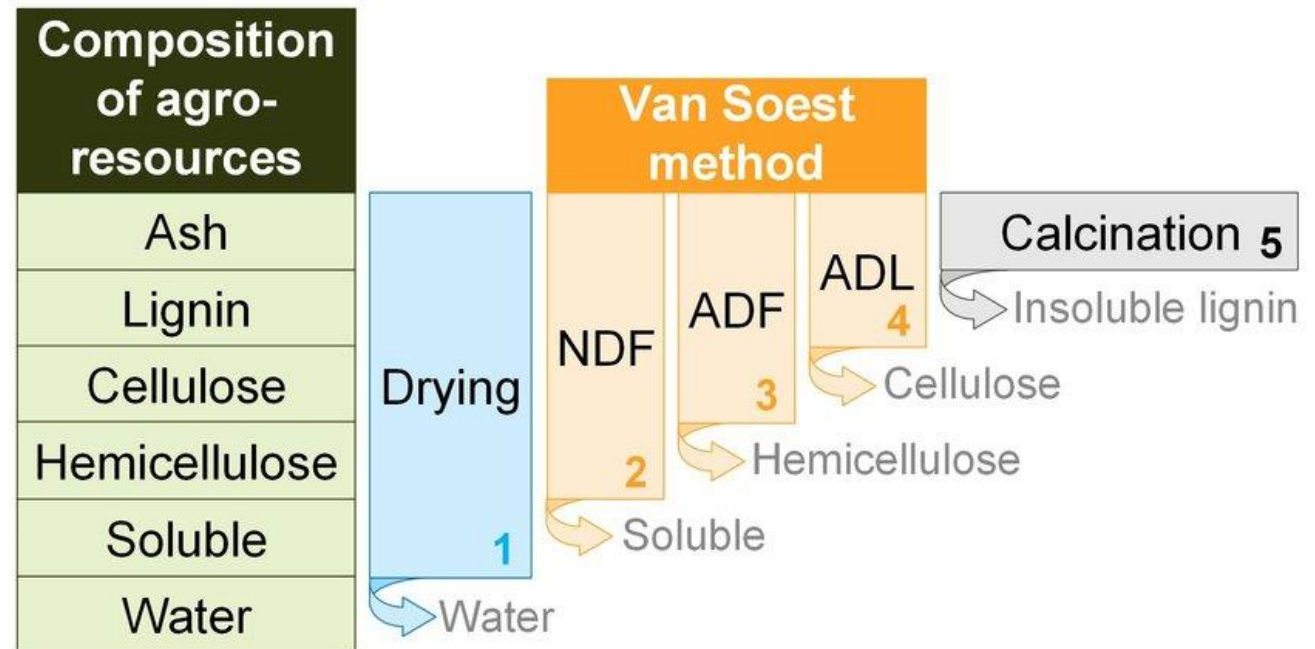
12. Proximate analysis

- This is the common and basic system used in most laboratories for testing feedstuffs.
- The analysis evaluates:
 - Dry matter content (DM)
 - Crude protein (CP)
 - Crude fiber (CF)
 - Fats/Ether extract (EE)
 - Ash
 - Starch
 - Sugar
 - Digestibility



13. Van Soest analysis

- The Van Soest method of analysis looks into the composition of fiber component of forages.
- Proximate analysis offers the general analysis of crude fiber in forages.
- For ruminant nutrition, it is important to understand how different fiber components affects digestibility and intake.
- The van Soest method differentiates fiber components into:
 - Neutral detergent fiber (NDF)
 - Acid detergent fiber (ADF)
 - Acid detergent lignin (ADL)



14. Interpreting feed/fodder analysis reports: Energy

- Energy value shows the amount of energy a cow can get from the feed for various body functions.
- Energy is mathematically calculated and measured in MJ/Kg.
- Total digestible nutrients (TDN) is used as a measure of energy.
- The higher the energy value the higher the energy present in the feed.
- Energy is greatly needed for many body functions of the cow and should be given priority.

