E-PRACTICAL MANUAL

NR 2208

RANGELAND AND LIVESTOCK MANAGEMENT

2 (1+1)

B.Sc. (Hons.) Forestry

Prepared by

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E-Practical Manual on
Rangeland and Livestock Management

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FOREWORD

I am pleased to learn that the Department of Livestock Production & Management is bringing out the lab manual of NR 2208: Rangeland and Livestock Management for the students of B.Sc. (Hons.) Forestry. The university has always been supportive for providing all sorts of help in facilitating the best teaching and learning environment. This lab manual will be helpful to improve students' understanding of the subject and easily accessible all the time. With this lab manual, the students will be able to develop their skills for better performance in academics and in the professional field as well.

I appreciate the tireless efforts of Dr. Narendra Kumar, Assistant Professor, Department of Livestock Production & Management and Dr. Sanjeev Kumar, Dean, College of Forestry in developing and designing this manual. I am sure that this lab manual will be very useful to the students registered for the course of 'Rangeland and Livestock Management'. This manual will work as a ready reckoner for the students to help them in preparation of competitive examination for higher studies.

With best wishes,

(G.S. Panwar)
Dean
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Exercise 1

Visit to Institutional Livestock Farm

Objectives

- To give hands on training to the students on the overall farm practices of livestock management including breeding, cleaning, feeding, watering, grooming, milking, routine health care, record keeping, sanitation, housing and fodder production.

We visit various livestock farms where cattle, buffalo sheep, goat, poultry species are maintained with different objectives. Information to be collected and critical observations to be made while moving round in the farm and having clear concept of target/goals for performance traits for different species or breed will help to analyze managerial practices and performance of the herd. Various information to be collected and certain observations to be made while visit to livestock farm are:

1.	Species/breeds: of livestock kept	Cattle, Buffalo, Sheep, Goat, Poultry
2.	Size of the farm	Small/Medium/large
3.	Institutional/organized or Private	a) Organized-Government/University /Trust b) Private
4.	Establishment	a) When: b) By whom:
5.	a. Objective/Motive	Academic/Research/both Business-Profit
	b. Objectives, if research farm	
6	Land available	Livestock farm, Fodder Farm
7.	Systems of Farming	Specialized/Diversified/Mixed Farming
8.	Building/Structure	a) Primary structures c) Layout of sheds b) Ancillary structures d) Type of arrangement
9.	Feed and fodder	Fodder crops Cultivated/Dry/ Purchased Feeds being utilized
10.	Observations while visit to sheds	Condition of animals, Condition of sheds, Cleanliness of sheds, floor, water trough, manger Drainage facility, Manure pit, distance from sheds, condition. Fly/Mosquito/Insects problem

11	Level of mechanization/use of machines	Chaff cutter Milking machine Harvester (mechanical harvesting)
12.	Information on method of rearing calves	Weaned /suckled
13.	Information on Herd performance traits	Production performance: wet average and Herd Average, Reproductive performance: Milch: Dry Ratio (% milch animals)
14	Herd performance characteristics	i) Age at First Calving (AFC) ii) Calving Interval/Inter-calving period (CI) iii) Lactation period/days iv) Total Lactation Milk Yield (TLMY) v) Standard Lactation Milk Yield i.e. first 300days (SLMY) vi) Dry period/days
15	Mortality in Calves/ the Herd	Calf mortality<6month of age or Overall herd Mortality
16	Efficiency of Land use	Cropping intensity

Exercise:

Q1. Write different species and their breeds available at institutional livestock farm?

Q2. Write down the different managemental activities at institutional livestock farm?

Exercise 2

To study different tools/instruments used in livestock management

Objective:

- To identify the different tools/instruments used in the animal farm.
- To discuss the uses of different tools/instruments.

Farm tools refer to hand tools, and power-operated equipments used for performing various farm operations in the animal production. The use of farm machinery helps to achieve improved timeliness of farm operations and efficient use of labour. The use of farm machinery also reduces the labour and time on the farm. Following machinery and equipments are commonly used in the animal farm for easy farm management.

Restraining devices

General restraining devices

These devices act as tools of restraining by confining the animals to a smaller area which results in easy handling of animals.

Trevis/crush/stocks - For restraining of animal in a confined space. Trevis is symbol of veterinary hospital. It is made up of hard wood or metal tubing. It consists of four posts well driven into the ground and cemented there, with two or more crosspieces at each side. Front end may have two or three removable cross bars whereas rear end at height of 0.5, 1.0 and 1.5m from ground level and back end with one removable bar at about 0.75m from ground. The inner length, breadth, and height of trevis are about 1.6 m, 0.8 m and 1.3 to 1.5m respectively. Animals can be kept restrained at standing position for examination treatment etc. inside the trevis.

Chute – It provides immobilization via a head catch and squeezable sides. The side panels can be dropped to examine feet and legs, whereas the side bars can be dropped to examine the dorsum of the animals.

Alley way – It is the narrow passage area that restricts cattle from turning around when they approach the chute. To prevent the backing up in the alley way poles or back gates can be used.

Hog hurdle – Sometimes a hog hurdle or portable partition is used to corner the animals so that grasping becomes easier.

Ropes: Ropes are essential for restraining farm animals. Cotton rope is preferable because it is strong, safe and easy to use when making knots. Rough, hard ropes like

coir should not be used since it can cause abrasions to the animals. Two sets of rope should always be kept ready:

- One about 2.5 - 3. cm thick and about 8 m long for use in casting or securing large animals, and
- Two or three pieces, 1 - 1.5 cm thick and about 2 m long for securing small animals and the feet or horns of large animals.

Twitches - are among the oldest and most commonly used methods of restraint.There are two methods of twitches: Natural and Mechanical, Natural twitches ("shoulder roll" or "skin twitch") are applied with the hand directly on the horse: no especial equipment is required. Mechanical twitches are manmade devices that are applied directly on the horse.The different types of twitches are the stick twitch, halter twitch, loop twitch, and leg twitch. Twitches should be applied immediately before the necessary restraint is used. Since the device inflicts pain, repeated use should be avoided.

a. **Stick Twitches**: The stick twitch consists of a piece of solid wood about 1 m long with a 1.5 cm hole about three cm from the end. A piece of rope is inserted through this hole. The twitch helps restrain the animal by causing a harmless pressure upon a sensitive area of the upper lip. It also diverts the animal's attention from the part being manipulated and affords a strong hold upon the head of animal. If it is not possible to apply a twitch on the upper lip, then the lower lip or an ear may be used.

b**. Loop Twitches**: The loop twitch consists of a pliable rope with a running noose on one end. The noose is passed over the poll, into the mouth, and pulled tight. It should be used very carefully since it is liable to cut the commissures of the lips.

c**. Leg Twitches**: The leg twitch is an ordinary tourniquet applied about 10 cm above the knee or hock to immobilize the leg.

Head restraining devices

Halters –Used for controlling large animals.

Rope halter – Used to lead, tie, secure or steady the head of animals. A temporary rope halters prepared by making a small loop at one end of the rope and second loop about 10c.m below the first loop. Then, free end is passed through first and second loop sequentially to complete the halter.

