UNIT 4

Feed Technology, Feeding Experiments and Standards

1. Processing of Concentrates
2. Processing of Roughages
3. Feeding Experiments
4. Feeding Standards
5. Conservation of Feed through Silage and Hay

1. Processing of Concentrates

Processing methods of grains

- A- Dry processing methods
  - Grinding, dry rolling, popping, extruding, micronizing and roasting
- B- Wet processing methods
  - Soaking, steam rolling, steam processing and flaking, pressure cooking, exploding, pelleting, reconstitution

A. Dry processing methods

1. Grinding

simplest and least expensive

by means of a hammer mill.

vary from fine to coarse depending upon mesh size of the sieve/screen.

Very fine grinding= dusty and less palatable

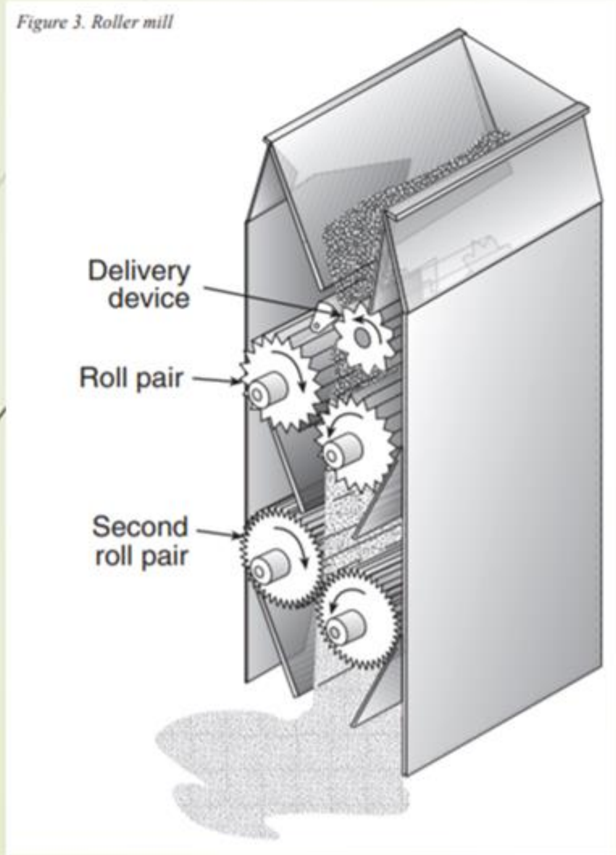
Expressing particle size of grounded material

- Grounded feed is expressed in terms of modulus of uniformity and modulus of fineness.
- Modulus of uniformity is expressed as ratio of coarse: medium: fine particle with suitable ratio will be 1:6:3.
- Modulus of fineness varied fro 1 to 7 and decreased with decrease of particle size of grounded material.

Advantages

- Grinding increased surface area thereby improved digestibility.
- Improved performance of animals by increasing nutrient utilization.
- Grinding makes mixing uniform and more efficient.
- Using grounded material makes pelleting and extruding easy, more effective, and efficient.
- Grinding reduced risk of particle segregation.
- /avoided by the grinding of grains. Selective feeding and risk of wastage by livestock will be minimized
- Grinding improves palatability.
- Grinding reduce energy loss occurs during mastication

2-Dry rolling



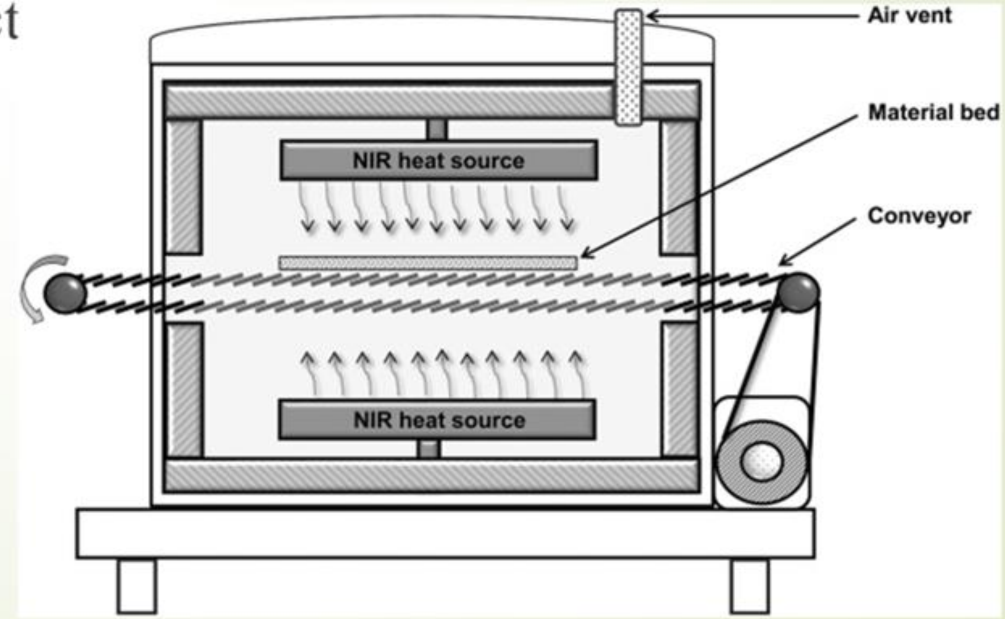
- Rolled grains are prepared by passing the grain through a roller mill.
- The physical properties of rolled grains are very similar to the of grains coarsely grounded in hammer mills.
- There is less issue of variation in the size of grounded material in rolling (material is uniformly grounded).