Parameter		Unit	Result	Method
Energy	E	MJ/Kg	9.41	Calculated
Protein	Protein	%	10.5	ISO 5983-2
Fibre	Fibre	%	33.8	ISO 6865
Fat	Fat	%	3.22	Gafta 3
Total Ash	Ash	%	9.53	ISO 5984
Starch	Starch	%	< 0.10	NIR
Acid detergent fibre	ADF	%	42.5	NIR
Neutral Detergent Fibre	NDF	%	67.9	NIR
Sugar	Sugar	%	< 0.50	NIR
Digestibility (NCGD)	NCGD	%	58.8	NIR
Dry matter	DM	%	94.5	ISO 6496

14.1 Total Digestible Nutrients (TDN)

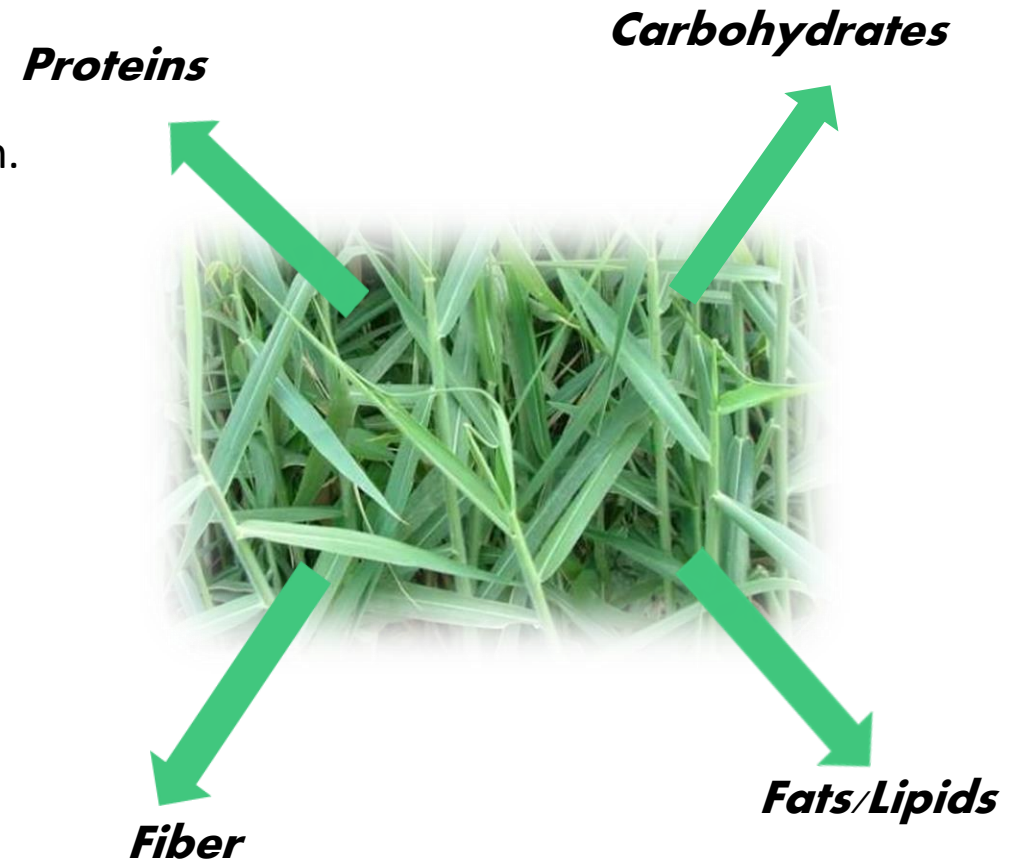
- TDN is in a dry matter basis and is calculated on ADF basis and directly related to digestibility.
- TDN over-estimates energy values of forages than grain.

$$\text{TDN} = \text{dig CP} + \text{dig CF} + \text{dig NFE} + (\text{dig Fats} \times 2.25)$$

$$\text{NFE} = 100 - (\% \text{Moisture} + \% \text{CF} + \% \text{CP} + \% \text{Fats} + \% \text{ash})$$

KEY: dig = Digestible, CP = Crude protein, CF = Crude fiber, NFE = Nitrogen free extract.