Leather and nylon halter – Permanent halters are made up of leather or nylon.

Polyrope sheep halter and Suckling halter.

Head Collars: Effective devices for controlling animals, head collars are used mostly with horses, but may also be used with cattle and buffalo. The head collar consists of a poll-piece, two cheek pieces, a nose band, a throat-piece, and a jowl-piece. Today, nylon head collars are increasingly being used because they are cheap, easy to clean, and durable. A head collar is a very effective means for securing a horse in a stable or stall.

Bull nose ring – Nose rings are worn by some bulls for the purpose of making them easier to handle. It is generally made of two semicircular pieces hinged together and may be made of non-rusting materials such as copper, aluminium, or some other alloy. According to age and size small and large ring can be used. Some bull needs a new ring every year due to greater amount of wear and tear. The ring is applied through the nasal septum about one cm back from the nostrils. A hole is first punched with a special bull puncher. When punching the hole, care should be taken not to punch it too far back. It results in too little space being available in that part of the ring lying outside the nostrils to accommodate a rope or a chain.

Some time nose ring applied to pig to control as well as to prevent them from rooting.

a) **Self-piercing**" rings -Self-piercing rings with sharp ends designed to be pressed through the septum and then pulled together with a screw.
b) **Non piercing**

Bull nose punch - The ring is normally placed on the bull between 10 and 14 months of age. It is usually done by a veterinarian, who pierces the septum with a punch.

Bull holder or bull tong: Animal are restrained by grasping the nasal septum between thumb and finger through nostrils, forming a nose tong but to restrain a large animal in this manner is difficult hence metallic bull tong or nose tong is used. Used for holding of bulls and fixed into the nostrils of bulls. Made up of two semi circulars 'bent finger like 'structures. Apply the instrument to the bull nose ring to lead the bull. It reduces the damage to nasal cartilage because of tongs having a smooth surface and space between the balls.

Muzzle – Muzzle are used to stop animal from biting people or other animals, eating their bedding and in large animals to prevent them from taking medicines applied on the body etc. They are applied to mouth and fixed behind the horn by means of strap/string. Calves are muzzled to prevent them from suckling their mothers or other mates. Three kinds of muzzles are in common use, namely leather, wire and string muzzles.

Leather Box Muzzle: This is the best type of muzzle, but it is expensive.

Wire Muzzle: This is less comfortable for the animal, but it is durable and inexpensive.

String Muzzle: This is a practical and inexpensive muzzle that can be made at home. The muzzles should not be put on too tightly; otherwise, the animal will present its reapplication. Muzzles are taken off at feeding time.

Gags – Gas are use for keeping the two jaws apart for examination of mouth, teeth or for passing the stomach tube in cattle sheep and goats. These are mostly made of metal. The one in common use with large animals is called Varnell's movable gag. The bars of the gag or mouth piece fit into the inter dental space. The tongue must always be free. The bars should be covered with rubber or leather to prevent damage to gums. Gags are also available for use with small animals such as sheep and goats.

Pig catcher - Used to secure an adult pig. It is made up of iron bar about 1m long. The iron bar is provided either ring at one end or a handle on the other. The ring is slipped over the upper jaw behind the tusks.

Neck restraining devices

Neck Cradle – A cradle is a device consisting of 10 or 12 pieces of wood strung on two pieces of rope. It is device commonly used to immobilise the neck of horse, cattle and buffalo. It is usually constructed from smooth wooden slates bounded together with leather of string. It is put around the neck of the animal and tied along the crest. This device is used to prevent an animal from flexing his/her neck so that it may not suck/lick/bite its limb having wound or suckling their own milk. It is also helpful in restraining a milking female when she wants to suck her own milk. Cradles allow very little vertical or lateral flexion of the head if properly applied.

Long handle neck tongs applied is applied to control the pig.

Limb restraining devices

Hobbles - A hobble is a device that prevents or limits the locomotion of an animal, by tethering one or more legs. They are made from leather, rope, or synthetic materials such as nylon. This is used in female animal when milking or going to give birth to prevent them from kicking.

Anti cow kicker - It is used to control a cow while milking or for examination of udder. It comprises of two metal springs clips connected by a chain. The clips are fitted on the Achilles tendon region of hind legs of a cow.

Livestock identification tools

Ear tagging set

- Ear tag - Metal ear tag, large and small plastic ear tag (either pre-numbered or blank)
- Ear tag applicator or tagging forceps - Metal tag applicator, Plastic tag applicator.

There are two types of tags self piercing type and non piercing type. In non piercing type tags a hole is made with a tag punch or pen knife. Self piercing type tags are fixed on ear with tag applicator. Ear tags have two parts one is having a nail which it is known as male part another having a hole is known as female part.

Branding set

- Hot branding iron rod consists of numbers 0 to 9 and letter A to Z
- Freeze branding rods
- Electric branding iron

Tattooing set

- Tattooing pliers/ forceps
- Tattooing ink or paste (insoluble carbon black or green vegetable pigments that are inert to tissue)
- Tattooing number and letter

Banding set - Banding carried out in birds. Bands are of two types viz., wing band (dayold chick) and leg bands (grower or adult birds).

- Aluminium band for wing and legs
- Banding plier

Ear notching – Right ear shows the litter number while left ear shows individual pig number.

- Ear notcher/ Sharp scissor or pincers

Livestock dehorning devices

- Electrical dehorning iron (for calf)
- Dehorning saw and clippers (older cattle)
- Elastrator

Livestock castration devices

- Burdizzo (emasculatome) castrator for large animals/calf (nonsurgical)
- Burdizzo (emasculatome) castrator for small animals/sheep (nonsurgical)
- Band castrator with rubber ring
- Scalpel or sharp knife (for surgical method)

Hoof care tools

- Hoof nipper - Nippers are used to trim the outgrowth of hoof wall from the hoof.
- Hoof knife - A hoof knife is for trimming away loose dried-out sole. Do not cut into live flesh or the sole will be sore and may bleed—not a good thing. The hoof knife is also used to trim off loose and ragged frog.
- Hoof tester - Hoof testers can help detect abscesses, stone bruises, hot nails, navicular disease, and many other problems.
- Hoof rasp - After trimming with the nippers, use the rasp to level the bottom of the hoof wall, remove burrs, and smooth and round the outside edge of the hoof wall.
- Hand hoof chisel - chisel for cutting and shaping animal hooves.
- Hoof pick - A hoof pick is used to clean debris from the bottom of the hoof, along the grooves on the sides of the frog, and from the sole area. This debris, if not removed, will dull your hand tools and may hide injuries to the hoof.
- Wire hoof brush - clean hooves with a hoof pick and brush so that debris and grit won't dull the cutting edge.
- Calipers - Use calipers to measure the hoof's length at the centre of the toe.
- Hoof gauge - The hoof gauge is used to match pairs of feet in their angle to the ground.

