# JKPSC VO

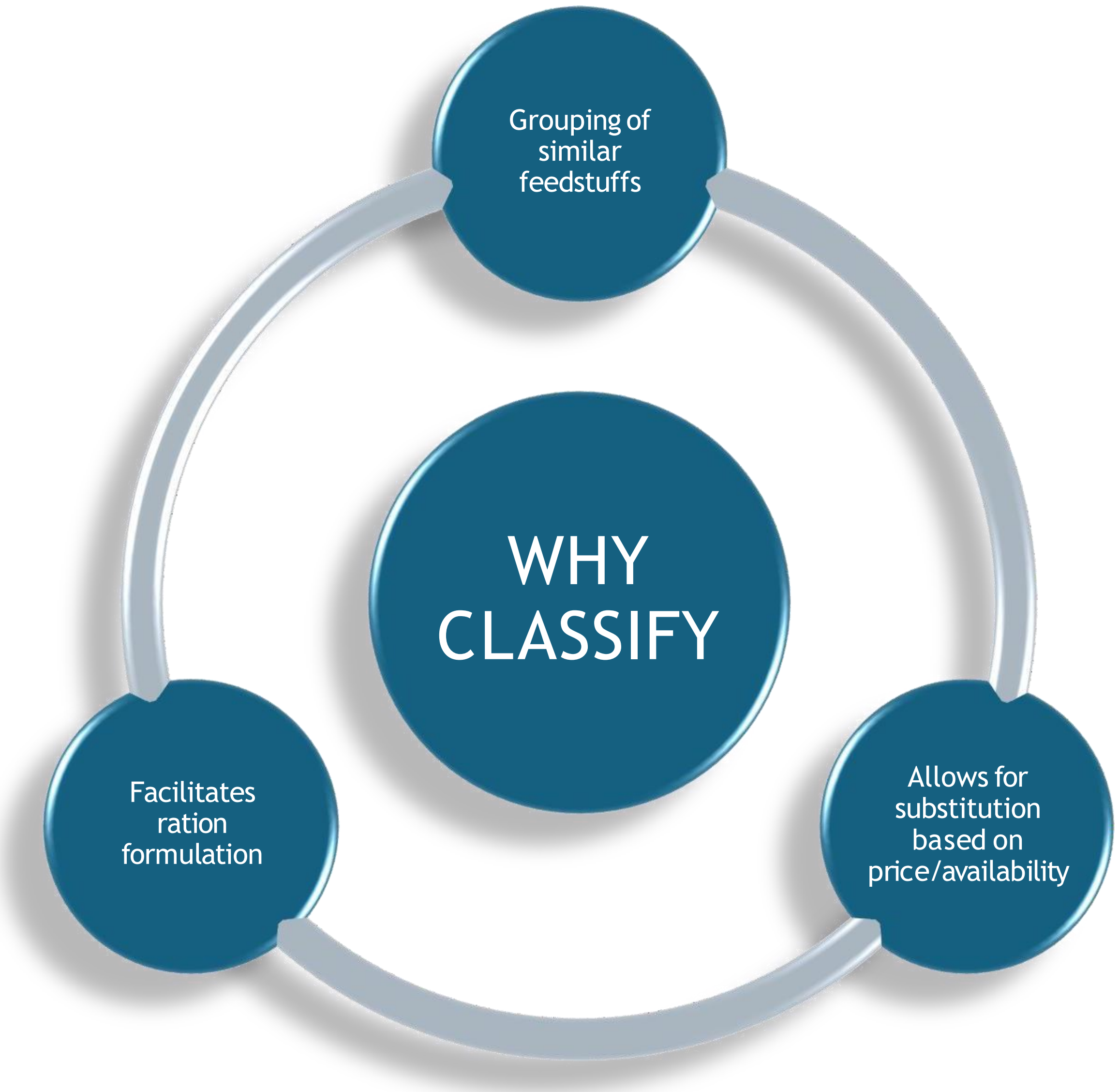
## 2024

**ANN Lecture - 1**

# Syllabus for JKPSC VO Exam - Animal Nutrition

1. Classification of Feeds
2. Feeding Standards
3. Computation of Ration
4. Mixing of Rations
5. Conservation of Feed and Fodder

# 1. Classification of Feeds



# 4.2 Base for Classification:

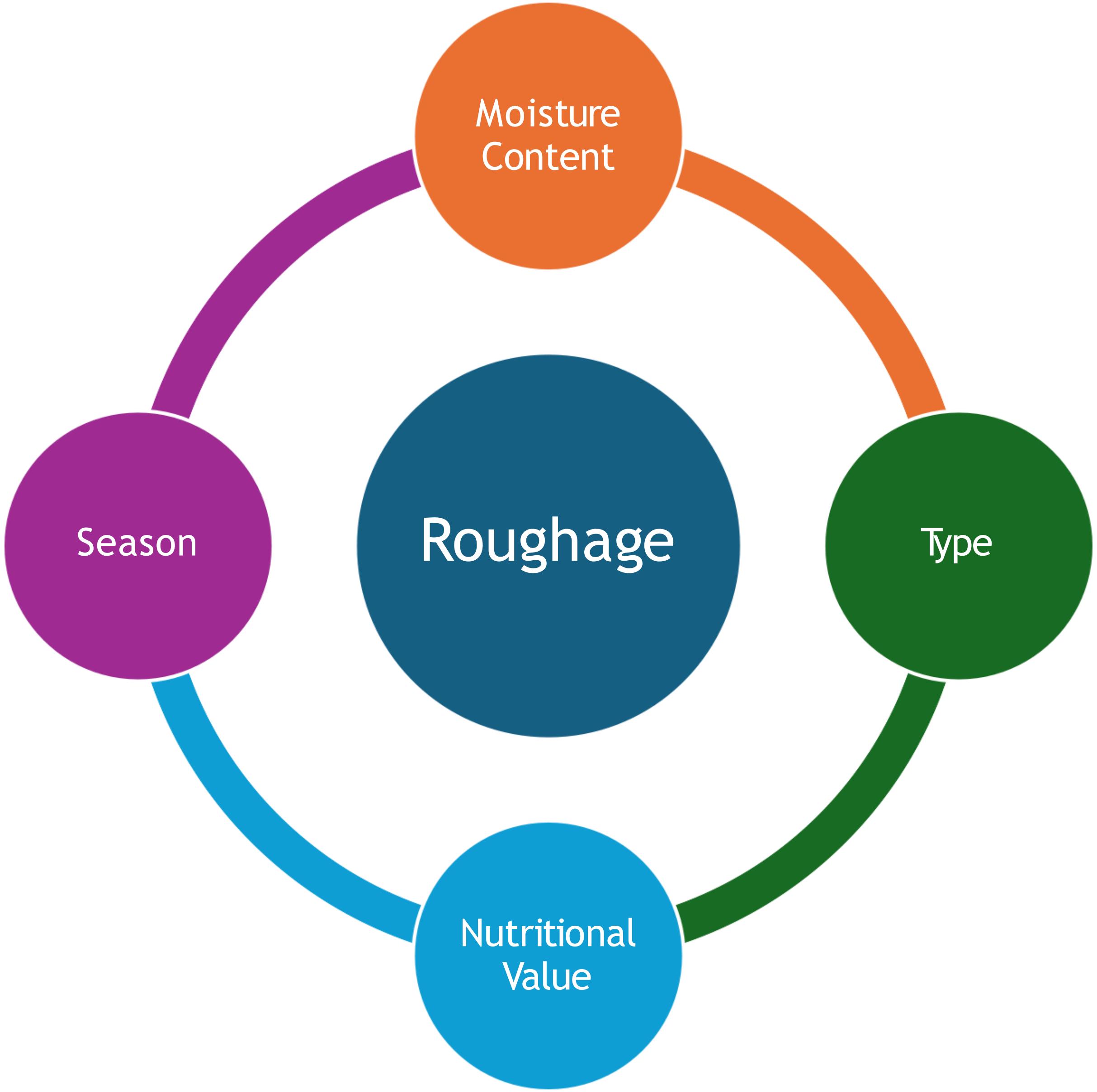
1. Physical characteristics (Bulkiness)- Roughages & Concentrates
2. Chemical characteristics-