- Nitrogen free extract (NFE) consist of carbohydrates, starch and sugars like substances.



15. Crude Protein (CP)

- Measures the protein content in feeds using ISO 5983-2 method.
- CP is measured in percentage (%) and also provides energy.
- Measure of protein in feed is determined by the amount of nitrogen (component of protein) in the feed.
- It is assumed that proteins contain an average of 16%N hence the conversion rate of 6.25 (100/16).
- It is calculated by multiplying the %nitrogen with 6.25

$$\text{CP (\%)} = \%N \times 6.25$$




16. Crude Fat (Ether Extract)

- Measures crude fat content of feedstuff and is estimated using Gafta 3 method.
- Is a source of energy, but not an important source of energy for ruminants.
- Fat content in feed is advised to be low; at least less than 5% of the total ration as it interferes with digestion of fiber.
- High fat content in ration coat fiber in the digestive tract interferes with fiber digestion and feed palatability.

Parameter		Unit	Result	Method
Energy	E	MJ/Kg	9.41	Calculated
Protein	Protein	%	10.5	ISO 5983-2
Fibre	Fibre	%	33.8	ISO 6865
Fat	Fat	%	3.22	Gafta 3
Total Ash	Ash	%	9.53	ISO 5984
Starch	Starch	%	< 0.10	NIR
Acid detergent fibre	ADF	%	42.5	NIR
Neutral Detergent Fibre	NDF	%	67.9	NIR
Sugar	Sugar	%	< 0.50	NIR
Digestibility (NCGD)	NCGD	%	58.8	NIR
Dry matter	DM	%	94.5	ISO 6496

17. Ash

- Ash in feed is compiled by minerals in the feed and possible contamination of soil.
- It determines the content of inorganic components in the feed.
- Value for ash should range between 5-8%.
- Grasses have ash content around 6%.
- Lucerne on the other side has a value of 8%.
- Recommended ash content should be below 10%. If ash content is higher than 10% chances are that the forage is contaminated with soil.

Parameter	Parameter	Unit	Result	Method
Energy	E	MJ/Kg	9.63	Calculated
Protein	Protein	%	13.4	ISO 5983-2
Fibre	Fibre	%	31.9	ISO 6865
Fat	Fat	%	3.88	Gafta 3
 Total Ash	Ash	%	11.7	ISO 5984
Starch	Starch	%	< 0.10	NIR
Acid detergent fibre	ADF	%	42.5	NIR
Neutral Detergent Fibre	NDF	%	63.0	NIR
Sugar	Sugar	%	< 0.50	NIR
Digestibility (NCGD)	NCGD	%	60.2	NIR
Dry matter	DM	%	89.8	ISO 6496

18. Starch

- Starch is a readily accessible source of energy for cows.
- It shows the level of starch content present in highly fermentable carbohydrates for example cereals/grains (wheat bran) and maize silage.
- Starch is analysed using Near Infra-red (NIR) spectroscopy method.
- High starch levels should be limited to dairy cows; this prevents rumen pH going low causing rumen acidosis. This condition limits fiber intake.

Parameter		Unit	Result	Method
Energy	E	MJ/Kg	9.41	Calculated
Protein	Protein	%	10.5	ISO 5983-2
Fibre	Fibre	%	33.8	ISO 6865
Fat	Fat	%	3.22	Gafta 3
Total Ash	Ash	%	9.53	ISO 5984
Starch	Starch	%	< 0.10	NIR
Acid detergent fibre	ADF	%	42.5	NIR
Neutral Detergent Fibre	NDF	%	67.9	NIR
Sugar	Sugar	%	< 0.50	NIR
Digestibility (NCGD)	NCGD	%	58.8	NIR
Dry matter	DM	%	94.5	ISO 6496