Grooming, shearing and clipping tools

- Grooming involves brushing, combing and rubbing of hair coat of the animals. Grooming is done to remove dirt, loose and dead hairs, skin secretion, lice, hair follicle, oil gland and muscles.
- Brushing should be done in sweeps and move in the same direction as the flow of hair. However, brushing has to be done against the fall of hair for removing dried mud, dung etc., sticking to hair.
- Clipping is the process of removal of excess hairs and it is done to improve general appearance, to make milking process more hygienic. Clipping should be done against the lay of hair, slowly and gently. Udder, flank, underline and end of tail switch are clipped in a dairy cow.
- **Metal or rubber currycomb** - A tool made of rubber or metal with short "teeth" on one side. It is usually the first tool used in daily grooming. The animal is rubbed or "curried" to help loosen dirt, hair, and other detritus, plus stimulate the skin to produce natural oils. The curry comb is usually used in a circular motion to work loose embedded material.

- **Dandy brush** - A brush is used to remove the dirt, hair and other material stirred up by the curry.
- **Body brush** - A brush removes finer particles and dust, adds a shine to the coat and is soothing to the animal. Some natural body brushes are made of horsehair, goat hair or boar bristles. The body brush is generally the last brush used on the animal.
- **Sweat scrapper** - Sweat scraper use to remove sweat after exertion or water after bathing.
- **Mane and tail comb** - Animals with short, pulled manes have their manes combed with a wide-toothed plastic or metal comb.
- Hand shear and Machine shear

Body brush

Hoof picker

Mane comb

Dandy brush

curry comb

Hoof rasp

Grooming kits

Drug administration Devices

- Teat catheter
- Trocar and cannula
- Drenching bottle
- Drenching pipe
- Needle and syringe
- Dispensing spatula

Drenching bottle

Travis

Trocar and cannula

Mouth gag

Exercise:

Q1. Identify the name of common farm tool and write down their uses?

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

Q2: Name following equipment used during Artificial insemination of cattle

1

2

3

4

5

Q3. Draw the below mentioned farm tool and write their use.

1. Trocar and cannula

2. Bull Nose ring

3. Drenching bottle

4. Burdizzo castrator

Exercise 3

Routine management practices followed on livestock farm

Introduction: "Routine" means a prescribed and detailed course of action to be followed regularly. Establishing routines in our activities improves our efficiency.

Farm: Farm is a production unit having specific boundary, comprising of piece(s) of land with all the infrastructures (buildings, etc.), where crops and/or livestock are kept under one common management.

Objectives:

- To get the farm jobs completed on time and properly
- To utilize labour efficiently
- To provide better regular care to animals
- To get higher returns through efficient management practices
- To be able to carry out farm activities efficiently

Schedule of day-to-day operation on dairy farm

Time (hours) farm operations	**S.N.**	**Time (hours) farm operations**
03.00-03.30	1.	Cleaning/brushing of milch animals
03.30-05.00	1.	Feeding half of the daily concentrate ration just before milking
	2.	Milking cows
05.00-05.30	1.	Delivery of raw milk (in cans) to the milk pick up van of dairy plants and receiving previous day's empty cans
	2.	Washing and disinfection of milking barns
05.30-08.00	1.	Cleaning of milk cow sheds.
	2.	Feeding of dry/green fodder to milch stock
	3.	Cleaning farm premises.
	4.	Isolation of sick animals.
	5.	Isolation of "in-heat" cow for artificial insemination
		Note: Use milkers at the rate of one for every 12-14 cows, for all the above operations. Milkers go off duty by 8 a.m. and farm labour come on duty.
08.00-12.00	1.	Cleaning calf, maternity, dry-stock, bullock and bulls.

	2.	Feeding half of the daily concentrate ration to calves, pregnant Cows and bulls.
	3.	Exercising and grooming of bulls.
	4.	Treating stick animals.
	5.	Breeding cows that are "in-heat".
	6.	Harvesting, chaffing and feeding of green fodder to all the stock. Mangers in all sheds should be filled with green fodder.
		Note: Animals should be taken for grazing (if practiced) between 9 a.m. And 2 p.m. in winter, and between 6 a.m. and 10 a.m. and again between 5 p.m. and 7 p.m. in summer.
12.00-13.00		Lunch-cum-rest period for labourers.
13.00-15	1.	Miscellaneous jobs of dairy farm stock-identification; periodical vaccination; preparation of concentrate mixture; repair of farm fences, fittings and repair ofequipments; rope and halter making; weekly scrubbing and white-washing of drinking water tanks; manure disposal/conservation; hay and silage making; periodical spraying of animalhouses with suitable pesticides; periodical deworming of stock; clipping hair from sides andhind-quarters of cows; grooming toe trimming; dehorning of calves; attending to sale andpurchase of live stock and their transportation; fitting and training of cows for show.
		Note: The dairy manger should plan the jobs well in advance in such a way that they are evenly distributed over the week. Some jobs may require longer time and the labour have to work extra time on such occasions
		Milkers come on duty by 14:30 hours and remain up to 17:30 hours whereas general farm labour go off duty by 17:00 hours.
14:30-15:00	1.	Washing/brushing of milch cows by milkers
15.00-16.30	1.	Feeding the other half of daily concentrate ration to milch cows Just before milking.
	2.	Milking.
	3.	Cleaning calf, maternity, dry-stock and bull sheds and feeding the other half of concentrate ration to calves, pregnant cows and

		bulls.
16.30-17.00	1.	Delivery of milk (in cans) to milk pick up vans of milk plants and collection of morning's empty cans
	2.	Washing and disinfection of milking barns.
	3.	Feeding dry and green fodder to calves, dry-stock and bulls
17.00-18.30	1.	Cleaning of milch cow shed.
	2.	Feeding green/dry fodder to milch stock
	3.	Cleaning farm premises.
18.30-03.00		Night watchman on duty.

Farm routine of sheep and goat farm

These are the exercises/ activities that are normally carried out periodically while dealing with sheep and goats. These are sometimes documented and the details are displayed in the farm premises. These may be in the form of calendar for year round activities as well as daily farm routines.

Approximate time (hours)	**Farm Operations/ activities**
7:00 am	❖ Turning animals to grazing lands during summer months (at around 09:00 hours during winter months). Other farm operations can also be started at this hour. ❖ Observe and isolate sick animals before letting them out. ❖ During breeding season, leave marked rams also with the flock for grazing. ❖ Nursing mothers should be retained in pens with their lambs.
08:00 am	❖ Feeding half of the daily concentrate ration to nursing ewes and fattening or market lambs. ❖ Arrange for watering sheep on grazing lands.
08:30 am	❖ Feed chopped green or dry fodder to penned sheep. ❖ Cleaning of all sheds and disposal/ conservation of manure
09:00 am to 3:00 pm	❖ Special jobs of sheep farms should be carried out during this period : shearing, vaccination, dehorning, identification, weighing, daily posting of data, buying and selling of animals, initial grading and bailing of wool & marketing, training and fitting animals for shows.

	❖ Turning sheep out of grazing fields (i.e. into pens). ❖ Feeding the other half of the daily concentrate ration to nursing ewes and fattening lambs. ❖ Feeding chopped dry or green fodder to all animals.
Note:	The milking does can be milked once in the morning and once in the evening at convenient timings.

Exercise:

Q1. Mention the periodic routine (as observed) operations at the university goat farm?

Q2. What are the differences between shearing & clipping?

Q 3. Mention the periodic routine (as observed) operations at the university dairy farm?