3-Popping or puffing

- Popping is produced by the action of dry heat (370-425 degree celsius) for 15-30 sec.
- Popping caused sudden expansion of grains which rupture the endosperm and this is responsible for the rupture of starch granules and makes starch more available for the digestion.
- Popped grains are less in moisture and are bulky in nature.
- Popping improved palatability, feed intake and digestibility.
- Puffed grains are good carrier of molasses.

4-Micronizing

- Micronizing is similar to popping except that heat generated is in the form of infra-red energy.
- Micro waves with 3 x 10^8 to 3 x 10^{11} cycles/sec are emitted from infra-red burner.
- Generally micronized grains are rolled to produce a uniform dense product



5-Roasting

- It occurs by passing the grains through flame resulting in heating to about 300 degree Fahrenheit or 148.9 degree Celsius.
- Roasting results into the expansion of grain starch to a certain extent which produce a palatable product.
- Moisture content of the roasted grain is around 3-5%.

Drum type grain roaster

6-Extruding

- Extrusion is used by the feed industry in the production pet feeds, fish feeds, laboratory animal feeds, etc.
- Extrusion results in the gelatinization of starch in variety of cereal grains and also cooking of soybean and pulses for the control antinutritional factor.
- It also used in the cooking of meat, fish, and feather meals for the control of pathogenic agents (salmonella).
- Gelatinization of starch results into the improved digestibility, feed conversion efficiency and performance of the animal.

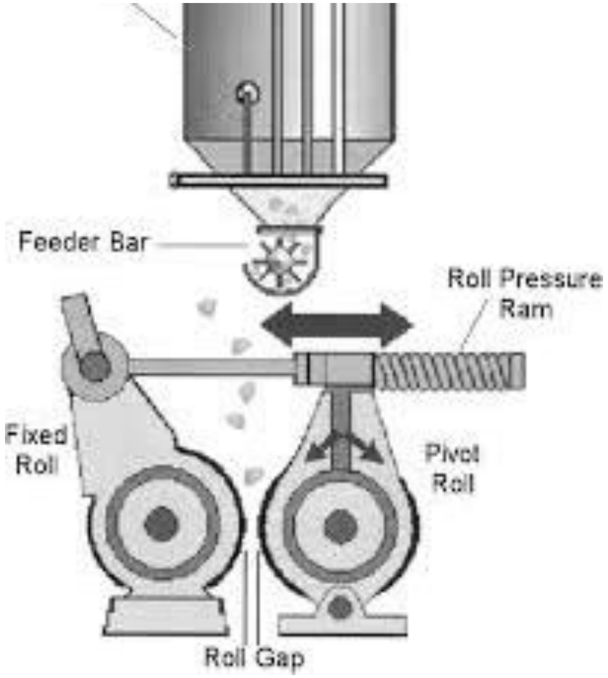
B-Wet processing method

1-Soaking

- Soaking of grains for 12-24 hours in water improved palatability and intake of soaked grain.
- Soaked concentrate mixture feeding is popular in swine feeding.
- Soaking of MOC, till cake and other feedstuffs remove certain antinutritional factors.

- Steam conditioning is a process where grains are exposed to steam at 210-215°F for 8 to 20 minutes.

- subjecting grains to 22-60 psi pressure for 50 seconds to 2 minutes is a conditioning method aimed at enhancing their quality by improving moisture absorption, digestibility, and overall nutritional value.

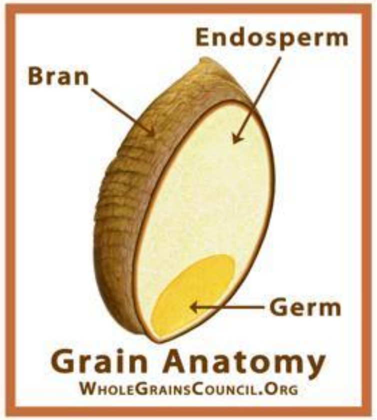


3-Steam processing and flaking

- Somehow similar to the steam rolling. After steam treatment, grains are passed through the roller mill.
- The tolerance set between the rollers depends upon the flatness of the flake desired.
- Drying is required while storing the steam processed and flaked grains.