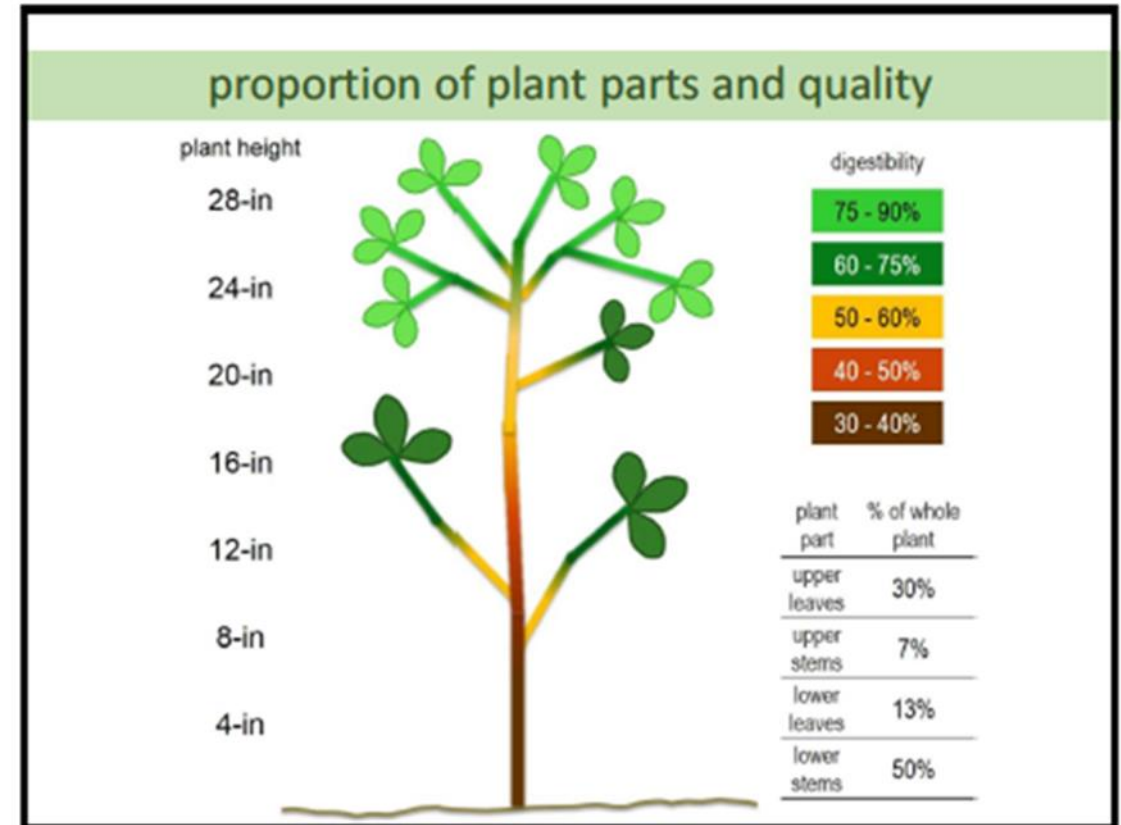
19. Sugar

- Is a rapidly fermentable carbohydrate.
- Level of sugar should be considered as it can cause acidosis at excessive levels.
- Sugar is analyzed using Near Infra-red spectroscopy method.
- Example of such feed sources are molasses and brewers waste.



20. Digestibility

- Digestibility refers to the level at which a feedstuff is absorbed in cows body as it goes through cows digestive system.
- It is measured as a percentage.
- Digestibility is analysed using Near infra-red spectroscopy method.
- Digestibility varies with the type of crop and particularly stage of harvesting.



21. Dry Matter (DM)

- Dry matter is what remains after water (moisture) is removed from a feed/forage.
- Nutrients are found in the dry matter portion.
- DM is measured using ISO 6496 method.
- Rations are made on a dry matter basis.
- To convert 'as fed' basis to 'DM-basis', divide the 'as fed' basis by the sample percentage dry matter.