Q 4. Write down the milking methods with diagram?

Exercise 4

Identification of feed stuffs and their nutritive value for livestock

Introduction

Livestock improvement demands the efficient use of available feed resources. The provision of feeding stuffs of adequate nutritional quality is likely to be the most limiting factor in increasing livestock production in the developing countries. Factors like climate, agronomic practices, feed processing technologies and genetic variations ultimately affect the nutritive value of feed for livestock. Feeding resources and feeding systems of farm animals vary from one place to another. To maintain adequate performance at a minimal cost, least-cost diet formulations are required.

Objective:

- To provide least cost and balanced ration to farm animals according to their production.

Classification of Feed Stuffs

Livestock feeds are primarily classified into three major categories as depicted in Fig.1. viz., Pastures, harvested feeds and supplements & additives.

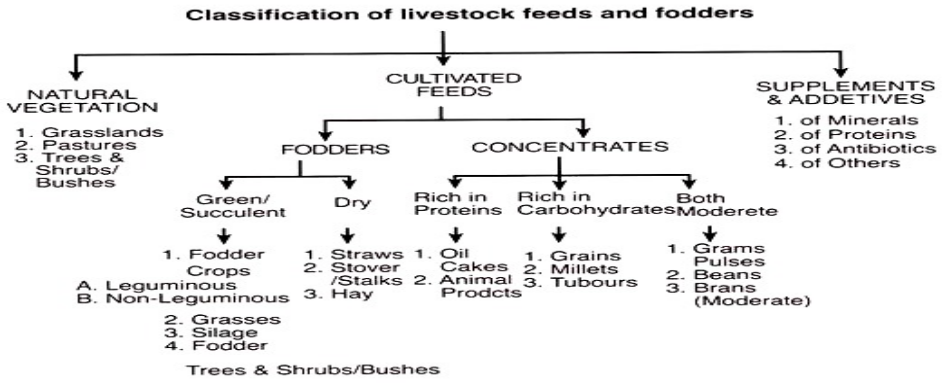


Fig.1

Pastures

Pastures form the 'oldest' form of livestock feed. The word 'pasture' refers to land on which different types of edible grasses and other plants grow or are grazing livestock. Permanent pastures are those covered with perennial or self seeding annual species of plants. Temporary pastures are those planted with quick growing crops like Sudan grass and millet to provide supplemental grazing during lean seasons. The main objective in grassland management is to

provide maximum feed nutrients to the livestock from the pasture without any detriment to the health and productivity of the pasture. Association with proper grazing management can improve pastures considerably. Many systems of grazing have been evolved to ensure optimum productivity of pastures. They include:

a) Controlled continuous grazing,
b) Deferred grazing,
c) Rotational grazing,
d) Hohenheim system, and
e) Deferred rotational grazing

Cultivated feeds

These are classified as roughages, concentrates and unconventional feeds and fodders

Roughages

Feeds with a higher proportion of crude fibre or non digestible materials are grouped together under the general term, roughages. They are bulky and usually contain more than 18% crude fibre. Roughages may be further classified into succulent and dry depending on the moisture content. **Succulent roughages**: A condition of plants characterized by juiciness, freshness and tenderness, making them appetizing to animals. **Dry roughages:** Feeds in dry state that are bulky and low in weight per unit volume; usually they contain more than 18%CFandrelatively low in energy. Succulent roughages are further classified into green fodder and silage. Green fodder includes leguminous fodder and non leguminous fodder.

Leguminous Roughages: Leguminous fodder consists of the stem and leaves of a group of plants belonging to the family Leguminaceae. Important leguminous fodder crops include true clovers (Trifolium species), Medics (Medicago species), Crotalaria species and certain other miscellaneous legumes. Eg: Berseem (Trifolium alexandrium) among medics. Lucerne (Medicago sativa) is the most popular fodder crop. Crotalaria group includes a large number of species useful for foraging like Sun hemp (Crotalaria junia), Cow pea (Vigna sinensis) and Kudzu vine (Pueraristhunbergiana). Certain other legumes like soybeans (Glycene Soya) are also important in livestock feeding.

Non-leguminous Roughages: Non-leguminous fodder generally contains lower percentage of nitrogen. Therefore, when livestock get non-leguminous fodder, special care has to be taken to add sufficient protein-rich concentrates to balance the ration. They include many

cereal fodder crops, perennial cultivated grasses, some indigenous grasses and introduced grasses. Important members of cereal crops used as fodder are Maize (Zea mays), Sorghum (Sorghum vulgare), Bajra (Pennisetum typhoides), Oats (Avena sativa) and Teosinte (Euchlaenamexicana). Among the perennial cultivated fodder grasses Para grass (Brachiaria mutica), Guinea grass (Pancium maximum), Napier grass (Pennisetum purpureum), Hybrid Napier (an interspecies cross between Napier and Bajra), Rhodes grass (Chloris gayana) Blue panic grass(Panicum antidotable) and Sudan grass (Sorghum vulgare var. sudanese) are the important members.

Some of the important indigenous grasses are Anjan grass (Kolukattain grass, Cenchruscialiaris), Dhub grass (Hariali, Cynodondactylon), Giant star grass (Cynodonplectostachyus), Marval grass (Dichanthiumannulatum), Sewan grass (Elyonurushirsatus) and Masel grass (Iseilemalaxum).Many other grasses like Deenabandhu grass (Pennisetum pedicellatum), Orchard grass (Dactylus glomerata), Signal grass (Brachiariabrizantha) introduced to India from Africa, USA, Australia, UK and other countries.

Classification of Roughage on basis of nutritive value:

- **Maintenance type**: DCP-3-5%: non legumes, cereal crops and their hay.
- **Non maintenance type**: DCP below -3% : straws and stover
- **Productive type**:DCP more than 5% : legumes fodder and their hay

Concentrates

Concentrates are high in energy and/or protein, low in fiber (under 18%), and highly digestible. These feeds include cereals, oil seeds and meals, cereals brans, molasses and sugar beet pulp. Two local types of concentrates are common.

- **Energy-rich** (carbonaceous) or basal concentrates including cereal grains (wheat, maize, barley, oats, sorghum, rice), wheat bran, rice polishing, molasses (sugar cane and sugar beet molasses), sugar beet pulp.

- **Protein-rich** (proteinaceous) sources from plant origin include oilseed cakes (cottonseed, mustard seed, maize oil, sunflower, sesame, oil seed meals (cottonseed, soybean, guar, maize gluten), maize gluten feed, maize gluten meal and from animal origin are blood meal, fish meal, meat meal and feather meal.

Basal concentrates are rich in carbohydrates and usually have a low protein percentage. Thus, they can be used in the ration of livestock mainly as a source of the energy. This does not mean that they do not supply any protein. Often, the protein present in grains is highly digestible. But the proportion of protein present is low. Use of wheat as a livestock feed has been limited only.

Protein-rich concentrates have a greater proportion of protein as a constituent. They may be of plant or animal origin. Protein-rich concentrates of plant origin are products or by-products derived from plants. Pulses and grams like cow-pea, black gram, horse gram and Bengal gram form an important group of protein-rich concentrates of plant origin. The important animal proteins in livestock feeding are by-products like tankage, fish meal, meat meal, dried skim milk and dried butter milk.