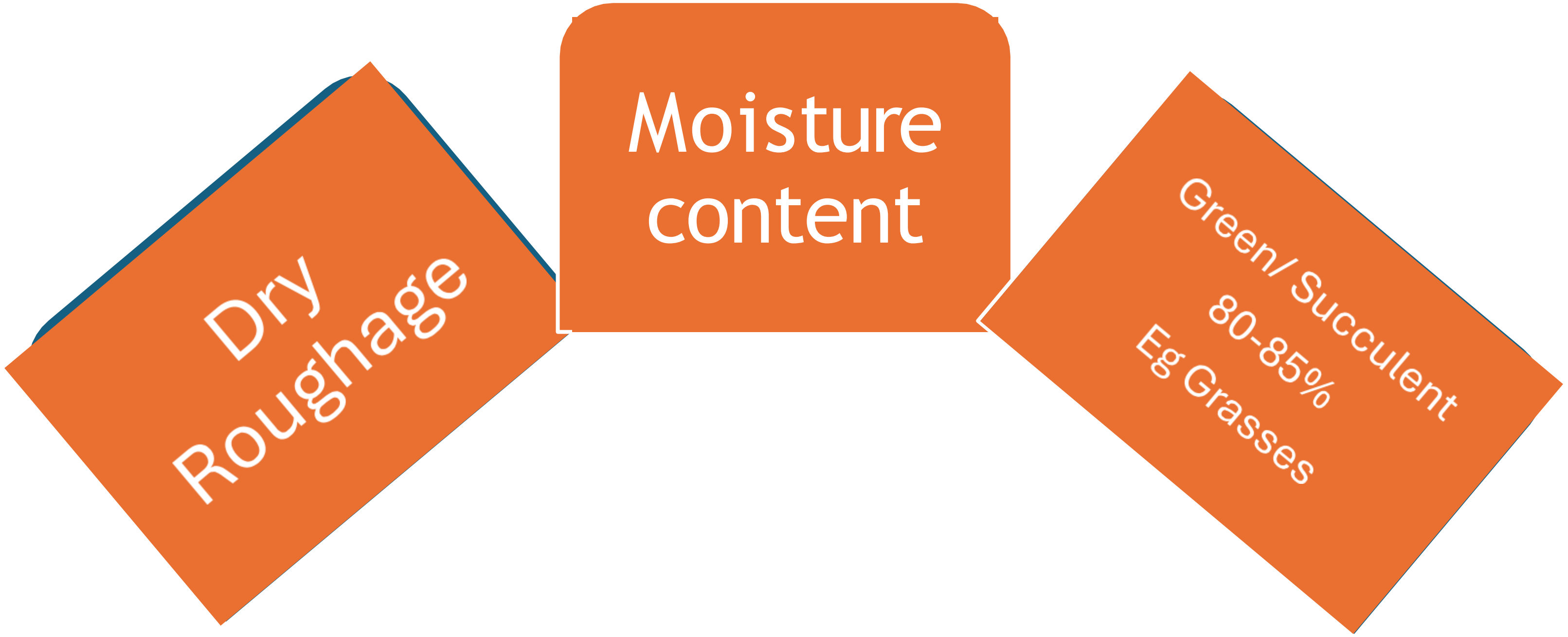
| SN | Item | Roughage | Concentrate |
|---|---|---|---|
| 1 | Crude Fibre | CF>18% | CF<18% |
| 2 | TDN | TDN<60% | TDN>60% |
| 3 | Energy Content | Low | High |
| 4 | Digestibility | Low | High |
| 5 | Function | Bulk | Energy |
| 6 | Example | Straw, hay, silage | Grains, meal, cake |

# 4.3 Crampton and Harris Classification (NRC):

1. Dry forage, roughages and Hay
2. Green/succulent forage and pasture
3. Silage
4. Energy feeds
5. Protein supplements
6. Mineral supplements
7. Vitamin supplements
8. Additives

# Classification of Roughages





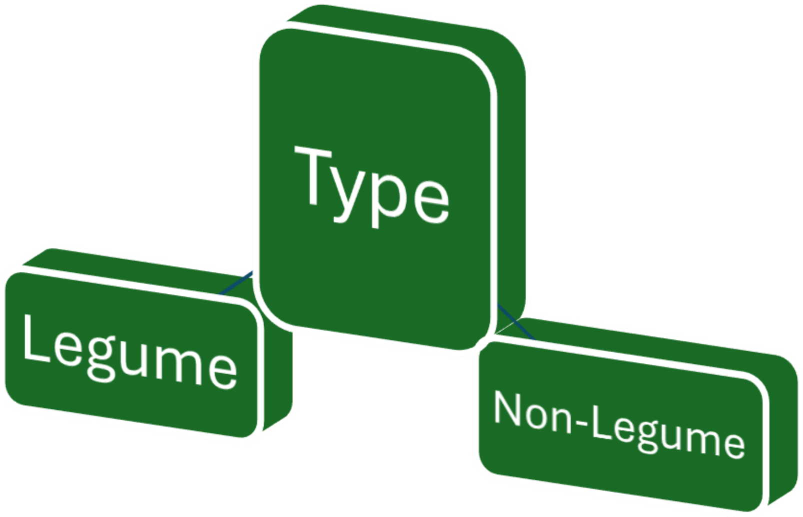

- A. By Moisture Content

1. **Dry Roughages**: Contain less than 15% moisture.

- Examples: Hay, straw

2. **Green/Succulent Roughages**: Contain 80-85% moisture.

- Examples: Fresh pasture grasses, silages

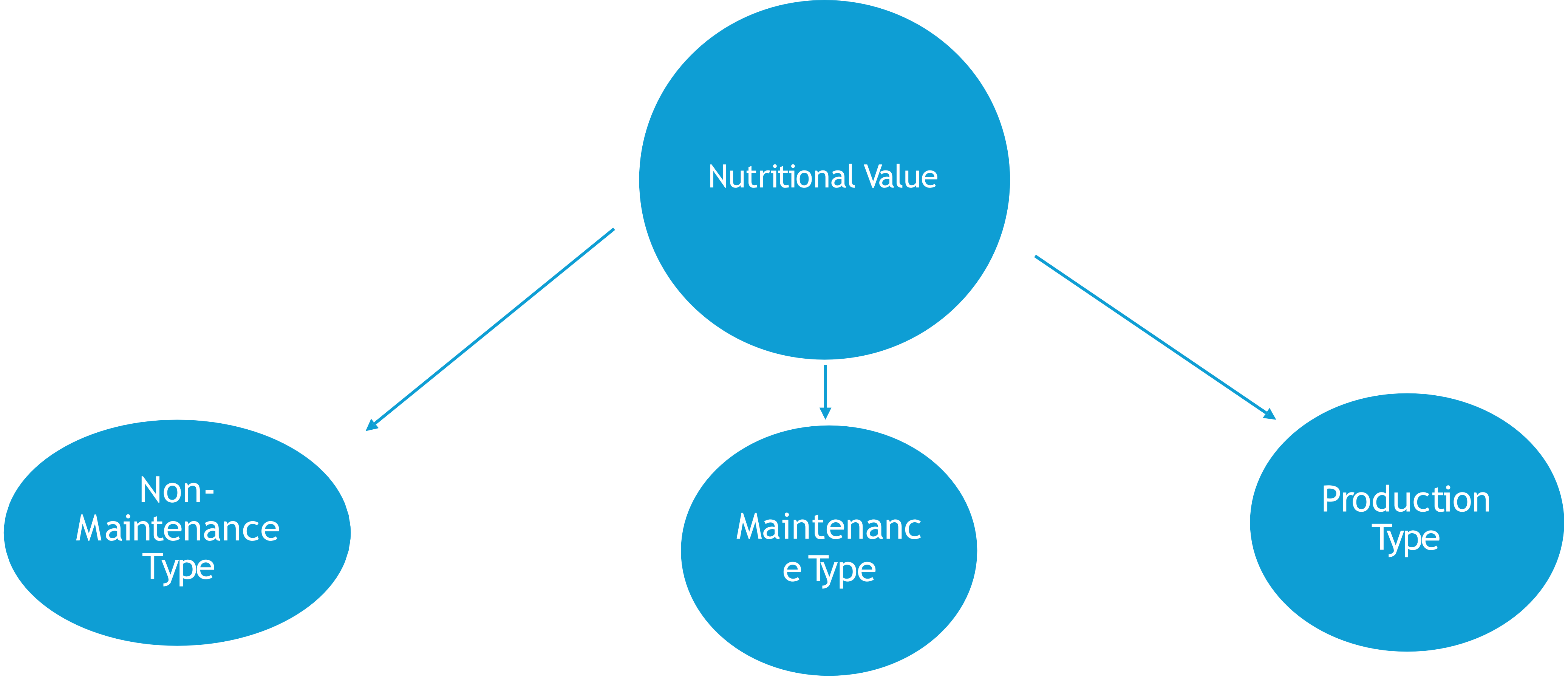



1. Legume Roughages: High in protein and often used for production purposes.

- Examples: Berseem, Lucerne (Alfalfa), Cowpea.

2. Non-Legume Roughages: Lower in protein compared to legumes.

- Examples: Maize, Bajra (Pearl Millet), Sorghum, Oat.




Contain less than 3% Digestible Crude Protein (DCP) Examples: Straw, stover.

Contain 3-5% DCP.Examples: Non-leguminous cereal fodder.

Contain more than 5% DCP. Examples: Legume fodders

- **Legumes**: They are plants from the Fabaceae family, such as alfalfa, clover, peas, and beans. They are called "legume fodder" because of their ability to fix nitrogen and typically higher protein content.
- **DCP content**: Although many legumes have high DCP (often 20% or more), the classification as "legume fodder" doesn't depend only on DCP. Even if a legume fodder falls below the expected 20% DCP, it's still called a legume due to its botanical classification

Season

Rabi Season

Kharif Season

Berseem

Lucerne

Maize

Bajra

2. **Green/Succulent Forage and Pasture:** They have high moisture content(80-85%).

- Types of Green/Succulent Forages
- **1. Pasture:** Plants that are either natural or cultivated and used for grazing.
- Examples: Various grasses and legumes that are grown in fields and consumed directly by grazing animals.
- 2. **Fodder:** Crops harvested and used for stall feeding. Typically comes from crops that are grown specifically for animal feed, like maize or sorghum.
- 3. **Top Feeds:** comes from **trees or non-crop plants**, where only the top portions or leaves are used as feed, rather than the whole plant. Examples: Tree leaves from **leguminous trees** or shrubs, and cuttings from plants like **bamboo** or **mulberry**.