21.1 Examples of recommended DM of feed

- Recommended DM of maize silage is 30-37%.
- Recommended DM of grass silage is 30-35%.
- DM in silage is influenced by time of harvesting.
- Recommended DM of dry fodder (hay) is 82-85%.
- If the dry matter content in silage is below 30%, the silage is considered to be wet.
- Wet and very dry forages are difficult to ensile.
- If the DM is above 40%, that silage is considered to be dry.

30-37% DM

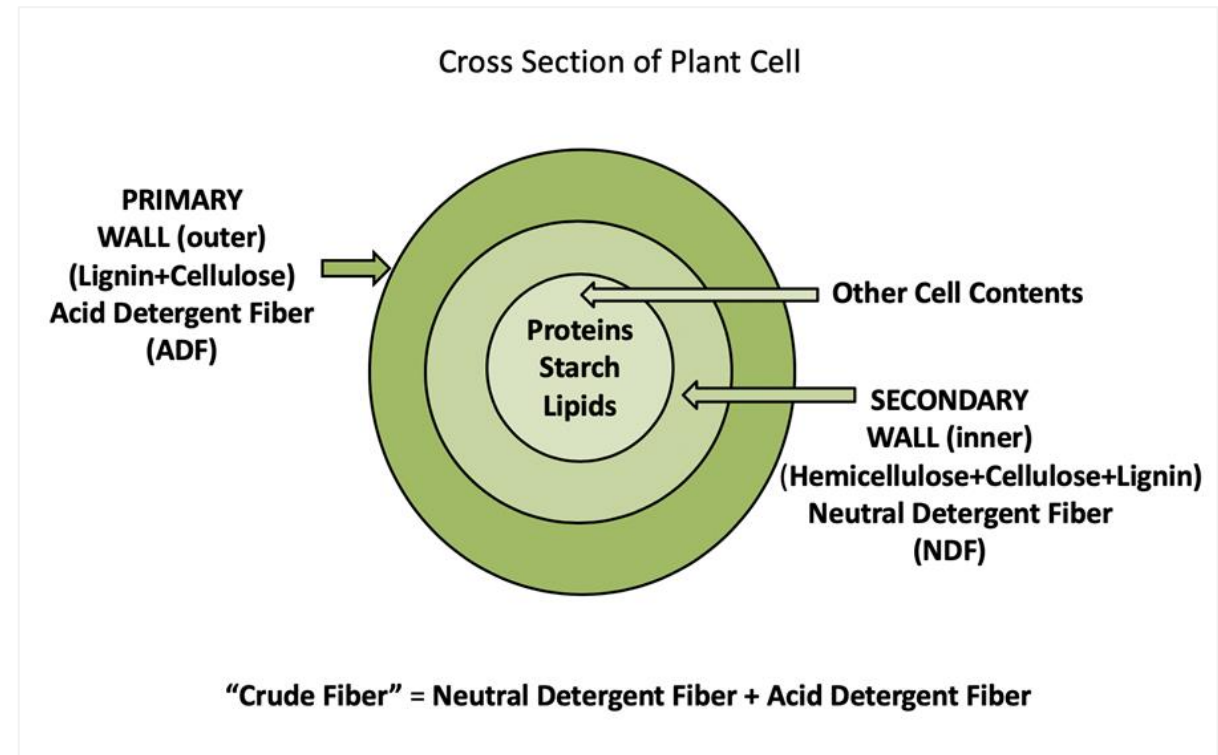


82-85%DM



22. Crude Fibre (CF)

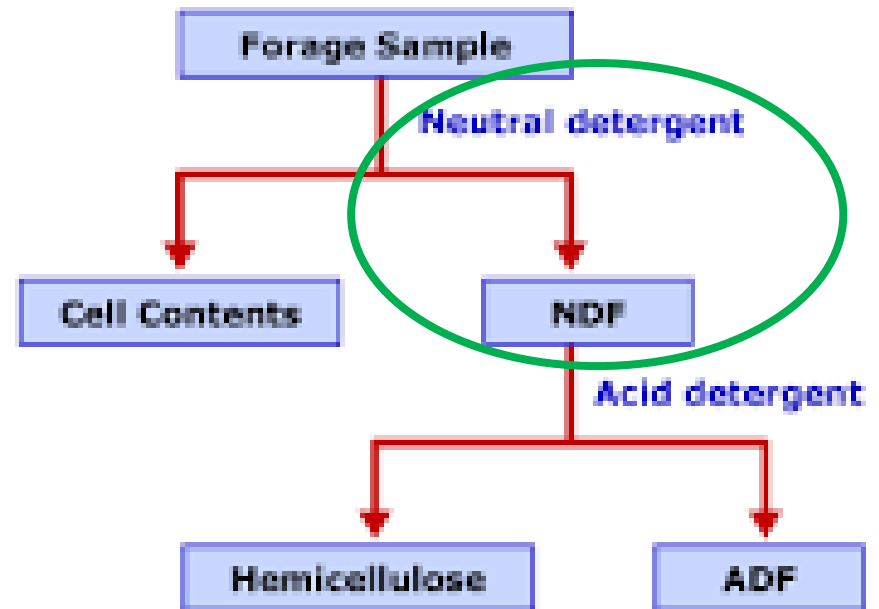
- Commonly represented as fiber in forage analysis reports.
- Measured using ISO 6865 method.
- Crude fiber measures the total fiber contents in forages.
- Total fiber looks at the amount of less digestible/indigestible parts of a feed that is for example; cellulose, hemicellulose and lignin.
- The higher the fiber the lower the energy content in feed.
- Most common fiber components measured in forage are crude fiber, NDF and ADF.



23. Neutral Detergent Fibre (NDF)

- NDF measures total cell wall content of a plant, which includes ADF fraction (lignin & cellulose) plus hemicellulose.
- It indicates the fibre content indicating plant maturity.
- High levels of NDF restricts animals intake, NDF increases as forage matures and low levels of NDF affects the rumen health, caused by rumen acidosis.
- Concentrates have the lowest NDF (causes rumen acidosis if taken in large amounts).
- NDF is measured as a percentage and is linked with DM intake of feed as it provides fill.
- The target is to keep NDF content <40% Alfalfa and NDF <55% in tropical grasses.