Maize: Maize has high metabolisable energy value with low fibre content and 8-13% of crude protein. The maize kernel contains two main proteins Zein and Glutelin. Recently, new variety of maize (Opaque 2,Floury 2) was produced at UK with high methionine and lysine. Farmanimals are fed with crushed maize. Improperly stored maize having higher moisture content is prone to aspergillusflavus infestation and produce aflatoxin.

Barley (Hordeumvulgare): Barley has high fibre content with 6-14% of crude protein having low lysine and less than 2% of oil content.

Oats (Avena sativa): Oats has highest crude fibre of 12 - 16% with 7-15% of crude protein. Methionine, histidine and tryptophan are deficient in oats but abundant in glutamic acid. Cattle and sheep are fed with crushed or bruised oats whereas pigs and poultry are fed with ground oats.

Wheat (Triticumaestivum): Wheat contains 6-12% of crude protein. The endosperm contains prolamin (gliadin) and glutelin (glutenin) protein mixture, which is referred as gluten.Finely milled wheat is unpalatable to animals because it forms the pasty mass in the mouth and may lead to digestive upset.

Millets: Millets are cereals having high percent of fiber and produce small grains and are mostly grown in tropics. eg. Sorghum, Bajra, etc.

Sorghum /Jowar/Milo (Sorghum vulgare): Sorghum is similar to maize in chemical composition but they have higher protein and low fat than maize. Pig and poultry can be fed with cracked grain whereas cattle are fed with ground sorghum.

Bajra / Cumbu (Pennensetumtyphoides): Nutritive value of bajra is similar to sorghum with 8-12% of crude protein and rich tannin content. Seeds are hard so they have to be ground or crushed before feeding to cattle.

Milling byproducts:

Bran: It is the outer coarse coat of the grain separated during processing. Eg. rice bran, wheat bran, maize bran.

Rice bran: Rice bran is a valuable product with 12-14% of protein and 11-18% oil mostly with unsaturated fatty acids and hence it becomes rancid. The oil removed rice bran is available as de-oiled rice bran in the market for livestock feeding.

Wheat bran: It is an excellent food for horses with more fibre content. It is laxative when mashed with warm water but tends to counteract scouring when it was given dry. It is not commonly fed to pigs and poultry because of the fibrous nature and low digestibility.

Gluten: Gluten is a tough substance obtained after the removal of starch from flour. This is not usually given as a feed to non- ruminants due to poor quality protein, bulkiness, unpalatability.

Middling: A byproduct from flour milling industry comprising several grades of granular particles of bran, endosperm and germ. Middlings contain 15-20% protein and deficient in calcium.

Polishing: During rice polishing this byproduct accumulates to contain 10-15% protein, 12% fat and 3-4% crude fibre. It is rich in B- complex and good source of energy. Due to high fat content rancidity may occur.

Molasses: Byproduct during juice/extract prepared from selected plant material for example- Cane molasses, Beet molasses, Citrus molasses and Wood molasses. Cane molasses is a product of sugar industry contains 3% CP, 10%ash. Beet molasses: product during production of beet sugar and 6% CP. Citrus molasses is bitter in taste with highest protein (14%) and produced when oranges or grapes are processed for juice. Wood molasses is a product of paper industry with 2% protein and palatable to cattle. Molasses is a good source of energy and an appetizer. It reduces dustiness in ration and is very useful as binder in pellet making. Molasses can be included up to 15% in cattle ration and up to 5% in poultry ration.

Plant origin protein concentrates:

Oil seed cake / meal:

The byproducts left after extraction of oil from oil seeds are used for feeding all kinds of livestock. Oil content and protein content varies according to the method of processing. Three main processes are used for removing oil from oil seeds. – Use pressure to force out oil (ghani and expeller) and solvent extraction. Material of higher oil content undergoes modified screw pressing to lower the oil content to a suitable level followed by solvent extraction. Only material with oil content of less than 35% is suitable for solvent extraction.

Ground nut cake: Contains about 45% CP, deficient in cysteine, methionine and lysine, but good source of Vitamin B_{12} and calcium.

Soybean meal: Soybean meal: 44-46% CP: Rich in all EAAS except cysteine, methionine.

Sunflower cake: 40%CPwithlow lysine and twice the amount of methionine than soy protein. It can be fed to cattle ration up to 20% level and 10% to poultry ration. Sunflower cake is not recommended for calves, lambs, chicks and young pigs.

Cottonseed meal: Lactating cows fed large amount: milk become hard and firm, butter from such milk fat difficult to churn. Cottonseed meal contains 0.3-20g/kg DM yellow pigment (ANF) known as Gossypol, a polyphenolic aldehyde. Gossypol toxicity can be reduced by the addition of calcium hydroxide and iron salts.

Mustard cake: It is widely used in cattle feed in Northern India. Its nutritive value is lesser than groundnut cake. D.C.P and T.D.N are 27% and 74 % respectively. Up to 10% of the ration, it can be fed to poultry and for pigs it may be up to 20%. It has rich calcium and phosphorus content of about 0.6% and 0.1% respectively.

Sesame seed meal: It contains 40% protein rich in leucine, arginine and methionine but low lysine.It has high phytic acid, which make phosphorus unavailable to monogastric animals. Sesame seed meal has laxative action and can be included in the cattle ration upto 15%. Sesame seed meal is not suitable to young pigs and poultry.

Rapeseed meal / canola meal: It contains low protein content than soybean meal with balanced essential amino acids. It also contains 14% fibre with low ME. Rapeseed meal contains tannins and consequently lowers the digestibility. Canadian produced a variety of rapeseed referred as canola. Canola meal is low in glucosinates and warrants lysine supplementation.

Animal protein concentrates: Protein supplements from animal origin are Fish meal, Meat meal, Blood meal, Hatchery waste, Milk products.

Non protein nitrogen compounds: NPN is an important source of nitrogen for ruminant animals

Urea: It is a nitrogen rich (46%), white, crystalline compound. Rumen microbes hydrolyze urea with the help of urease enzyme and produce ammonia. Urea should be given in such a way as to slow down its rate of breakdown and enhance NH3 utilization for protein synthesis. Rumen microbes require readily available source of carbohydrate to serve as energy for capturing ammonia and therefore urea diet should contain readily available carbohydrate so that the animal can satisfy the needs of its rumen microorganisms. One gram of urea should be given along with 0.13g of anhydrous sodium sulphate at the N:S ratio of 15:1 thus minimize sulphur containing amino acids deficiency. Urea does not provide energy, minerals, or vitamins to animals so adequate supplementation of these nutrients in diet is necessary.

Non-conventional feeds and fodders

Non-conventional feed refers to those feeds which are not traditionally used in animal feeding but have the potential to be used as feed. There are many agro-industrial by-products and wastes available in the province, which have not yet found their way in animal feeding, such as by-products of the sugar industry, and cereal industry (straw and pods of soybean, chickpea, peanut, mustard and sunflower heads). In addition to the above, other crop by-products not currently used by farmers as feed have the potential for incorporation in the diet of ruminants. However, for effective utilization these fibrous feeds need various physical or chemical or biological treatments. Some such feeds are discussed below. Tree leaves as fodder considering the widespread shortages of nutritious conventional feeds.