# 3. Energy Feed

Crude Protein (CP): <20%

Crude Fibre (CF): <18%

Total Digestible Nutrients (TDN): 75-80%

Main Types of Energy Feeds: Cereal Grains, Molasses, Fat

**a) Cereal Grains:**

Main component: Starch (60-65%)

CP: 8-12%

Fat: 2-5% (mostly unsaturated fatty acids)

Deficient in essential amino acids (lysine and methionine

**c) Fat:**

- Highest energy yield (2.25 times that of carbohydrates)
- Limitations in ruminants: Not more than 6% of dry matter intake

**b) Molasses:**

- Instant energy source (sugar)
- Rich in minerals
- CP: up to 5-6%
- Used with urea in ruminant diets
- Can be included up to 10% in concentrate mixture
- Higher levels may cause digestive disturbances

# 4. Protein supplements

- **Characteristics of Protein Supplements**

Crude Protein (CP): Greater than 20%
Crude Fiber (CF): Less than 18%
Protein Types: Can be true protein or Non-Protein Nitrogen (NPN)

**A. Plant Origin Protein Supplements**

1. Cottonseed Cake (CSC) CP
2. Groundnut Cake (GNC) CP

**B. Animal Origin Protein Supplements**

1. Fishmeal CP
2. Meat and Bone Meal (MBM) CP
3. Blood Meal (BM) CP

**C. Single Cell Protein (SCP)**

- Archaea : *Methanomonas methanica*.
- BGA: *Spirulina*
- Yeast species: *Torulopsis utilis*.

**D. Non-Protein Nitrogen (NPN) Sources**

- Definition: Nitrogen in forms other than true protein and peptide.
- Examples: Urea (46% N), Biuret (35% N).

**Issues with Urea Supplementation**

- Rapid Hydrolysis: which can lead to toxicity.
- Source of Nitrogen Requires energy (e.g., starch) for effective utilization.
- Optimal Ratio: Starch to urea ratio should be 10:1 (1 kg starch per 100 g urea).
- N:S Ratio: For optimal rumen microbial function, the nitrogen to sulfur ratio should be 10:1.

**Urea/NPN Supplementation Guidelines**

- Concentrate Mix: Up to 3% of the mix.
- Total Dry Matter Intake (DMI): Up to 1%.
- Total Nitrogen/Protein Need: Up to 33% (one-third).
- Straw Treatment: 4% for treating straw.
- Not Beneficial: If Total Mixed Ration (TMR) CP is greater than 13%.
- Maximum Permissible Level (MPL): 27 g/100 kg body weight or 100 g/day for an adult cow, and not more than 10 g/day for goats.
- Toxicity Treatment: Administer 45 liters of cold water followed by 2-6 liters of 5% **acetic acid (vinegar).**

Urea Products

- Examples: Uromol, Urea-Molasses Mineral Block (UMMB), Urea-Molasses Liquid Feed.

# 4. Mineral

- Mineral supplements are essential for maintaining the health and productivity of livestock. They are categorised into macro-minerals and micro-minerals based on the quantities required by animals.

- Mineral Mixture (MM): Typically, 2% of the concentrate mix.

- Salt: Usually 1% of the concentrate mix. Salt acts as a condiment, encourages water intake, and helps manage heat stress.

# 5. Vitamin Supplements

- Vitamins are organic compounds required in small quantities for various physiological functions. They are categorised based on their solubility:
- Water-Soluble Vitamins
- B-Complex Vitamins: Includes B1 (Thiamine), B2 (Riboflavin), B3 (Niacin), B6 (Pyridoxine), B12 (Cobalamin), Folic acid, Pantothenic acid, Biotin, and Choline.
- Vitamin C (Ascorbic Acid): Regular supply is essential as it is not stored in the body.
- Fat-Soluble Vitamins
- Vitamin A,D,E,K
- **Note:** Vitamin B is synthesised by rumen microbes, and green fodder is a good source of vitamins.

# 6. Additives

- Additives are non-nutritive substances added to feed to improve body weight gain, feed efficiency, and control or prevent diseases. They include:
- Antibiotics: Used to prevent subclinical infections and promote growth.
- Antioxidants: Prevent oxidative rancidity of fats and improve feed stability.
- Buffers: Help maintain optimal pH in the rumen.
- Colors & Flavors: Enhance the palatability and attractiveness of feed.
- Hormones: Used to enhance growth and production eg. Trenbolone acetate (TBA)
- Medicines: Added to feed to prevent or treat diseases. E.g. **Ionophores Example: Monensin**

# JKPSC VO

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### ANN Lecture - 2

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5. Conservation of Feed and Fodder

# Fermentation

**Fermentation** is a metabolic process that cells use to generate energy in the absence of oxygen. It involves breaking down sugars (usually glucose) into simpler molecules, such as acids, gases, or alcohol, while regenerating **NAD+** (nicotinamide adenine dinucleotide) so that glycolysis (the breakdown of glucose) can continue to produce a small amount of energy in the form of ATP (adenosine triphosphate).

•**Lactic acid fermentation**: Produces lactic acid from pyruvate (e.g., *Lactobacillus*).
•**Alcohol fermentation**: Produces ethanol and $CO_2$ from pyruvate (e.g., *Saccharomyces cerevisiae*—yeast, not bacteria, but similar principles apply).
•**Butyric acid fermentation**: Produces butyric acid, $CO_2$, and hydrogen ($H_2$) (e.g., *Clostridium* species).

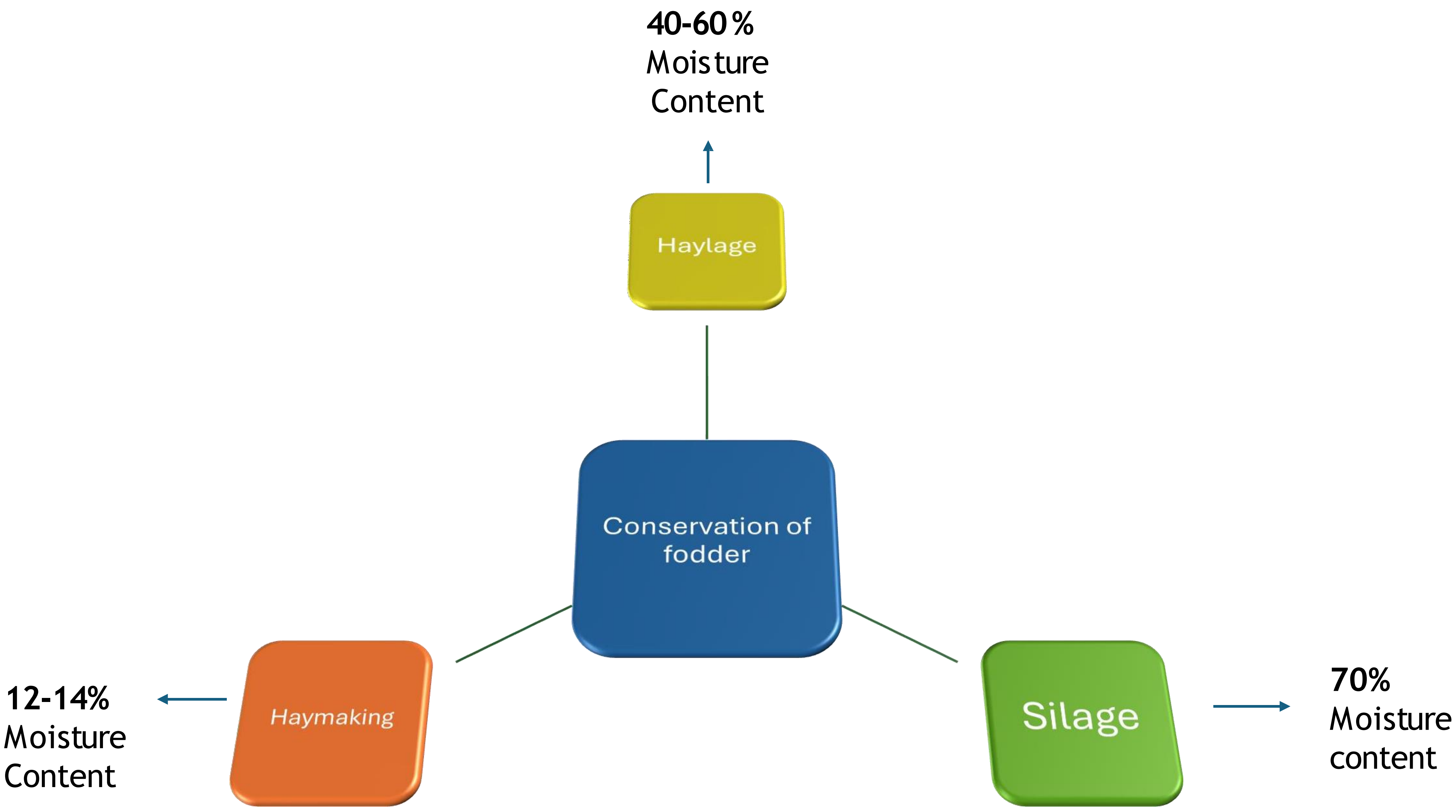
•In **lactic acid fermentation**, NADH donates its electrons to pyruvate, forming lactate and regenerating $NAD^+$.
•In **alcoholic fermentation**, NADH transfers its electrons to acetaldehyde (derived from pyruvate), producing ethanol and regenerating $NAD^+$.