4-Pressure cooking

- Pressure cooking is similar to the steam rolling or steam processing and flaking.
- Grains are pressure cooked at 50 psi for 1.5 min in air tight pressure chambers at temperature 300 degree Fahrenheit.
- The temperature is reduced to below 200 degree Fahrenheit and the moisture to 20% by passing them through cooling and drying tower prior to flaking.
- Pressure cooked grains are difficult to flake to the same degree of flatness due to spongy nature of the pressure cooked grain.
- Pressure cooked flakes are less brittle and therefore not break.



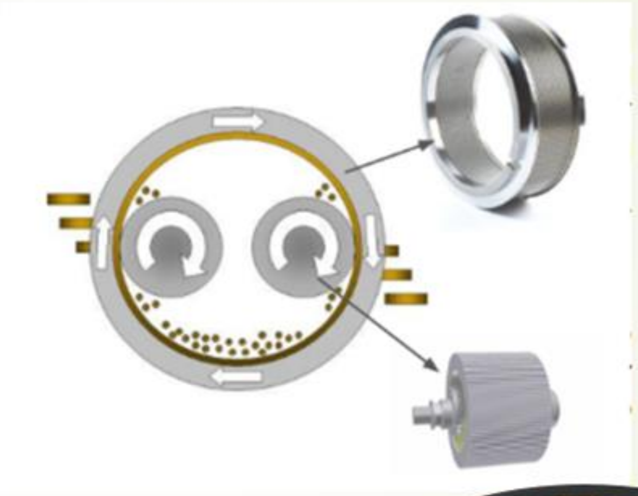
5-Exploding

- It is done by subjecting grains to high pressure steam (250 psi) for very short time (20 sec) followed by sudden decrease to atm pressure.
- This results into rapid expansion of grain kernels and produced a low density product (similar to popping).

6-Reconstitution

- Reconstituted grains are matured grain (10% moisture) to which water is added to raise the moisture level to 25-30% and wet grains are stored in an oxygen-limited silo of 14-21 days prior to feeding.
- Reconstitution of grain increases the solubility of the grain protein.

7-Pelleting



- Pelleted feeds are agglomerated feeds formed by extruding feed/grain by forcing and compacting and forcing through die openings by any mechanical process.
- The purpose of pelleting is to change dusty and unpalatable feed material into more palatable, easy to handle large particles by application of optimum amounts of heat, moisture and pressure.
- The normal size of the pellets is 3.9-19 mm with most optimum particle size of pellets are 6.25-9.4 mm.

Advantages of pelleting

1. Increase the palatability and therefore increase feed intake.
2. Increase the density of feed and thereby reduce the storage space required.
3. The segregation of ingredients in a mixing, handling or feeding process is prevented.
4. Waste during the eating process is minimized.
5. Requires less labour (easy to handle) in pelleted feed handling as pelleted material is free flowin.
6. Heat labile inhibitors are destroyed , gelatinization of starch occurs.
7. Feeding pelleted feed improved performance of the animals.
8. Bulk density is increased, which enhances storage capabilities of most bulk facilities. Shipping facilities are also increased, thereby reducing transportation costs.
9. Feed in pellets forms reduces natural losses because it reduces the formation of dust.

Disadvantages of pelleting

1. Increase the cost of the feed due to the pelleting process.
2. Decrease eating time, creating more boredom.
3. Decrease the amount of fiber a animal receives.
4. Poor-quality feed ingredients can be hidden in a pellet.
5. Excessive heat during the pelleting process may decrease the availability of amino acids such as lysine and may destroy some Vitamins.
6. Greedy eaters may be more prone to choke, colic, or other digestive disorders.

1. Which of the following involves the irreversible destruction of the crystalline order in starch granules to make the surface of every molecule accessible to solvents for improving digestibility? Mppsc 2023

[A] Reconstitution
[B] Extruding
[C] Pelleting
[D] Micronizing

2. The stages involved in processing of animal feed include: **Kerala PSC**

(A) Receiving and cleansing of the raw materials
(B) Pelleting and crumbling
(C) Grinding and mixing of the ingredients
(D) Steaming and cooking of ingredients
Choose the correct sequence given below:
a) (A), (C), (B), (D)
b) (A), (C), (D), (B)
c) (B), (D), (C), (A)
d) (A), (D), (B), (C)

3. In wet processing method, the reconstitution of grains is done to raise moisture level to **MPSC – 2019**

(1) 35-40%
(2) 25-30%
(3) 15-20% "
(4) 12-15%

4 Grinding of grains increases the digestibility, because of: Opsc 2013 -14
(a) Slower rate of passage in digestive tract
(b) Faster rate of passage in digestive tract
(c) Increased surface area for enzymatic action
(d) Decreased surface area for enzymatic action

5. Which of the following is a wet processing method for grains?

•a) Grinding
•**b) Soaking**
•c) Crimping
•d) Pelleting (dry)

6. What is the main objective of pelleting (moist)?

- a) To reduce feed density
- b) To increase dustiness
- **c) To densify grain with steam or moisture**
- d) To decrease palatability

7. Which of the following methods involves exposing grains to steam under high pressure and then suddenly reducing it to atmospheric pressure?