In general, the tree leaves were found to be a rich source of protein. Water hyacinth (Eichhornia crassipes) can be fed as hay along with ground nut cake and paddy straw without any sign of diuresis or diarrhoea. Silage also is prepared of water hyacinth with paddy straw in 4:1 proportion using 2 % common salt.Agricultural by-products can be fed as unconventional roughage resources. The left overs, after the removal of oil seeds and pulses, are generally considered a waste. Attempts have been made to utilize these left over by feeding to ruminants.

Feed supplements:

Mineral Supplements: Those supplements which are given to the animals for providing the major or minor minerals in desired quantity. Many mineral mixtures are marketed under the different trade names. Generally, salt, calcium carbonate, zinc sulphate and copper sulphate supplements improve production and reproduction.

Vitamin supplements: Various vitamin supplements for poultry, pigs and cattle are marketed in India under different names. For poultry Vit A, B and D synthetic vitamin supplements are marketed.

Feed additives: Feed additives are a group of feeding ingredients that can cause desired animal response in a non-nutrient role such as pH shift, growth or metabolic modifier. These are theproducts used for the purpose ofimproving the quality of feed and the quality of food from animal origin, or to improve the animals performance and health e.g., providing enhanced digestibility of the feed materials.

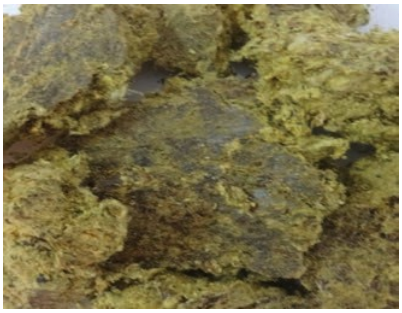
Hormones: Some of the hormones have growth promoting properties like oestrogens, androgens, progestogens, thyroxine and pituitary growth hormones. Synthetic oestrogenic hormones like stillbestrol and hexestrol are being used in many countries as growth promoters. There are certain side effects in the animals fed on synthetic hormones, like restlessness, milk secretion from rudimentary teats, etc. The most serious danger in the human beings arising from the residues of synthetic oestrogen in the meat which has carcinogenic properties.

Probiotics: Many microbial feed additives for animals have been used which include bacterial and/or fungal cultures from both ruminal and non-ruminal sources. Most commonly used products are based on *Aspergillus oryzae, Saccharomyces cerevisiae, Lactobacillus spp.*

Antibiotics: Antibiotics are not classified under nutrients, but are considered as feed supplements.At the lower intake antibioticsare known to stimulate the growth of animals when added to their feed and drinking water. There are number of antibiotics which have been tested for the growth promotion effect like chlortetracycline, penicillin, ox tetracycline, bacitracin,streptomycin,terramycine,neomycin,erythromycin,flavomycinetc.InIndiapenicillin, terramycin,tetracycline,flavomycinetc.arebeingusedasafeedsupplementinpoultry,pigsandpre-ruminantcalves.

Maize

Wheatbran



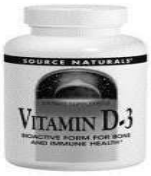
Cotton seed cake

Rice polish

Mustard cake

Soybean meal cake

Feed Additives:



VitaminD-3

B-Complex

Nutri-Sacc

Probiotics

dietary enzyme

Wheat straw

Berseem fodder

Hay

Silage

Sorghum fodder

Maize fodder

Various feeds and fodders for livestock

A.	**Grasses**	
	Sewan	*Lasirussindicus*
	Bhurat	*Cenchrusbiflorus*
	Dhaman	*Cenchrussetigerus*
	Anjan	*Cenchrusciliaris*
	Elephantgrass	*Pennisetumpurpureum*
	Dub	*Cynodondactylon*
	Para grass	*Brachiariamutica*
	Guineagrass	*Panicummaximum*
	Napiergrass	*Pennisetumpurpureum*
B.	**Top feeds**	
	Mango	*Mangiferaindica*
	Beri(pala)	*Zizyphusnummularia*
	Neem	*Azadirachtaindica*
	Ardu	*Ailanthusexcelsa*
	Subabool	*Leucaenaleucocephala*
	Sares	*Albizialebbek*
	Khejri(loong)	*Prosopiscineraria*
C.	**Shrubs**	
	Phog	*Colligonumpolygonoides*
	Ker	*Caparisaphylla*
	Kheemp	*Leptadeniapyrotechnica*
	Cinia	*Crotolariaburhia*
D.	**Cultivated fodder**	
	Legumes	
	Lucerne	*Medicagosativa*
	Berseem	*Trifoliumalexandrinum*
	Cowpea	*Vignasinensis*
	Sunhemp	*Crotalariajuncea*
	Non-Legumes	
	Oat	*Avenasativa*
	Jowar	*Sorghumvulgare*
	Bajra	*Pennisetumtyphoides*
	Maize	*Zeamays*
	Barley	*Hordeumvulgare*
E.	**Crop Residues**	
	Wheatbhusa(Tudi)	*Triticum aestivum*
	Paddystraw	*Oryzasativa*
	Bajrastraw(Kadbi)	*Pennisetumtyphoides*
	Mothstraw	*Phaseolusaconitifolius*
	Groundnutstraw	*Arachishypogaea*
	Guarstraw(phalgati)	*Cyamopsistetragonoloba*
	Moongstraw	*Phaseolusaureus*
	Soyabeanstraw	*Glycinemax*
	Sugarcanebagasse	*Saccharumofficinarum*
	Sugarbeetpulp	*Betavulgaris*
F.	**Concentrated feeds**	
	Wheatbran	*Triticum aestivum*
	Deoiledricebran	*Oryzasativa*
	Guarchuri/guarkorma	*Cyamopsistetragonoloba*
	Mothchuri	*Phaseolusaconitifolius*
	Groundnutcake	*Arachishypogaea*
	Cottonseedcake	*Gossipiumhirsutum*
	Tumbacake	*Citrulluscolocynthis*
	Mustardcake	*Brassicacampestris*
	Soybeanmeal	*Glycinemax*

Average nutritive value of common feeds/ fodders on fresh weight basis:

Kind of feeds	Name	Moisture (%)	CP (%)	TDN (%)
Concentrate feeds				
Grains	Maize	10	9.0	82
	Barley	10	9.5	75
	Jowar	10	7.2	70
	Bajra	10	6.6	65
	Gram	10	14.4	80
	Wheat	10	12.8	80
	Oats	10	10.4	75
Oil seed cakes	Groundnut cake	10	45.0	75
	Mustard cake	10	36.0	74
	Cottonseed cake	10	21.6	70
	Sesame(Til) cake	10	45.6	78
Agro-industry by-products	Wheatbran	10	15.0	60
	Ricebran	10	9.6	65
	Ricepolish	10	12.0	67
	ArharChuni	10	17.0	68
Animal by-products	Fishmeal	7	55.0	65
	Meat and bonemeal	5	40.0	69
Roughage				
Green fodders	Berseem	85	2.4	13
	Jowar	75	0.7	16
	Maize	75	1.6	17
	Oats	75	1.8	17
	Bajra	75	1.2	15
	Hybrid napier	75	1.5	15
Straws and crop	Wheat straw	10	3	40

residues				
	Rice straw	10	2	40
	Oat straw	10	7.2	55
	Maize Kadbi	10	1.8	40
	Jowar Kadbi	10	1.2	40
	Bajra Kadbi	10	1.2	40
	Sugarcane tops	30	1.2	42
Hay	Dub hay	15	4.5	45
	Berseem hay	10	15	60
Silage	Maize silage	70	1.2	18
	Oat silage	70	1.4	18

Exercise:

Q1. What are the different feeding ingredients required for formulating the concentrate mixtures?