- **Acetaldehyde**: In **alcohol fermentation** (in yeast and some bacteria), pyruvate is first converted to **acetaldehyde**, which then acts as the electron acceptor, being **reduced by NADH** to produce ethanol. This process regenerates $NAD^+$.

- **Nitrates ($NO_3^-$)**: In **denitrifying bacteria**, **NADH can donate electrons to nitrates**, reducing them to nitrogen gas ($N_2$) or nitrous oxide ($N_2O$) in a process known as **denitrification.**

- **$CO_2$**: In **methanogens** (a type of archaea), carbon dioxide **($CO_2$) acts as the electron acceptor and is reduced to methane ($CH_4$)** during **methanogenesis**, using NADH or similar carrier

# 5. Conservation of Feed and Fodder



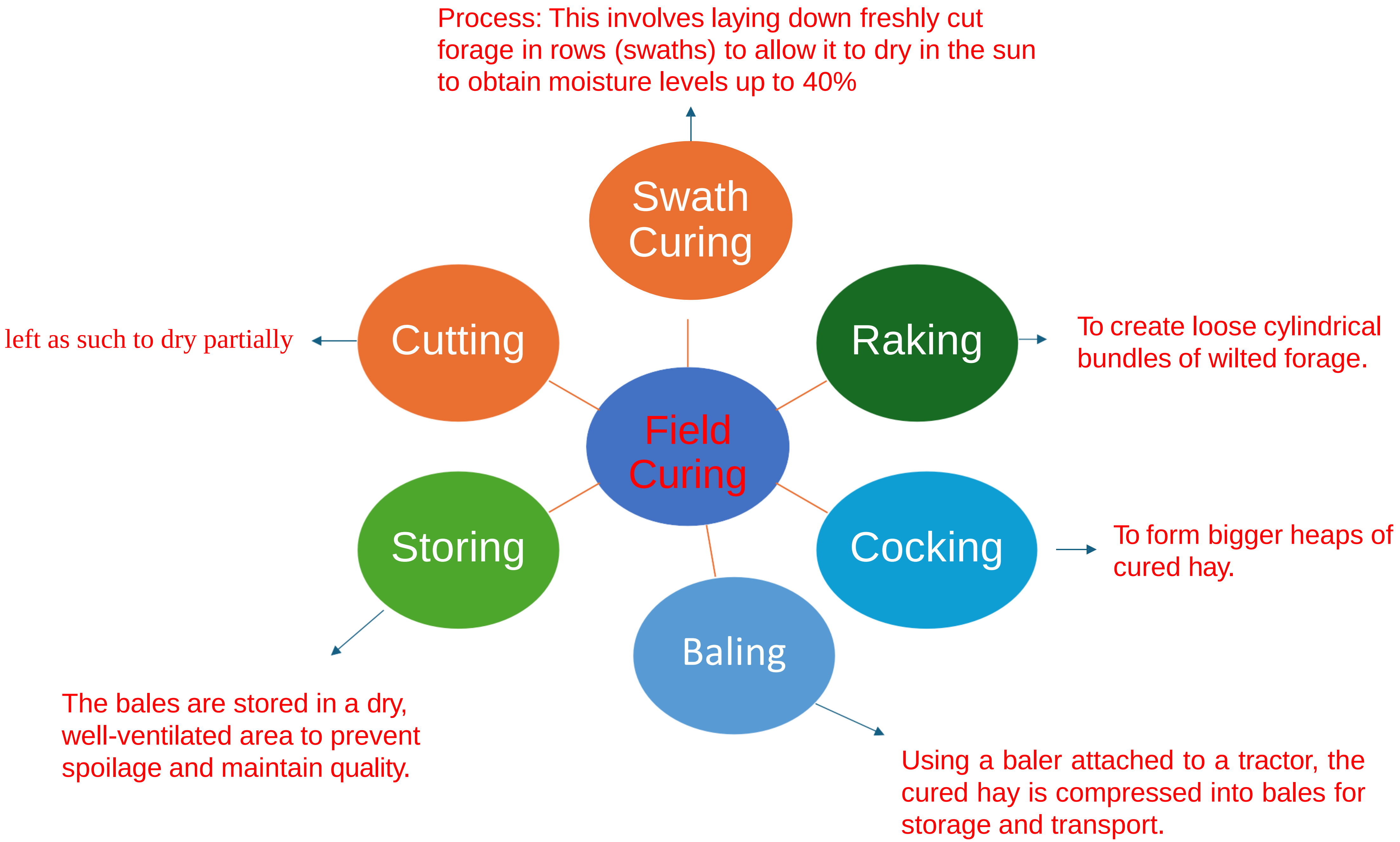
**Haymaking** is the process of cutting, drying, and gathering grass or other **Haymaking** plants, typically referred to as "hay," to be used as fodder or feed for livestock, particularly cattle, horses, and other herbivorous animals.

## Aim of Haymaking

- reduce the moisture content around 12-14%
- less susceptible to spoilage, molds, and microbial degradation
- Allowing it to be stored for extended periods without losing nutritional value.

## Methods of Drying

1. <u>Field curing:</u> sun drying
2. <u>Barn drying:</u> using fan/ air duct to reduce moisture to 20-25%.
3. <u>Artificial drying :</u> hot air-expensive but superior quality


Process: This involves laying down freshly cut forage in rows (swaths) to allow it to dry in the sun to obtain moisture levels up to 40%
Swath Curing
left as such to dry partially
Cutting
Raking
To create loose cylindrical bundles of wilted forage.
Field Curing
Storing
Cocking
To form bigger heaps of cured hay.
Baling
The bales are stored in a dry, well-ventilated area to prevent spoilage and maintain quality.
Using a baler attached to a tractor, the cured hay is compressed into bales for storage and transport.

# A-Dry processing methods

- *In these methods water content is reduced to a desired level.*

## Baling

- The forage is cut and dried in the field condition.
- Dried forage is then baled or bundled with Baler
- By this method we make storage and handling of forage easy and convenient.

The nutritive value of mixed hay depends upon the type of legume and non legume crops used in mixed hay