- a) Reconstitution
- **b) Exploding**
- c) Extrusion
- d) Crimping

8. What is the result of roasting grains?

- a) Gelatinization
- **b) Inactivation of enzymes or inhibitory factors**
- c) Swelling of grains
- d) Moisture absorption

9. Which dry processing method is the least expensive for reducing particle size of grains?

- **a) Grinding**
- b) Popping
- c) Extrusion
- d) Crimping

10. Which method increases the solubility of grain carbohydrates and protein by raising the moisture content to 25-30% and storing it for 2-3 weeks?

- **a) Reconstitution**
- b) Soaking
- c) Pelleting
- d) Exploding

2. Processing of Roughages

- **Roughage Processing methods**
  - A- Dry processing methods
    - Bailing, field chopping, grinding, pelleting, cubing and dehydration
  - B- Wet processing methods
    - Green chopping and soaking

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.

Chopping (Chaffing)

- The forages are chopped into small pieces as fine or coarse particles.
- Chopping avoids the selective feeding thus wastage of plant material is reduced.
- The machine used for the intended purpose is called chaff cutter.
- Chopping facilitates easy handling due to increased bulk density.
- Also improves digestion due to exposure of relatively large surface roughages for microbial digesting.

Grinding

- It is a process of particle size reduction.
- Course grinding: roughages improves the feed consumption and growth rate
- Fine grinding: reduce the digestibility of CF: due to faster rate of feed particles in GIT (reduce milk fat content).
- High cost: grinding of roughages is not economical.

Roughage-Pelleting

- The ground roughages are pelleted and fed to animals.
- Improves the consumption of poor quality roughages.
- The size of pellets is 12/64” to 48/64” and has a density of 40 lb/ cft.

Advantages

- Pelleting roughages puts them in free flowing form
- Must be ground prior to pelleting – expense
- Reduce space requirement by as much as 75%
- May increase intake of forages
- Reduces dustiness
- Increase efficiency for low-quality forages

Disadvantages

- Cost of additional processing (more costly for roughage than for concentrate)
- Reduces the roughage value of hay

Dehydration

- It is a process of reduction of moisture content in a dehydrator using a temp. 600-1500^{0}F for a short time period of 3-5 minutes.
- dehydrated forage: retains: lot of DM and CP
- No loss of leaves, but carotene content is reduced.

Cubing

- ➢ It increases the density of roughages upto 30lb/cft.
- ➢ good quality hay is sprayed with water to increase the moisture content upto 14%.
- ➢ broken down rather than to ground the roughage, so that there is minimum of fine particles in the cube.
- ➢ Cubing: Alfa- alfa hay is done: Developing country.

B: Wet processing methods:

- 1. Soaking is a process of mixing or spraying water on roughages so that stems become soft and mixing of concentrates with roughage is uniform which improves the feed intake and digestibility of roughages.
- 2. Green chopping: When green roughages are chaffed, there is no need of soaking and fed as such or mixed with dry roughage or concentrate mixture.

Chemical treatment/processing

- Poor quality fodders are treated with chemicals such as sodium or potassium hydroxide and
- urea to increase the availability of the nutrients to livestock.
- Urea treatment: Urea treatment is most economical and easiest of all chemical treatments.
- 4 kg urea dissolved in 40 litres of water for 100 kg of straw.
- • Urea hydrolysis by urease: Ammonia= breakage of lignocellulose bond by ammonia thereby releasing cellulose from lignin bondage for digestion and utilisation.
- • After 21 days the urea treated paddy straw is ready for feeding available

Advantage

- increase the CP and TDN content from 2% to 10% and 45 to 60%,
- respectively. It improves the palatability of straw and thus, increases feed intake.
- • Feeding Urea treated Straw: It is not advisable to feed the urea treated straw (NPN
- substances) for calves below 6 months of age. For efficient use of urea treated straw, an
- adaptation period is required.
- • NaOHtreatment: 1.2-1.5% sol.→ Beckmann's method
- • $Ca(OH)_2$ + NaOH: both 4%
- • 3% Anhydrous NH_3: bind with sugar → 4-methyl imidasol (Bovine bonker)

1. What is the main purpose of chopping or chafing roughages?

- a) To increase moisture content
- **b) To improve ruminal digestion by increasing surface area**
- c) To decrease feed bulk density
- d) To reduce the rate of fermentation

2. Which process involves treating straw with urea to release cellulose from lignin bondage for digestion?

- a) Ca(OH)2 + NaOH treatment
- b) Pelleting
- **c) Urea treatment**
- d) Cubing/block and wafering