Q2. Classify different types of roughage and concentrate used as animal feeding?

Q3. Mention different types of feed additives and their significance in animal feeding?

Q4. Mention the important characteristics of ration?

Exercise 5

Computation of ration and nutritive requirements for livestock

Objective:

- Practical feeding of animals under field conditions.
- To provide balanced ration to farm animals in view of production.
- To make economical use of available feed resources.

Principle: Computation of ration includes translating the recommendations contained in feeding standards into actual formulation of feed mixture and feeding practices. In formulation of ration for ruminants DM, DCP, energy in terms of TDN, minerals and vitamin A is given consideration.

Formulation of Ration: Ration may be defined as total allowance of the feed given to an animal during 24 hrs period to perform the various functions. The ration of animal may be divided for the sake of convenience into two parts, one for maintenance and other for production or reproduction whatever the case is. The word "balanced ration" means feeds or mixture of feeds which contain all essential nutrients in right quantity and in optimum proportion to meet the needs of the animal for maintenance and production.

Desirable Characteristics/Qualities of a Ration:

- Liberal Feeding: Dairy cows need all nutrients liberally incorporated in the ration for exploiting inherent capacity to the maximum. However, they should not be overfed, as it is wasteful and sometimes harmful.
- Individual Feeding: To obtain maximum profits, cows must be fed individually according to their production and physiological status instead of group feeding, because in group feeding, weaker or sicker animals get lesser feeds as against powerful ones.
- The ration should be well balanced for all nutrients required by animals. Excess of nutrients are wasteful. Any deficiency of nutrient affects health and production.
- Palatable Feeds: This affects feed consumption. Evil/bad smelling, mouldy, dusty, spoiled and inferior feeds are unpalatable.
- Variety of feed should be included in the ration: By combining many feeds in a ration, better and balanced mixture of proteins, vitamins and other nutrients are furnished. Moreover, variety of feeds in the ration makes it cheaper and palatable.

- ❖ The feeds used in the ration should be free from foreign materials like mould, dust, nails, toxins, gravel etc. It is better to clean them if necessary.
- ❖ The ration should be fairly laxative and not constipating. Otherwise, it may lead to digestive trouble and depression of appetite/hunger.
- ❖ The ration should be fairly bulky, so that the hunger of animal is satisfied. If ration is more bulky, animal cannot eat sufficient quantity to fulfill its nutrient requirement.
- ❖ Allow much of green fodders: As they are rich in carotene, slightly laxative, more palatable and easily digestible. Feeding only green fodder may not supply sufficient dry matter for satisfying hunger.
- ❖ Avoid sudden changes in the diet: These may cause digestive troubles.
- ❖ Maintain regularity in feeding timings. Otherwise, animals become restless and go down in production.
- ❖ Feed must be properly prepared/processed by chaffing, soaking, grinding, boiling, pelleting, mixing etc. These have special advantages associated with them.

Points to be Considered while Formulating the Ration:

a. Live weight of the animal

b. Age of the animal

c. Condition of the animal

d. Producing or non-producing e. Production level-high or low

f. Types of the feed and fodders available

Ration for Dairy Cattle: The computation of ration must be done in a systematic manner otherwise it will be a cumbersome exercise. The steps involved in ration formulation are:

Step-I Determination of dry matter requirement.

Step-II Distribution of required DM to different category of feeds.

Step-III Determination of DCP and TDN requirement of animal for maintenance.

Step-IV Determination of the DCP and TDN requirement for production or reproduction functions over and above the maintenance requirement.

Step-V Sum up the maintenance requirement of nutrients with production/reproduction requirement. This will be total requirement of the nutrients for particular animal in a day for maintenance and production/reproduction.

Step-VI Refer the chemical composition of the available feed resources to fulfil the DCP and TDN requirement as per the allocation of DM to particular feed category and at the cheapest price.

Step-VII Calculate the nutrients supplied through roughage and concentrate according to DM allocation and also calculate the quantity of individual feedstuff on fresh and dry basis.

Step-VIII Match the supply of nutrients with their requirement for one day. It should be exactly same or somewhat higher than the requirement but, if anyone is deficit then re-adjust the level of individual feed ingredient within the category and according to deficit nutrient.

Step-IX Preparation of ration.

Note: Mineral mixture @ 2 per cent and salt @ 1 per cent of the ration should be given to the animal.

Nutritive requirement for maintenance

Basal metabolism forms the major component of maintenance requirement. It is usually determined by calorimetric methods. The 'basal' conditions necessary for such estimations include

- having received prior good nutrition.
- having been adapted to a zone of thermo neutrality.
- post absorptive state;
- Minimum emotional stress and minimum muscular activity

Table 15.1 Nutrients required for maintenance requirement of dairy animals

Body weight(kg)	DCP (g)	TDN (Kg)	Ca(g)	P(g)
250	168	2.02	6	6
300	197	2.36	7	7
350	227	2.70	8	8

400	254	3.03	9	9
450	282	3.37	10	10
500	296	3.64	11	11
550	336	4.00	12	12

Requirement for growth

Similar to maintenance requirements the growth requirements for animals can be estimated by factorial calculations or by actual feeding trials. Usually, the requirements for growth and fattening are added to that of maintenance so that when animals are fed as per standards for growth, there is no need of adding' maintenance requirements to that.

Table 15.2 Nutrients required for a calf growing at the rate of 0.5kg per day during first two years and reaching adult body weight at the age of approximately 3 years.

Body weight(kg)	DCP(g)	TDN(g)
45	170	900
70	220	1300
100	280	1900
150	0.35	2.6
200	400	3000
300	470	4000
450	0.48	5.0

Requirement for lactation:

The requirements of an animal depend on the, daily milk yield, proportion of nutrients in the milk and the efficiency with which these nutrients are utilized for milk production.Energy, protein and ash content of milk have relationships to the fat-percentage. Therefore, the energy, protein, calcium and phosphorus requirements have been related to the fat content of milk. The TDN requirement per kg milk varies from 0.26 kg TDN/kg of 2.5% fat milk to 0.41 kg TDN/kg of 6% fat milk. On the basis of energy balance studies, the NE ranges from 0.59 Mcal/kg 2.5% fat milk to 0.93 Mcal per kg of 6% fat milk.The total protein requirement for lactation has been calculated factorially which ranges from 72 g/kg of 2.5% fat milk to 108 g/kg of 6% fat milk.