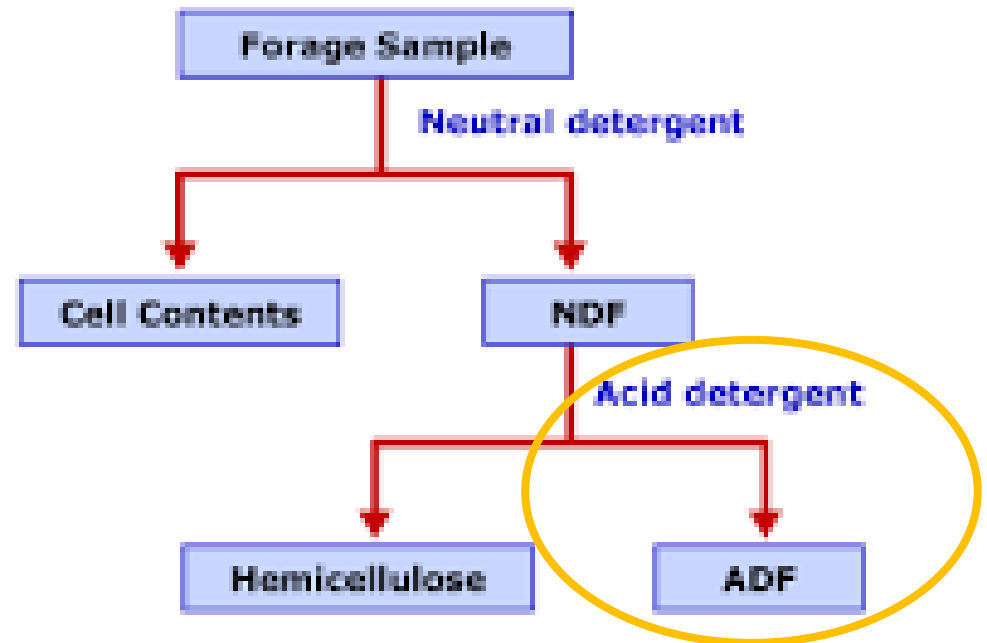
Detergent Fiber System



24. Acid Detergent Fibre (ADF)

- It measures the indigestible portions of a plant cell wall i.e. lignin and cellulose.
- ADF reflects degree of lignification.
- High ADF indicates plant is more mature & low quality hence poor digestibility.
- It is linked with energy calculation, forages that are high in ADF generally have low energy.
- Is measured as a percentage.
- Target <35% Alfalfa and <35% grasses.

Detergent Fiber System



25. Feed analysis report

Logo

- Found at the top of the report.
- Address of laboratory can also be found here or at the bottom of the report.



Type of analysis

- Kind of analysis done is indicated at the top near the logo.

Report reference

- Client/customer detail i.e. contact and address
- Detail of sample and reason for test.
- Date i.e. when sample was received and analyzed.

Feed Analysis Report
Proximate Analysis on Dry Feed (NIR)

Report Ref#: CN-91241 TL/21

Customer :	[Redacted]	Comments :		Date Received :	08-Jun-21
Address :	[Redacted]	Condition :	Hay	Analysis Date :	11-Jun-21
Farm Name :	[Redacted]		Ruminant	Report Date :	11-Jun-21
Contact Person :	[Redacted]			Sample ID :	CS303AF0002

Sample Name : Sample 1 Voi

Parameter	Unit	Result	Method	
Energy	E	MJ/Kg	9.11	Calculated
Protein	Protein	%	10.6	ISO 5983-2
Fibre	Fibre	%	32.3	ISO 6865
Fat	Fat	%	3.19	Gaifa 3
Total Ash	Ash	%	10.1	ISO 5984
Starch	Starch	%	< 0.10	NIR
Acid detergent fibre	ADF	%	42.1	NIR
Neutral Detergent Fibre	NDF	%	64.7	NIR
Sugar	Sugar	%	2.69	NIR
Digestibility (NCGD)	NCGD	%	56.9	NIR
Dry matter	DM	%	88.6	ISO 6496

25.1 Components of feed analysis report

Results section

- Results of feed analysis are reported on Dry Matter basis.
- Other laboratories offer results on both 'As fed' and 'Dry Matter' basis.
- The table in the results section gives details of;
 - Parameter tested
 - Unit of measure for specific parameter
 - Result of parameter
 - Method used to measure parameter tested.

Approval section

- Contains date and signature from authorized personnel to show result is approved by the organization.
- Comment section is also found here and in other cases at the top before results section.

Sample Name : Maize Silage			
Parameter		Unit	Result
Energy	E	MJ/Kg	8.50
Protein	Protein	%	8.58
Fibre	Fibre	%	19.1
Fat	Fat	%	3.90
Ash	Ash	%	4.59
Starch	Starch	%	16.3
Acid detergent fibre	ADF	%	21.3
Neutral Detergent Fibre	NDF	%	49.3
Sugar	Sugar	%	< 0.50
Digestibility (NCGD)	NCGD	%	53.3
Dry matter	DM	%	27.3
Aflatoxin (Total)	Aflatoxin(Total)	ppb	