3. What is the disadvantage of finely grinding fodder plants for pelleting?

- a) Increased palatability
- **b) Reduced normal rumen functions and rumen pH**
- c) Increased mastication time
- d) Improved salivary secretion

4. Which method is most economical and easiest for chemical treatment of roughages?

- **a) Urea treatment**
- b) Sodium hydroxide treatment
- c) Potassium hydroxide treatment
- d) Anhydrous ammonia treatment

5. What is the purpose of white-rot fungi in biological processing of roughages?

- a) To increase moisture content
- b) To improve the palatability
- **c) To degrade lignin in lignocellulosic straws**
- d) To reduce the protein content

6. What temperature range is used for dehydration of roughages in a dehydrator?

- a) 600-1500°F
- b) 300-500°F
- c) 150-250°F
- **d) 100-200°F**

7. Which of the following fungi can degrade 65-75% of lignin in lignocellulosic straws?

- a) *Ganoderma applanatum*
- **b) *Phanerochaete chrysosporium***
- c) *Coprinus fimetarius*
- d) *Pleurotus spp*

8. In the Karnal process, what is mixed with urea-treated cereal straw before inoculating it with Coprinus fimetarius?

- a) Sodium hydroxide
- **b) 1% single superphosphate and 0.1% calcium oxide**
- c) Anhydrous ammonia
- d) Potassium hydroxide

9. Which processing method involves spraying water on roughages to soften the stem and improve palatability?

  - a) Grinding
  - **b) Soaking**
  - c) Baling
  - d) Cubing

3. Feeding Experiments

1.Comparative feeding trials

Two or more rations may be compared with growth and production.

For two rations, ‘t’ test is used

three or more rations ”analysis of variance” test is applied

2. Feeding trials with laboratory animals (like rats, mice, hamsters etc.)

- Low cost and the shorter time, easy

3. The purified diet method

A. Purified diets = lab animals.

B. purified sources of the various nutrients.

C. For example

- ★ Carbohydrates is supplied as starch, glucose or sucrose
- ★ Protein is supplied as Casein, Purified soybean, urea
- ★ Fat as lard or some oil
- ★ Minerals a chemically pure salts

Vitamins as pure crystalline compounds

3.3 Experimental designs

- Completely Randomized Design (CRD)
- Randomized Block Design (RBD)
- Latin Square Design (LSD).

1. CRD: Treatments are completely at random so that each experimental unit has the same chance of receiving any one treatment.
2. RBD: Experimental units are grouped into blocks, with the different treatments to be tested randomly assigned to the units in each block. Data analysis is simple and easy to understand.
3. LSD: Experiments to minimize the number of animals required to detect statistical differences.

Methods of determining digestibility

1. Live animal experimentation: *In-vivo* method
   - A. direct *in-vivo* method
   - B. indirect *in-vivo* method
     - by difference method
     - by indicator/ markers

2. Laboratory method:
   - *in sacco* / semi *in-vivo* method
   - *in-vitro* method

A. In-vivo methods:

1. Direct in-vivo method

a. **By digestion** – only feces collection – ruminants

b. **By metabolism trial** – feces and urine (and milk in milch animals) both collection - poultry

Norms of trials:

a. Animals: homogenous, four (minimum), male are preferred (collection of urine and feces easy)
b. Preliminary period: 7-14 days in ruminants and 2-5 days in pigs.
c. Collection period: 5-7 days (7-10 days sometime)

1. **Indirect in-vivo method:**

a. **By Difference:** difference of nutrient intake and fecal excretion is considered.

1. **Maintenance ration:** one trial is conducted. Ration that maintains constant BW is given and dig. is estimated.
2. **Productive ration:** 2 digestion trials (e.g. concentrate) are conducted.
    a. Trial 1 = (maintenance ration) and
    b. Trial 2 = (maintenance + production ration).
    c. So, Dig% = (Trial 2 – Trial 1).
3. **Non-maintenance ration :** 3 digestion trial (e.g. wheat straw)
    a. Trial 1 = (maintenance ration)
    b. Trial 2 = (maintenance + production ration)
    c. Trial 3 = (Non-maintenance + production ration)
    d. Dig% = Trial 3 - (Trial 2- Trial 1)

Drawback of difference method:

1. Associative effect of feeds:

Addition of productive ration (protein cake/ grains) may influence digestibility of basal/ maintenance ration or non-maintenance ration (wheat straw)

2. Digestibility in poultry:

- By surgical mean: separate urine and feces
- By chemical method: Urine N- uric acid and Fecal N – true protein

b. By Indicator/ markers: inert reference substance

- Ideal marker:
  - ➔ totally indigestible and non-absorbable
  - ➔ no pharmacological action on GIT (inert)
  - ➔ mix intimately and uniform distribution
  - ➔ uniform rate of pass through tract even a small amount of feces collected at any time gives an amount of nutrient per unit of marker.
  - ➔ voided completely
  - ➔ can be determined chemically in feces
  - ➔ natural constituent of feed – preferable

Indicator	
Internal	**External**
Natural constituent of feed	Not natural constituent of feed
Lignin	Chromic oxide (Cr_2O_3)
Silica	Ferric oxide
Acid insoluble ash	Radioactive isotopes: Cr51, Ce144

Estimation of Feed intake in grazing animals

Digestibility= internal indicator (lignin)

Fecal output= external marker (Cr_2O_3)

Chromic oxide capsule – fed and then sampling at different intervals to know avg. conc per unit of feces.