## Mixed hay

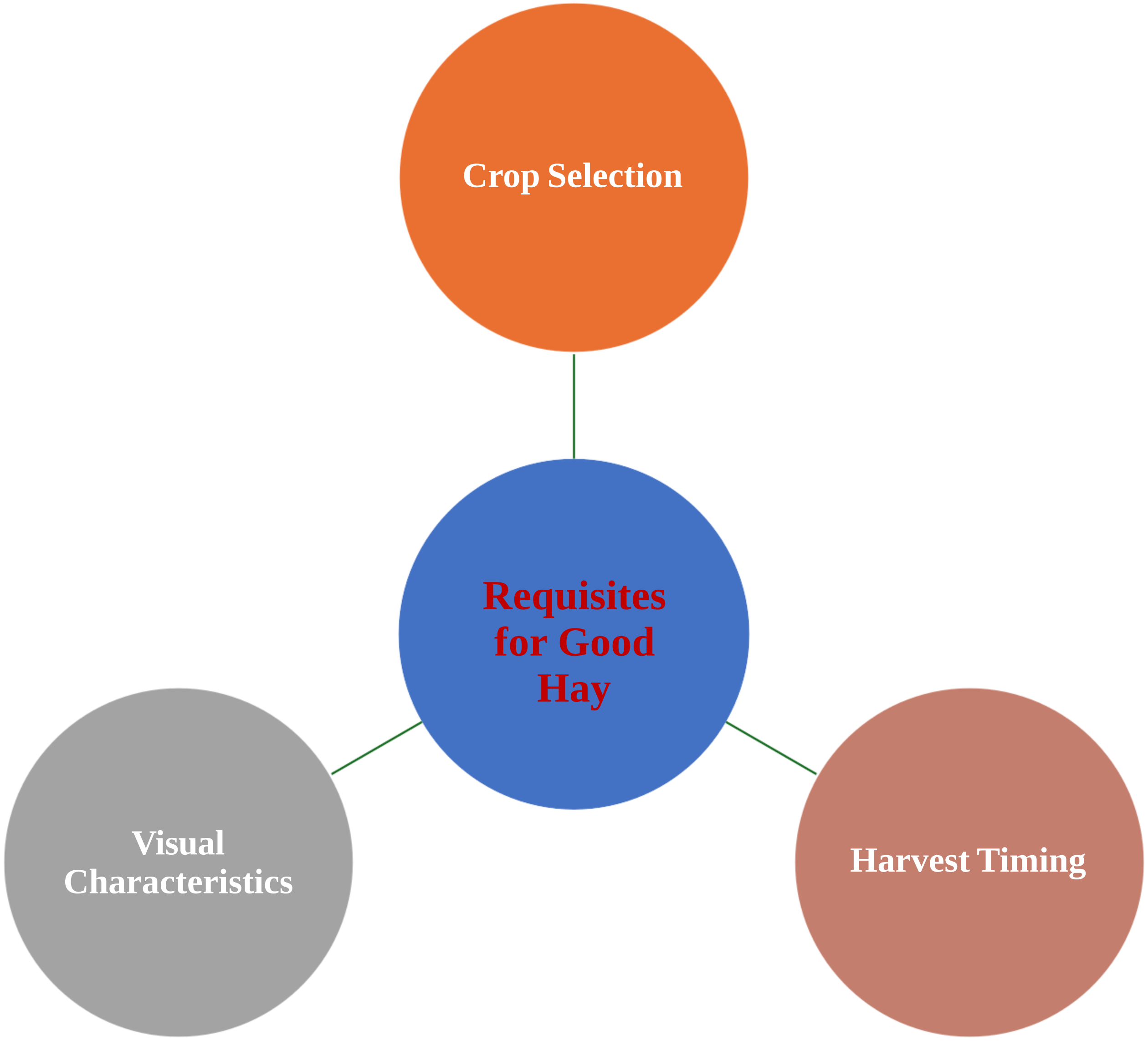
# Types of hay

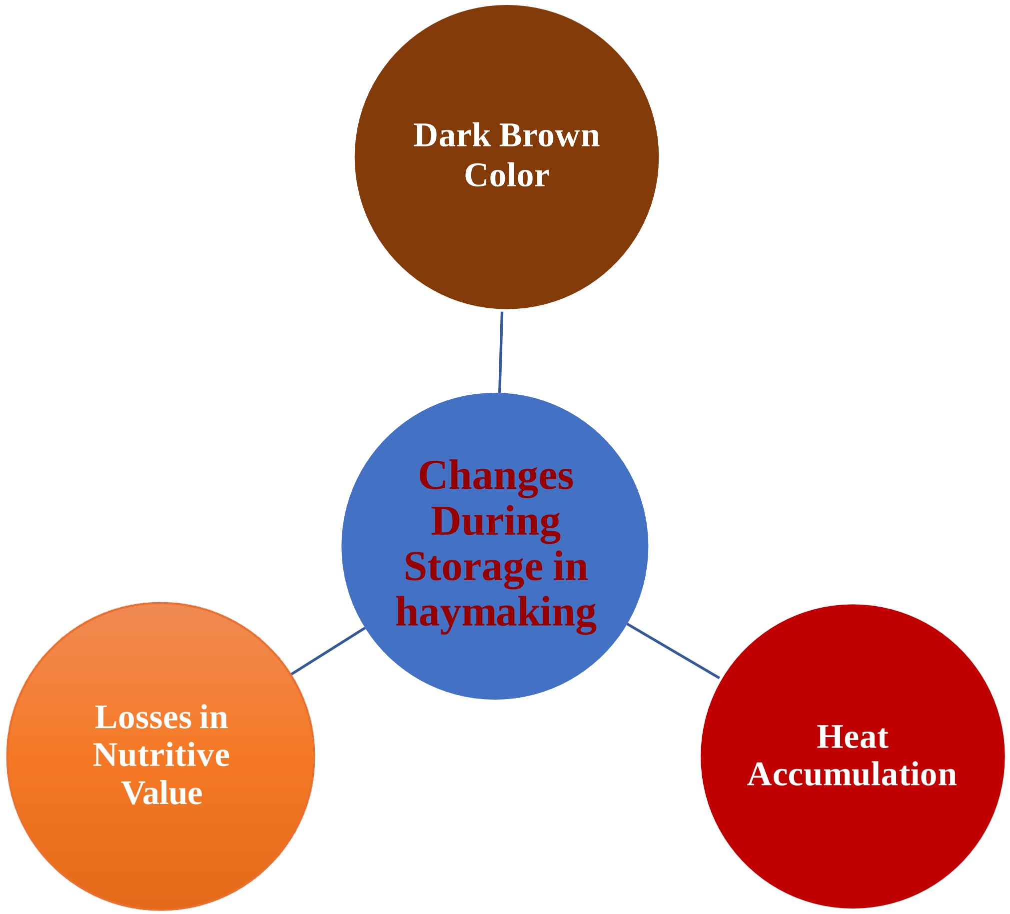
## Legume hay

It has got a higher TDN and DCP and is rich in protein & minerals. Crops –Lucerne, Cowpea, Berseem.

## Non – legume hay:

It is less palatable and has less amount of protein, vitamins and nutrients than legume hay but rich in carbohydrates. Crops – Oat, barley, Bajra, sorghum and grasses


Crop Selection
Requisites for Good Hay
Visual Characteristics
Harvest Timing


Dark Brown Color
Changes During Storage in haymaking
Losses in Nutritive Value
Heat Accumulation

# Biochemical Changes During Storage

### Carbohydrates

Plant respiration continues after harvest, leading to the **oxidation of sugars** to $CO_2$ and $H_2O$. Organic acids' concentration decreases during wilting.

### Nitrogenous Constituents

Plant enzymes can **proteolyzed** proteins, resulting in the formation of free amino acids.

### Vitamins

During sun drying, **oxidation can lead to a reduction in carotene** concentration. However, sun drying can also **enhance the vitamin D** content in hay due to irradiation of ergosterol present in green plants.

# Nutrient losses during hay making

**Losses by shattering**

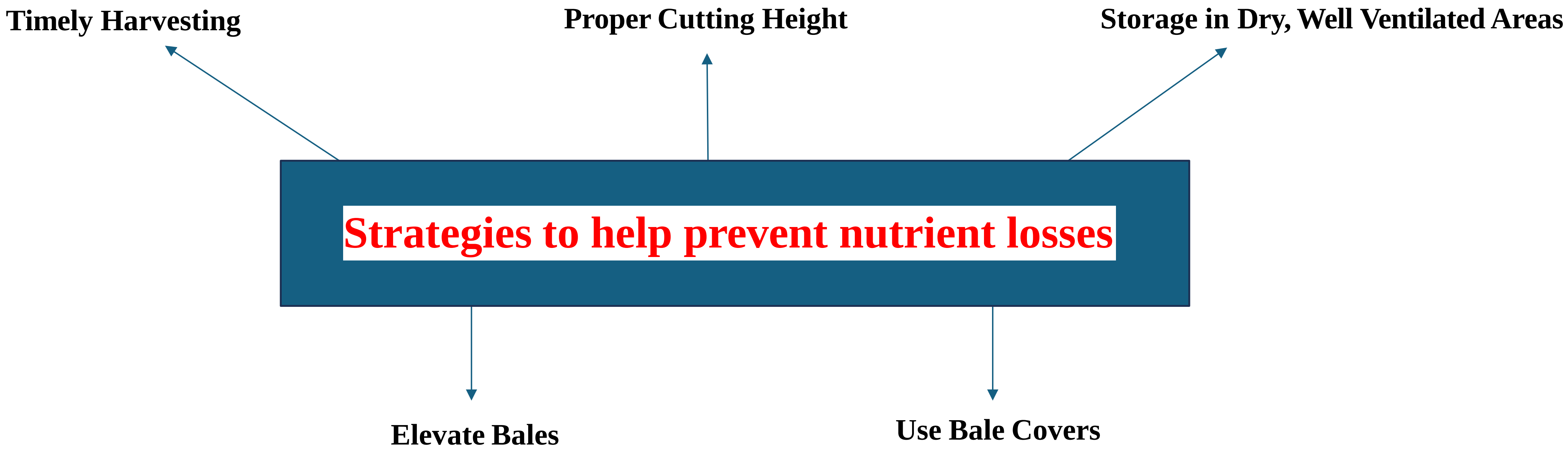
**Losses due to fermentation**

**Losses of vitamins due to oxidation**

**Losses due to leaching**

**Total loss estimated in hay making**

- Loss of DM – 20-30% in legumes and 10-15%in grasses
- Loss of protein – 28%
- Loss of carotene- 90%
- Loss of energy - 25%


Timely Harvesting
Proper Cutting Height
Storage in Dry, Well Ventilated Areas
Strategies to help prevent nutrient losses
Elevate Bales
Use Bale Covers

# Silage

Green succulent fermented material produced by controlled anaerobic fermentation of the green fodder crop retaining the high moisture content. This process of making silage is called ensiling.