CROPNU
LABORATORY FOR
ROCKET FISH PRODUCTION

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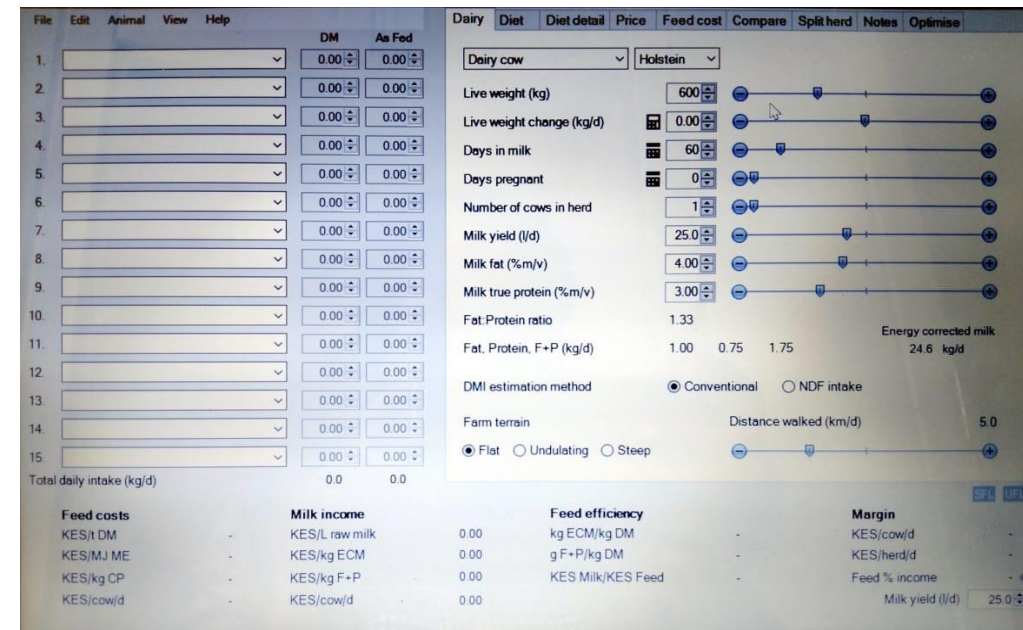
Parameter	Unit	Result	
Energy	E	MJ/Kg	8.50
Protein	Protein	%	8.58
Fibre	Fibre	%	19.1
Fat	Fat	%	3.90
Total Ash	Ash	%	4.59
Starch	Starch	%	16.3
Acid detergent fibre	ADF	%	21.3
Neutral Detergent Fibre	NDF	%	49.3
Sugar	Sugar	%	< 0.50
Digestibility (NCGD)	NCGD	%	53.3
Dry matter	DM	%	27.3
Aflatoxin (Total)	Aflatoxin(Total)	ppb	

Approved by: *[Signature]* Managing Director
Approval Date: 16/04/2020

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26. Utilizing forage analysis report

- Results of feed analysis can be easily used to balanced feed rations for cows.
- Information from forage report guides farmers and nutritionists when supplementation should be considered .
- Cows have different requirements depending on stage of lactation, production and weight of the animal.
- Farmers can either use;
 - i. Manual calculation,
 - ii. Excel spreadsheet, or
 - iii. Computer programs for example Rumen8.



The screenshot displays the Rumen8 software interface. On the left, there is a table for inputting feed ingredients (1-15) with columns for DM and As Fed values, all currently set to 0.00. The main panel on the right allows for adjusting various parameters for a 'Dairy cow' (Holstein breed) with a live weight of 600 kg. Parameters include live weight change (0.00 kg/d), days in milk (60), days pregnant (0), number of cows in herd (1), milk yield (25.0 l/d), milk fat (4.00 %m/v), milk true protein (3.00 %m/v), fat:protein ratio (1.33), and energy corrected milk (24.6 kg/d). The 'DMI estimation method' is set to 'Conventional'. The 'Farm terrain' is set to 'Flat'. The 'Distance walked' is 5.0 km/d. At the bottom, a summary table shows feed costs, milk income, feed efficiency, and margin.

Item	Unit	Value
Feed costs		
KES/t DM	-	
KES/MJ ME	-	
KES/kg CP	-	
KES/cow/d	-	
Milk income		
KES/L raw milk	0.00	
KES/kg ECM	0.00	
KES/kg F+P	0.00	
KES/cow/d	0.00	
Feed efficiency		
kg ECM/kg DM	-	
g F+P/kg DM	-	
KES Milk/KES Feed	-	
Margin		
KES/cow/d	-	
KES/herd/d	-	
Feed % income	-	
Milk yield (l/d)	25.0	