Feces output: Marker consumed (g/d)/Marker conc. (g/g feces)

Digestibility % = 100 - % Indigestibility = (intake – output/intake x 100)

Intake: (Output/% Indigestibility) x 100

B. Laboratory:

1. in sacco / semi in-vivo method/ in-situ technique

- Only ruminal digestion
- Fistulated animals: at least 3

a. Bag technique:

- Bag : nylon, dacron or silk – kept in rumen
- Important parameters of in sacco method:

    Bag size: 6.5 x 14 cm (may be larger)

    Porosity of bag: 40-60 μm

    Feed particle size: 1-2 mm

    Sample size to bag surface area: 10-20 mg/cm2

Limitation: effect of mastication, rumination and transit not considered

b. VIVAR technique: in-vivo artificial rumen.

Limitation of semi-in vivo method: effect of mastication, rumination and transit not considered.

Factors that affect the degradability of feed in nylon bag technique:

- Particle size- 1-2 mm screen.
- Bag porosity- 40-60 um
- sample size to bag surface ratio- 10-20 mg/cm2
- Diet of the animal
- Bags per animal
- Numbers of animals- 3 fistulated animals
- Positioning of bags in the rumen
- Incubation length-depend on the type of the feed
- Timing of bag introduction in the rumen and pre ruminal soaking

2. in-vitro rumen fermentation technique

1. One-stage technique: feed + rumen liquor + artificial saliva – 39oC / anaerobic condition
2. Two stage technique: 1st stage: rumen fermentation foregut digestion
   2nd stage: acid- pepsin solution hindgut digestion

Important Facts

- In-vitro gas production system : Menke and Steingass (1988) Menke's method
- Drawback: feed intake, palatability not considered
- Use of in-vitro rumen fermentation technique:
  : Rapid screening of large no. of samples
  : Evaluation of newer/ unconventional feeds

Drawback of in-vitro technique: feed intake, palatability and associative effects of feed ingredients not considered

1. Determination of digestibility of feed in following species is complicated: **UTTARAKHAND VO – 2024**

a) Cattle
b) Buffalo
c) Poultry
d) Swine

2. 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

3. if an animal consumes 5 kg Dry matter and excretes 6 kg of feces with 50% moisture, the digestibility coefficient will be: PUNJAB 2016

a) 40%
b) 50%
c) 60%
d) None of the above

4. Which method is used to compare two rations in a comparative feeding trial?

- a) Analysis of variance (ANOVA)
- **b) t-test**
- c) Chi-square test
- d) Regression analysis

5. What is an advantage of using laboratory animals like rats or mice in feeding trials?

- a) Higher cost
- **b) Lower cost and shorter time**
- c) Difficult to slaughter
- d) Higher variability between animals

6. What is the source of protein in purified diets used for feeding trials with lab animals?

- **a) Casein**
- b) Lignin
- c) Glucose
- d) Minerals

7. In which experimental design are treatments assigned completely at random to experimental units?

- a) Latin Square Design (LSD)
- **b) Completely Randomized Design (CRD)**
- c) Randomized Block Design (RBD)
- d) Factorial Design

8. Which of the following methods involves collecting both feces and urine in metabolism trials?

- a) Feces collection method
- **b) Metabolism trial method**
- c) Bag technique
- d) VIVAR technique

9. What is the purpose of using chromic oxide as a marker in digestibility trials?

- a) It is a natural feed constituent
- b) It is completely digestible
- **c) It is indigestible and used as a reference substance**
- d) It has a pharmacological action on the digestive tract

10. In the in-sacco method for measuring digestibility, what is the recommended porosity of the nylon bag?

- a) 10-20 µm
- **b) 40-60 µm**
- c) 80-100 µm
- d) 100-150 µm

Classification of feeding standards

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 2. Scandinavian feed Unit" Standard	1. Grouven's Feeding standard 2. Wolff's feeding standard 3. Wolff's Lehmann feeding standard 4. Haeckers's Feeding standard 5. Savage feeding standard 6. Morrison standard 7. National Research Council standard 8. Indian standard	1. Kellner-feeding standard 2. Armsby feeding standard 3. Agricultural and Food Research Council standard.

A. COMPARATIVE TYPE

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

- Different feeds should be compared using **meadow hay** as a unit.
- The only measure was the practical feeding experience.