## Advantages of Silage Making:

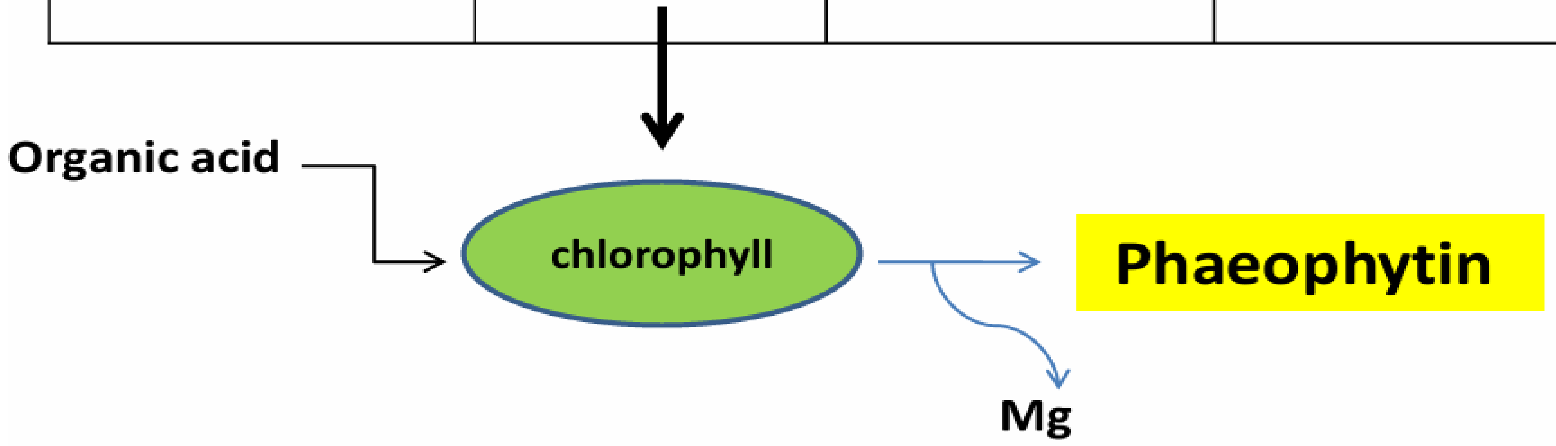
1. **Year-Round Feed Supply**
2. **Weather Independence**
3. **Increased Livestock Capacity**

## Disadvantages of Silage Making:

1. **Equipment and Infrastructure:** e.g., choppers, compactors, silos and infrastructure (e.g., silo structures)
2. **Labor-Intensive:** labor-intensive
3. **Fermentation Odor**
4. **Risk of Spoilage:** <u>Inadequate packing or sealing</u>

# Silage quality- Flieg index (butyric acid)

| parameters | Very Good | Good | Fair | Poor |
|---|---|---|---|---|
| **Butyric acid** | Absence | Traces | Little | High |
| **pH** | 3.8-4.2 | 4.2-4.5 | 4.5-4.8 | >4.8 |
| **Ammonia Nitrogen** | <10% | 10-15% | 15-20% | >20% |
| **Colour** | Greenish brown | Brownish | Tobacco brown | Blackish |




Hppsc 2017, VMO

## Factors to Consider in Silage Making

- Crop Selection
- Time of Harvest
- Chafing
- Wilting
- Additives

# Principles of Fermentation in Silo

## Aerobic Phase

**(Phase 1)**

- **Objective:** Eliminate oxygen.

## Anaerobic Phases (Phases 2-4)

- **Phase 2**: **Lag Phase**
  - **Objective**: Break down plant cells.

**Phase 3**: **Lactic Acid Fermentation**
**Objective:** Produce lactic acid.

- **Phase 4**: **Spoilage Prevention**
- **Objective**: Prevent spoilage.

**Heterofermentation by enterobacteria in silage** refers to the fermentation process where **enterobacteria** (a group of bacteria commonly found in the intestines and environment) metabolize plant sugars in silage to produce **multiple end products**, including **lactic acid**, **acetic acid**, **carbon dioxide ($CO_2$)**, and **ethanol**.

**(Phase 1)**

- **Objective:** Eliminate oxygen.
- **Process**: Initial phase where aerobic bacteria break down sugars, producing $CO_2$, water, and heat. This phase lasts a few hours to a couple of days and is critical for setting the stage for anaerobic fermentation.

# Anaerobic Phases (Phases 2-4)

- **Phase 2**: **Lag Phase**
  - **Objective**: Break down plant cells.
  - **Process:** Plant cells are broken down by enzymes, providing nutrients for bacteria. This phase lasts 24 to 96 hours and involves hetero-fermentation by bacteria like Enterobacteria.

**Phase 3**: **Lactic Acid Fermentation**

**Objective:** Produce lactic acid.

**Process**: Lactic acid bacteria (LAB) dominate, producing lactic acid and lowering the pH. This phase is critical for preserving nutrients and preventing spoilage. Lactic acid is typically produced by **lactic acid bacteria** (LAB) like:

- **Lactobacillus**
- **Streptococcus**
- **Lactococcus**

- **Phase 4**: **Spoilage Prevention**
  - **Objective**: Prevent spoilage.
  - **Process**: Minimize oxygen ingress during feedout by maintaining an airtight silo and using additives to prevent spoilage by undesirable microorganisms

## Methods of Preparing Silage:

1. Chopping
2. Moisture Management
3. Sealing
4. Fermentation
5. Fermentation Period

| particular | silage | Hay |
|---|---|---|
| DM Loss (%) | 30-35 | 10-15 |
| Type of crop<br>**Difference in silage and Hay** | Non leguminous type. Maize ,jowar,sorghum, bajra | Leguminous type Lucerne, oats berseem |
| Texture OF CROP | Thick stemmed, carbohydrate rich | Thin stemmed, protein rich |
| Method utilised | Fermented product | Sun dried product |
| Losses of nutrients | less | more |
| Time of harvest of crop | between flowering and milk stage | 2/3rd flowering stage |
| digestibility | Partially digested during fermentation so more digestible | Not digested during drying. Less digestible. |
| Drying | Crop is not dried and used after cutting only | it is dried first |
| Air | Complete exclusion of air | Openly dried in air |

- **Haylage (hay+silage):** Dry matter in crops used for haylage making is 40- 45%.
- **Wastelage:** Anaerobically fermented animal waste like poultry droppings, poultry litter, swine excreta and bovine dung along with other feed ingredients with the help of lactic acid producing bacteria.

# JKPSC VO

2024

## ANN Lecture - 3

# Syllabus for JKPSC VO Exam - Animal Nutrition

1. Classification of Feeds
2. Feeding Standards
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# Feeding Standards

Feeding standards are statements or quantitative descriptions of the amounts of one or more nutrients needed by animals.
Requirement is expressed in quantities of nutrients required per day or as a percentage of diet.

**Objectives of feeding standards:**

- To guide farmers to formulate properly balanced rations for their livestock.
- Estimate the adequacy of feed/ nutrient intake for various spp. of animals.
- To classify the nutrient requirement according to different physiological functions like growth, maintenance, lactation, egg production and wool growth.

**Limitation of feeding standard:**

- No standard can be a complete guide to feeding because some other factors like palatability and physical nature of ration can play significant roles.
- Environmental conditions

**Expressions of nutrients requirements in different standards are:**

DE, ME, NE, TDN, CP, DCP, MP.

| Feeding standards | | |
|---|---|---|
| A. *Comparative type* | B. *Digestible- Nutrient system* | C. *Production-value type* |
| **Compare different feeds to a standard one** | **Feeding based upon digestible portions of nutrients in different feed.** | **Based upon efficiency of feed to increase productivity.** |
| 1. Hay standard<br>2. Scandinavian feed Unit" Standard | 1. Grouven's Feeding standard<br>2. Wolff's feeding standard<br>3. Wolff's Lehmann feeding standard<br>4. Haeckers's Feeding standard<br>5. Savage feeding standard<br>6. Morrison standard<br>7. National Research Council standard<br>8. Indian standard | 1. Kellner-feeding standard<br>2. Armsby feeding standard<br>3. Agricultural and Food Research Council standard. |

# A. COMPARATIVE TYPE

1. **Hay standard:** suggested by Thaer In 1810

•Different feeds should be compared using **meadow hay** as a unit.
•The only measure was the practical feeding experience.
•Nothing was known of the chemical value of feeds and the physiological requirements of the animals.

2. **Scandinavian "feed unit" standard: By** Professor Fjord In 1884

•only the feed **unit** was taken.
•The value of one pound of common grain such as corn, barley or wheat, is given as one unit value and the value of all other foods is based upon this.
•According to this standard, one feed unit is required for each 150 lbs. of body weight and an additional unit for every three pounds of milk production.

**Application and Precision**:

•The **Meadow Hay Standard** Based on practical experience rather than precise measurements of energy or nutrients.

•The **Scandinavian Feed Unit Standard** introduced a slightly more quantitative approach, attempting to match energy intake more closely with animal needs based on body weight and milk.

# B. DIGESTIBLE NUTRIENT SYSTEM

**1. Grouven's feeding standard**

•Feeding standard with **crude protein, carbohydrates and fat** contained in the feed as the basis of the standard.

**2. Wolff's feeding standard: by** Dr. Emil Von Wolff In 1864

•Based on **digestible protein, digestible carbohydrates and digestible fats**.
•This standard is an improvement over the standard of Grouven,
•It does not consider the quantity and quality of milk produced.

**3. Wolff's Lehmann feeding standard:**

•Dr. G. Lehmann of Berlin modified Wolff's standard in 1896.
•He took into account the **quantity of milk** produced, but he failed to take into account the quality of milk.

**4. Haecker's feeding standard**

•First time considered the **quantity as well as the quality of milk** produced in formulating a milk standard.
•First to separate the requirements for maintenance from the requirements of production.
•His standards included digestible crude protein, carbohydrates and fats.
•Later it was expressed in digestible crude protein and total digestible nutrients.

**5. Savage feeding standard**

•Based on nutritive ration

•The **nutritive ratio** should not be wider than 1:6 or narrow than 1:4.5.

**Nutritive ratio:** Also called as albuminoid ratio.

NV = DCF + DNFE + (DEEx2.25) / DCP = TDN – DCP/ DCP

Where, TDN= DCF+DCP+DNFE+ (DEEx2.25)

• Protein rich feeds: Narrow NV e.g. protein cakes.

•Poor protein feeds: wider nutritive ratio e.g. roughages.

**6. Morrison feeding standard**

•First presented in the 15th edition of "Feeds and Feeding" published in 1915

•Also called "Modified Wolff and Lehmann standard".