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.

B. DIGESTIBLE NUTRIENT SYSTEM

1. Grouven's feeding standard

- with **crude protein, carbohydrates and fat**

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:**

quantity of milk produced, but not quality of milk.

4. **Haecker's feeding standard**

- First time considered **quantity as well as the quality of milk**
- First to separate the requirements for maintenance from the requirements of production.
- 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.
- About two-thirds of the dry matter should be from the roughages and one-third from the concentrates.

Nutritive 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**

expressed in terms of **Dry Matter (D.M.), Digestible crude Protein (DCP) and (TDN).**

- **net energy values instead of TDN** in computing rations were also included.
- allowances for calcium, Phosphorus and Carotene
- accepted for Indian livestock.

7. **National Research Council (NRC) standard:** includes **digestible protein and total digestible nutrients (TDN)**

- Also **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

8. **Indian standards**

- Sen and Ray standards**:** he adopted the **average of maximum and minimum values recommended by Morrison**.
- **Indian Council of Agricultural Research**
- **C. PRODUCTION VALUE TYPE**

1. Kellner feeding standard

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

2. Armsby feeding standard

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

3. Agricultural Research Council (ARC) standard: requirements of poultry, ruminants and pigs.

- Followed in the United Kingdom. .

1. Feeding standards do not consider **JKPSC-2020**

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 **JKPSC-2020**

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 **JKPSC - 2019** 2019

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

5. 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

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

(1) Morrison

(2) Armsby

(3) Kellner

(4) Dubois

7. 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

8. Wolff-Lehman feeding standard developed in the year: Opsc 2013 -14 2nd

(a) 1903

(b) 1896

(c) 1884

(d) 1907

5. Conservation of Feed through Silage and Hay

- There are two methods of conserving forages;

1. Reduce moisture content- Hay

2. Maintain moisture content:

   Natural fermentation is facilitated to retain succulence- silage

Silage

Anaerobic fermentation of the green fodder crop retaining the high moisture content. It contains 25-35% DM & 14-16% CP.

process - ensiling.

Selection of crops for silage making:

- Thick stems
- High level of fermentable sugar
- Low protein like maize, sorghum, bajra etc.
- **Crop** should have 35 % dry matter or 60-70% moisture at the time of ensiling.
- Legumes are avoided
- harvested between flowering and milk stage

Method of Silage making

- A silo which is an air tight structure for storage and preservation.
- One cubic meter space is required for 400kg fodder silage making.
- Chopping of forage to a short length (1-3 cm).
- Compact forage as tightly as possible.
- Sprinkle salt at 0.5%, urea 1% and molasses 3% of the material weight to improve sugar content.
- Maintain sealing for 45 days.

Types of fermentation during Silage formation

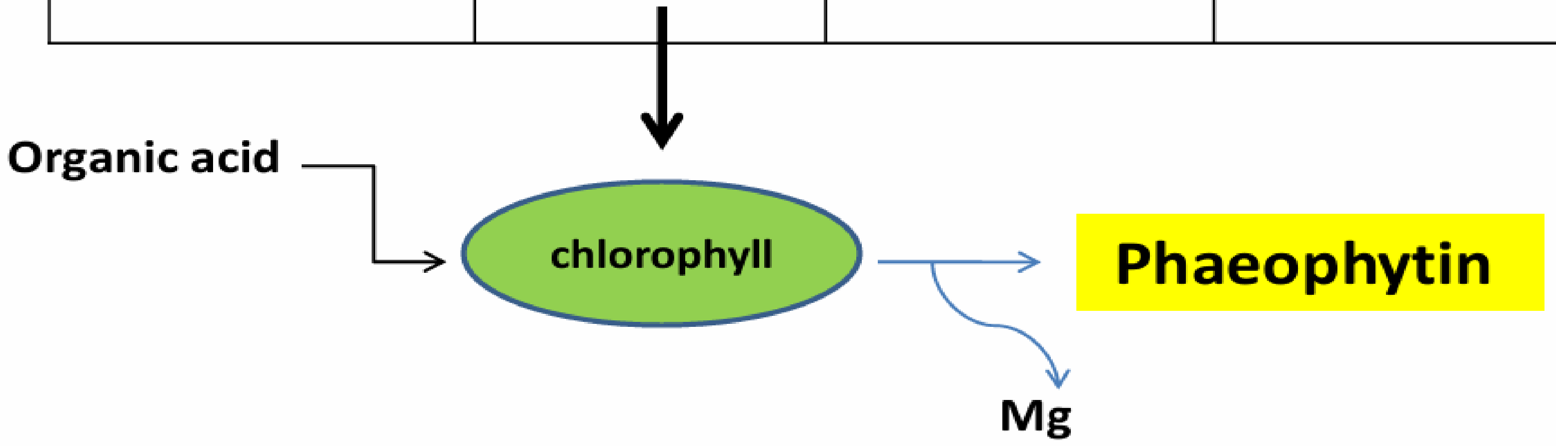
Lactic acid type- Desirable forage is carbohydrate rich.

Butyric acid type- When forage contains more protein than clostridium bacteria grow and deteriorate its quality.

Flieg index is used to evaluate silage quality which measures butyric acid produced. Lesser the butyric acid better will be silage quality.

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

Hay

Hay: dried green-fodder material

Reducing the moisture content of the green crop to a level low enough (12%-14%) to inhibit the action of plant and microbial enzymes is the aim of hay making.

Hay - free from moulds.

The harvested crop can be dried either by natural drying or through artificial drying.

Natural drying is preferred: It can be done without incurring expenditure towards electricity

Average quality hay will have 25-30 per cent crude fibre and 45-60 per cent TDN.

Crops for good hay

Selection of crop –

- The crop to be made as hay should have soft pliable, hollow stem.

Harvesting of crop –

- The nutritive value of hay depends on the stage of growth of the crop at the time of cutting.
- The crop should be harvested at 2/3rd flowering stage as it is at that time the plant will have the maximum nutrient in it.
- Delaying the harvesting further would divert the nutrients from the plant to seed production resulting in low nutritive value of the harvested crop.

HARVESTING AND CURING OF HAY

Good quality hay can be produced by harvesting the crop early in the morning and left in the field as such for curring.

Mechanical damage: Handling hay during early morning minimized loss of leaves.

Dry until the moisture content is reduced to about 14%.

Frequent turning is necessary to facilitate uniform drying.

On sunny days field drying of harvested crop for two days is sufficient to make hay.

Hay should always be stored in well ventilated place as they catch fire easily.

Methods

Field curing- sun

Barn drying: fan/ air duct

Artificial drying-hot air-expensive

Hot air (150°C) for 20-50 minutes.

Hot air (500-1000°C) for 0.5-2 minutes.

Types of hay

Legume hay: higher TDN and DCP and are rich in protein & minerals. Crops –Lucerne, Cowpea, Berseem. Good quality hay.

Non legume hay: less palatable and less amount of protein, vitamin and nutrients than legume hay but rich in carbohydrates. Crops – Oat, barley, Bajra, sorghum and grasses.

Mixed hay: The nutritive value of mixed hay depends upon the type of legume and non legume crops.

Losses in nutritive value of hay

Losses due to late cutting

Losses of leaves by shattering

Losses due fermentation

Losses due to leaching

Losses due to bleaching- green material (HPSC-2018)

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

Difference in silage and Hay

Particular	Silage	Hay
DM (%)	30-35	10-15
Type of crop	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.

- **Oat hay poisoning/ nitrate poisoning**: Nitrate poisoning can occur in crops like sorghum, lucerne, and Sudan grass. In the rumen, nitrate is reduced to nitrite, which, when absorbed into the bloodstream, oxidizes the ferrous ion in hemoglobin to ferric ion, forming methemoglobin. This causes the blood to become chocolate brown, leading to a brownish discoloration of the mucous membranes and skin.

1. Which fodder crop is most suitable for silage production? **PUNJAB 2022**

a) Berseem

b) Lucerne

c) Lobia

d) Maize

2. The pH range of good quality silage is RPSC 2019

(1) 3.5-4.2

(2) 3.2-3.5

(3) 4.2-4.5

(4) 4.5-4.8

3. Silage is Punjab 2021

(A) Preserved dry fodder

(B) Fermented fodder

(C) Succulent fodder

(D) none of above

4. Very good silage should have pH ranging from Rpsc 2013

(1) 4.2 to 4.5
(2) 4.5 to 4.8
(3) 3.7 to 4.2
(4) 4.8 to 5.0

5. Best crop suitable for silage making is Rpsc 2013

(1) Jowar
(2) Bajra
(3) Maize
(4) Oats

4. Very good silage should have pH ranging from Rpsc 2013

(1) 4.2 to 4.5
(2) 4.5 to 4.8
(3) 3.7 to 4.2
(4) 4.8 to 5.0

5. Best crop suitable for silage making is Rpsc 2013

(1) Jowar
(2) Bajra
(3) Maize
(4) Oats

8. Following is the 'best quality hay' for feeding of sheep: Opsc 2013 -14 2nd

(a) Lucerne hay

(b) Grass hay

(c) Mixed grass hay

(d) Guinea grass hay

9. The acid required for good quality silage is: Opsc 2013 -14 2nd

(a) Acetic acid

(b) Butyric acid

(c) Propionic acid

(d) Lactic acid

10. Moisture content of chopped hay is: Opsc 2013 -14 2nd

(a) 19-22%

(b) 25-28%

(c) 20-25%

(d) 25-30%

11. The pH of good silage is: Opsc 2013 -14 2nd

(a) 7

(b) 4

(c) 6

(d) 3.5