•These standards were expressed in terms of **Dry Matter (D.M.), Digestible crude Protein (DCP) and Total Digestible Nutrients (TDN).**

•After revision, **net energy values instead of TDN** in computing rations were also included.

•In the year 1956, Morrison included in the standard the allowances for calcium, Phosphorus and Carotene

•The average of Morrison standards has been accepted for Indian livestock.

7. **National Research Council (NRC) standard: F**irst published in 1945

•The standard includes **digestible protein and total digestible nutrients (TDN)**

•Also includes the recommended **requirements for calcium, phosphorus, carotene and vitamin D** for most animals.

•They use ME for poultry, DE for swine and horses, DE, ME and TDN for sheep, ME, TDN and NE*m* and NE*g* for beef cattle and for dairy cattle, values are given for DE, ME, TDN, NE*m* and NE*g* for growing animals with additional values as NE*l* for lactating cows.

8. **Indian standards**

•Sen and Ray standards**:** he adopted the **average of maximum and minimum values recommended by Morrison**.

•**Indian Council of Agricultural Research:** considered the fact that nutrient needs of livestock and poultry breeds under tropical environments are different from those developed in temperate climate.


भारत
INDIA
30
1838-1884
केशव चन्द्र सेन
1980

## C. PRODUCTION VALUE TYPE

**1. Armsby feeding standard**

•Based on **true protein and net energy** values.

**2. Kellner feeding standard**

Based upon **“Starch” as a standard unit of measurement (Starch equivalent)**.

•**Starch equivalent:**

•Fat producing power of feed (A production type/ NE system).

• SE of a feed is the number of Kg of starch that produces the same amount of fat as 100 kg of the test feed.

•This starch equivalent in turn can be converted into energy by a method worked out by Armsby and Kellner.

**3. Agricultural and Food Research Council (AFRC)**

•Nature: The AFRC was a former research council in the United Kingdom that focused on agricultural and food research.

•Function: It aimed to promote and coordinate research in agriculture and food sciences across various institutions in the UK.

# Topic 4 MCQs

1. Feeding standards do not consider **<u>JKPSC-2020</u>**

    A) Production Level of Livestock
    B) Nutrients Requirement of Livestock
    C) Nutritive Value of Feed Ingredients
    D) Economics of Livestock Production

2. Starch equivalent system is based on **<u>JKPSC-2020</u>**

    A) NE & Digestible True Protein
    B) DCP, TDN & NE
    C) DCP & TDN
    D) DM,DCP & TDN

3. Who developed the starch equivalent value of feed **<u>JKPSC - 2019</u>** 2019

    (A) Atwater
    (B) Morrison
    (C) Armsby
    (D) Kellner

4. Which one of the following is the Digestible-Nutrient system type feeding standard? RPSC 2019

(1) Hay standard
(2) Armsby feeding standard
(3) Scandinavian "Feed unit" standard
(4) Morrison standard

5. Starch equivalent based energy system was given by Rpsc 2013

(1) Morrison
(2) Armsby
(3) Kellner
(4) Dubois

6. In 1890, a feeding standard based on the "available fuel values of the feeds" was proposed by Mppsc 2021

(A) Armsby
(B) Atwater
(C) Kellner
(D) Lehmann

7. Wolff-Lehman feeding standard developed in the year: Opsc 2013 -14 $2^{nd}$

(a) 1903
(b) 1896
(c) 1884
(d) 1907

# JKPSC VO

2024

**ANN Lecture - 4**

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# Balanced Ration and Its Characteristics

Ration: feed offered to an animal for 24 hours.

- Diet: feed eaten at a time
- **Balanced ration:** nutrients in proper proportion & proper amount according to physiological requirement for 24 hours.

# Characteristics of a balanced ration:

1. **properly balanced**.
2. The Food must be **Palatable**
3. **Variety** of Feed in the Ration: A better and balanced mixture of proteins, vitamins and other nutrients. Variety of feed in the ration makes it more palatable.
4. The Ration should contain enough mineral **matter**.
5. The Ration should be **fairly laxative**.
6. The Ration should be **fairly bulky**.
7. Allow much of **Green Fodder**: because of their cooling and slightly laxative action.
8. Avoid **sudden changes** in the Diet: SARA, LDA etc.
9. Maintain **Regularity** in Feeding
10. The Feed must be **Properly Prepared**: should be grounded, Soaking, chopping before feeding

# Computation of Ration

Computation of ration" means calculating or determining the correct amount of feed for animals based on their nutritional requirements. This process involves figuring out the amount and type of food each animal needs to stay healthy, grow, produce milk or meat, or perform well if they're working animals.

## Methods of ration formulation

1. **Hit and trial/ trial and error method** – ruminants and poultry
2. **Pearson square method** - ruminants and poultry
3. **Algebraic method** - ruminants and poultry
4. **Linear programming**/ computer method/ least cost-ration ruminants and poultry
5. **In hand calculation** – ruminants

## Computer-Formulated Rations: 'Least cost' ration/ Linear Programming:

If a ration is balanced using a combination of ingredients with the lowest possible total cost, the resulting mixture is called a "least cost" ration.

Formulating a ration to fulfill the nutrient needs of the animal at the lowest possible cost is difficult by hand. Therefore, computer based models called linear programming are used to formulate the ration with least possible cost.

**Accuracy** and **speed** of calculation are the major advantages of computer formulation.

## Limitations of Computer method:

1. **Nutrient density within the mix**
2. **The 'Associative effects'** of feeds are not considered.

# In-hand calculation method for Ration formulation: <u>Ruminants</u>

## Dry matter intake (DMI) calculation:

For indigenous cows, DMI = 2.5% of body weight (BW).

- For crossbred cows and buffalo, DMI = 3% of BW.
- For milking animals, add 10% of their milk yield (MY) to the DMI.

**Partitioning DMI:**

- Divide the DMI between roughages (forage like hay, grass) and concentrate (high-energy feed).
  - Roughages = 2/3 of the total DMI.
  - Concentrate mixture = 1/3 of total DMI.

# Types of Roughages: Dry Roughage & Green Roughage

- **Types of Roughage**:
- **Dry Roughage**: Feeds like hay or straw, which have low moisture content.
- **Green Roughage**: Fresh, green plants that are more moist, like grass or green fodder.

**Partitioning of Roughage**:

- If **non-legume green fodder** is available (e.g., grass or maize), the roughage should be split as follows:
    - **2/3** of the total roughage should be **dry roughage**.
    - **1/3** of the total roughage should be **green roughage**.
- If **legume green fodder** is available (e.g., alfalfa or clover), which is usually higher in protein:
    - **3/4** of the total roughage should be **dry roughage**.
    - **1/4** of the total roughage should be **green roughage**.

**•Milking Animals' DMI Calculation**:

•For animals that are producing milk, their **DMI (Dry Matter Intake)** is calculated as:

$$DMI = 2.5\% \times \text{Body Weight (BW)} + 10\% \times \text{Milk Yield (MY)}$$

•This formula accounts for the animal's body weight and adds extra dry matter to support milk production.

**Maintenance Requirement for Milch (Milking) Animals**:

•Milking animals need **10-15% more dry matter intake** than non-milking (dry) animals to support the additional energy demands of milk production. This means their maintenance needs are higher due to the extra metabolic activity involved in producing milk.

DMI as % of Body Weight (BW) = 120 / NDF percentage

- **DMI as % of BW** refers to the amount of Dry Matter Intake (DMI) expressed as a percentage of the animal's body weight.
- **NDF percentage** is the percentage of Neutral Detergent Fiber in the feed.

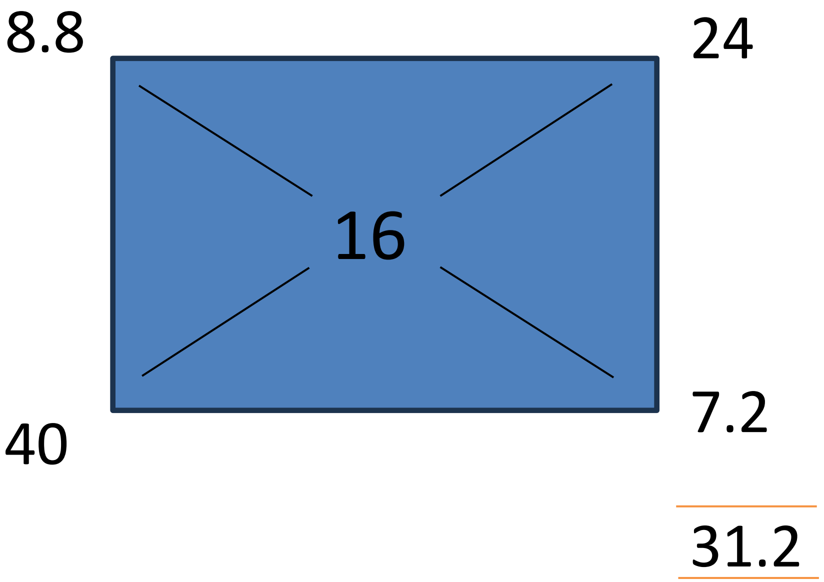
**How It Works:**

As the **NDF percentage** in the feed increases, the **DMI as a percentage of BW** decreases, because higher fiber content tends to reduce how much an animal can consume. NDF measures the fiber content that fills the stomach but is slower to digest, so more NDF means less capacity for other feed.

## **Pearson square method** - ruminants and poultry

Formulating Concentrate mixture/ complete feed by using the pearson square method and Alzebric Method

Example1 : When only 2 feeds are involved: A farmwer has home grown maize(8.8%) and he purchases a protein supplement(40% CP) containing minerals, vitamins. Formulate a concentrate mixture with 16 % CP.



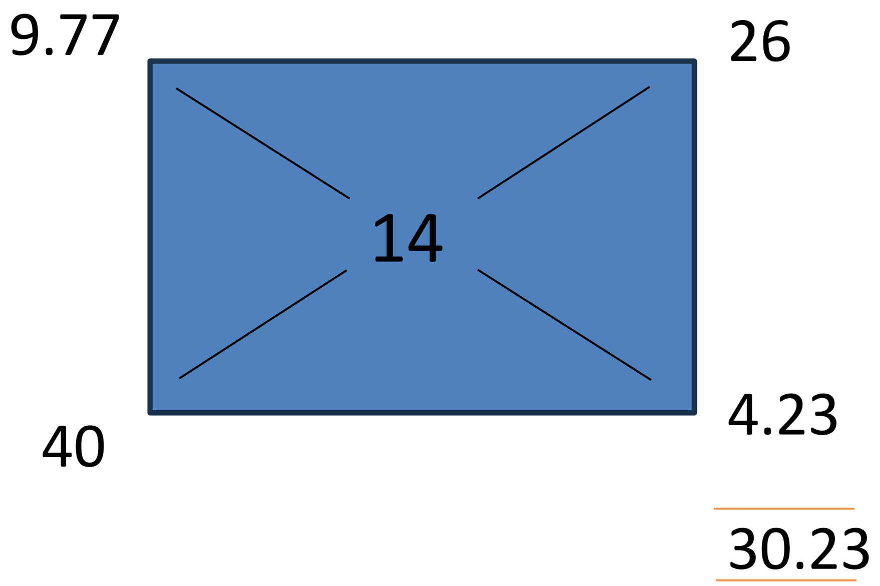

Maize: 24/31.2 = 76.92%

Supplement: 7.2/31.2 = 23.08%

# **Pearson square method** - ruminants and poultry

Example 2 : When 2 or more feeds are involved: In formulating a pig feed, grains like maize and oats are used in a **2:1 ratio** to circumvent the higher crude fibre level of oats. Formulate the pig feed using maize, oats and a protein supplement.

**Note**: Maize: 8.8 % CP & Oat = 11.7% CP. ( **2 part** of maize & **1 part** of oat)




29.3/3 = 9.77 %

Maize + oat = 26/30.23 × 100 = 86.01%

Supplement = 4.23/30.23 × 100 = 13.99%

Maize = 2/3 × 86.01=57.34

Oats = 1/3 × 86.01 = 28.67 %

# Algebraic method

## II Algebraic Method

*Example 1:* A farmer has the following ingredients

| | CP (%) | TDN (%) |
|---|---|---|
| Groundnut cake | 44 | 71 |
| Gingilly cake | 34 | 78 |
| Sorghum grain | 9 | 75 |
| Maize grain | 10 | 75 |
| Rice bran | 11 | 60 |

Compute a concentrate mixture with 18% CP and 70% TDN. Incorporate mineral mixture and salt at 2 and 1%, respectively.

**Procedure:**

1. Divide the ingredients into two groups based on their CP content and calculate the average CP.

$$\text{Oil seed cakes} = \frac{44 + 34}{2} = \frac{78}{2} = 39$$

$$\text{Grains and bran} = \frac{9 + 10 + 11}{3} = \frac{30}{3} = 10.0$$

2. Restrictions: Mineral mixture and salt = 3%
   Let X be kg of oil seed cakes for 97 kg mixture
   Let Y be kg of grains and bran for 97 kg mixture

| | | | | | | |
|---|---|---|---|---|---|---|
| X | + | Y | = | 97 | I | |
| 0.39 X | + | 0.1 Y | = | 18 | II | (minerals and salt do not contribute crude protein) |
| 39 X | + | 10 Y | = | 1800 | III | (Eq. II × 100) |
| 10 X | + | 10 Y | = | 970 | IV | (Eq. I × 10) |
| - | | - | | - | | |
| 29 X | | | = | 830 | | |
| | | X | = | 830/29 = 28.6 | | |
| | | Y | = | 97 - 28.6 = 68.4 | | |

Groundnut cake $= 28.6 \times \frac{44}{78} = 16.1$

Gingilly cake $= 28.6 \times \frac{34}{78} = 12.5$

Sorghum $= 68.4 \times 9/30 = 20.5$

Maize $= 68.4 \times 10/30 = 22.8$

Rice bran $= 68.4 \times 11/30 = 25.1$

| Final Ration | CP | TDN |
|---|---|---|

| Final Ration | | CP | TDN | | |
|---|---|---|---|---|---|
| Sorghum grain | 20.5 | 1.845 | 15.375 | | |
| Maize grain | 22.8 | 2.28 | 17.1 | | |
| Rice bran | | 25.1 | 2.761 | 15.06 | CP = 18.22% |
| Groundnut cake | 16.1 | 7.084 | 11.43 | | TDN = 68.72% |
| Gingilly cake | 12.5 | 4.25 | 9.75 | | |
| Mineral mixture | 2.0 | - | - | | |
| Salt | 1.0 | - | - | | |
| Total | 100.0 | 18.22 | 68.72 | | |

# Mixing of Rations

Different methods for mixing animal rations ensure a balanced diet, prevent selective feeding, and improve feed efficiency. Here are the primary methods used:

**1.Hand Mixing**:

1. Suitable for small farms with limited animals.
2. Ingredients are measured and manually mixed in a trough or on a clean surface.
3. Requires careful measuring and thorough mixing to ensure even distribution of nutrients.

**2.Mechanical Mixing**:

1. **Vertical Mixers**: Ingredients are added into a vertical drum and mixed with rotating paddles. Common for mixing roughage and concentrates.
2. **Horizontal Mixers**: Ingredients are mixed in a horizontal drum with rotating blades. Good for larger farms with more animals and diverse feed ingredients.

**3. TMR (Total Mixed Ration)**:

1. Combines all feed components (roughages, concentrates, minerals, etc.) into a single mix.
2. Ensures each bite is nutritionally balanced, preventing animals from picking out specific ingredients.
3. Widely used in dairy and beef farms for consistent intake and nutrient balance.

**4. Pelleting**:

1. Ingredients are ground, mixed, and pressed into pellets.
2. Reduces feed wastage and prevents animals from selectively eating only preferred ingredients.
3. Common in poultry, swine, and some dairy feeding systems.

1) A method of determining the least-cost ration using a series of mathematical equations. **JKPSC-2020**

A) Pearson Square method

B) Algebraic method

**C) Linear Programming**

D) Two by Two Matrix method

2) Arrange the following activities stepwise in formulation of ration for dairy cattle **JKPSC-2020**

1) Calculate nutrient requirements of animal according to its production

2) Choose available feed ingredients

3) Manipulate each ingredient to match the supply and requirement of nutrients

4) Know the nutrient content and inclusion levels of feed ingredients

5) Calculate the nutrients supplied by a set weight of feed ingredients

**A) 1,2,4,5,3**

B) 2,4,1,3,5

C) 1,2,5,3,4

D) 4,2,5,1,3

3. Which technique is employed in computer analysis to calculate least cost ration? Uppsc 2022

**a. Linear programming**

b. Nonlinear programming

c. Curvi-linear programming

d. Integer-linear programming

4. Consider the following statement regarding ration formulation: **JKPSC - 2019**

1) Age, Pregnancy, milk Product and Physical activity must considered when formulating ration

2) It should contain all essential vitamins and minerals

3) It should contain balance of protein carbohydrates and fats

Which of the statements given above are correct?

(A) 1 and 2 only

(B) 1 and 3 only

(C) 2 and 3 only

**(D) 1, 2 and 3**

5. The collection period for digestibility trial of large ruminant should be (J&K 2012)

**(A) 7-10 days**

(B) 10-14 days

(C) 5-7 days

(D) 20-22 days

6. The technique employed to calculate least cost and profit maximizing rations is called as Mppsc 2019

(A) Trial and Error method

(B) Pearson's Square method

**(C) Linear Programming**

(D) Algebraic method

7. Collection period (no. of days) followed in conducting digestibility trial by direct in vivo method in ruminants are: Opsc 2014

(a) 21

**(b) 7**

(c) 2

(d) 60

8. Following is the internal indicator for determination of digestibility of a feed in cattle: Opsc 2013 -14

(a) Chromic oxide

**(b) Lignin**

(c) (a) & (b)is correct

(d) cellulose

9. For determining the digestibility of a feed by conducting digestion trial in ruminants, the optimum length of 'preliminary period' followed is: Opsc 2013 -14

**(a) One week**

(b) Two weeks

(c) Three weeks

(d) 60 days

10. The amount of feed an animal needs to maintain its body mass and composition without any weight loss or gain: Opsc 2021-22

(A) Balanced ration

(B) Ideal ration

**(C) Maintenance ration**

(D) Production ration

11. The feed allowed for a given animal during a day of 24 hours is called as Mppsc 2021

**(A) Ration**

(B) Diet

(C) Balanced feed

(D) Complete feed