Nutrients Required for Production per Kg of Milk to Be Added to the Maintenance Allowance (SEN and RAY, 1964; ICAR Bulletin, No.25)

Milk Fat%	DCP(g)	TDN(g)
3.0	40	269
4.0	45	316
5.0	51	363
6.0	57	411
7.0	63	458

Nutrients Required For maintenance and Pregnancy for dairy animals from 5th month of gestation

Body weight (Kg)	**DCP (g)**	**TDN (g)**
250	270	3000
300	290	3400
350	320	3700
400	350	4000
450	400	4400
500	430	4800

Nutrient requirements for breeding bulls in service:

Body weight(kg)	**DCP (g)**	**TDN (g)**
500	430	4500
600	480	5100
700	540	5700
800	600	6300

Nutrient requirements for work bullocks

Body weight(kg)	**Normal work**		**Heavy work**	
	DCP (g)	**TDN (g)**	**DCP (g)**	**TDN (g)**
300	330	3100	420	4000

400	450	4000	520	4800
500	560	4900	710	6400

Illustration 1. Feeding of maintenance requirement of crossbred cows weighing 450 kg body weight.

(a) DCP requirement of the animal is around - 0.28 kg an TDN requirement is 3.37 kg.

(b) straw 5.0 kg (DCP-0%, TDN 42%) will supply DCP- 0 while TDN- 2.10 kg.

(c) Concentrate mixture (DCP-14% and tdn-68%) will supply dCP-0.28kg and TDN- 1.36 kg.

So, total DCP supplied to the animal is 0.28 kg and TDN supplied is 3.46 kg which are same to the requirement of the animal.

Illustration 2. Calculate the requirement of a cow weighing 450 kg milk with 4% fat

Requirement	DCP, kg	TDN, kg	Remark
For maintenance	0.28	3.37	
	0.45	3.16	
	0.73	6.53	
To be fulfilled through			
Straw, 5.0 kg	0	2.1	straw contains DCP- 0, TDN- 42%, green contains- DCP-8% and tdn-60%, concentrate- DCP-14 and tdn-68%.
Green, 3.0 kg (legume + nonlegume)	0.24	1.80	
Concentrate mixture, 4.0 kg	0.56	2.80	
Total supplied	0.80	6.70	

Feeding Cattle and Buffaloes by Thumb Rule Method

The following thumb rules may guide the farmers to feed their animals satisfactorily with particular reference to cases where individual attention and computation on body weight basis seem to be rather impractical.

Maintenance ration

This is the minimum amount of feed required to maintain the essential body processes at their optimum rate without gain or loss in body weight or change in body composition. The amount of concentrate and paddy straw that will provide optimum maintenance requirement for adult dairy cattle without any computation whatsoever are as follows:

Maintenance ration for Dairy cattle

SN	Items	For zebu cattle	For cross bred/ pure breed Indian cows/ buffaloes
1	Straw	4kg	4-6kg
2	Concentrate mixture(with straw only or with little greens)	1-1.25kg	2.00kg

The composition of Concentrate mixture is:

Oil cakes: 25-35 parts.

Millets/ cereals: 25-35 parts.

Cereal by-products:10-25 parts.

Pulse chuni: 5-20 parts.

To be fortified with mineral mixture:1 part and salt:1-2 parts and 20-30 gm vit-AD3/100kg., containing 50,000I. U vit-A and 5,000IU vit-D3 per gram. This concentrate mixture will provide 14-16 % DCP and 68%TDN.

Gestation ration: in the case of pregnancy further allowance of DCP and TDN should be made from 5th month of gestation onwards for proper growth of the fetus and to keep the mother fit for optimum milk production on calving. For this in addition to maintenance ration.a further amount of 1.25kg and 1.75kg of concentrate mixture is recommended for zebu and cross bred cow / buffaloes respectively. For high yielders liberal feeding of pregnant dams particularly cross bred cows / buffaloes from 8th month of pregnancy or 6 weeks before parturition with the object of securing full development of mammary glands for optimum milk production. For this 2.0kg to 3.0kg of concentrate for zebu and between 4.0-5.0 kg for crossbred/ pure bred Indian cattle/ buffaloes over and above maintenance requirements are recommended.

Production ration: Production ration is the additional allowance of ration for milk production over and above the maintenance requirement. For zebu 1kg additional amount of concentrate is required for every 2.5kg of milk over and above the maintenance requirement while the same amount of concentrate is required for every 2.0kg of milk for crossbred / Indian milch breed/buffaloes.

Exercise:

Q1. Give the partitioning of dry matter requirement of a dairy animal in chart form?

Q2. Calculate the maintenance requirement of a cow weighing 400 kg. the available feeds are concentrate mixture 14% DCP, 68% TDN, straw and berseem fodder.

Q3 Calculate the total requirement of a crossbred cow weighing 400 kg producing 10L of milk daily. The available feeds are concentrate mixture 14% DCP, 68% TDN, straw, maize, and berseem fodder.

Q4: Calculate the total requirement of a Buffalo weighing 500 kg producing 15L of milk daily. The available feeds are concentrate mixture 14% DCP, 68% TDN, straw, maize, and lucerne, sorghum fodder.

Exercise 6

Preservation of fodder as Hay and Silage

Objectives

- To familiarize the students with different methods of fodder collection and preservation.
- To make availability of fodder during off season and scarcity period.
- To help in feeding balance ration during scarcity period.
- To avoid wastage of excess fodder produced in peak season.
- To help in reducing the cost of feeding.

Methods of preservation

- Hay making
- Silage making

Hay making: Hay is a dry fodder green in colour containing moisture not more than 18 percent. There are three kinds of hay, viz., legume hay, non-legume hay and mixed hay

- Conservation of forages in the dry form is known as hay making. The moisture content in the forage plants is reduced drastically to 15% or below for long period storage.
- Hay differs from straw or stover in that straw is a by-product in the dried form while hay is the complete plant (in the dried form), cut before maturity.
- In a tropical country like India, the green fodder is available only during monsoon season. The excess green fodder has to be conserved and used during the lean periods.
- Usually the excess fodder is harvested, dried, bundled, heaped and used during summer. This is the local practice evolved through several years of experience by farmers. The grass from forest area and the natural pastures is also cut, dried and stored as hay.
- Fine stemmed grasses and legumes make good hay. They should be cut at the right stage and properly dried so that the hay is leafy, pliable, green in colour, free from moulds, weeds and dust and has pleasant characteristic smell and aroma.
- Thin stemmed and more leafy grasses like oats are good for hay making. However, crops like sorghum and maize are also converted into hay. Most grasses from pastures like *Cenchrus ciliaris*, *Dicanthiumannulatum, Cynodondactylon* when properly cut and dried make good hay. Grasses with spiny awns such as *Heteropogoncontortus*

should be cut very early for hay; otherwise, the hay will be unpalatable to livestock. Cultivated fodders like hybrid napier, para grass, guinea grass, teosinte are not suitable for hay making.

- Legume hays are more useful because of higher protein content. The legume crops suitable for hay making are cowpea; french beans or guar, horsegram, sunnhemp, pillipesara and lucerne. Leaf shedding will be a great problem during drying and curing process in the legumes. It is because, the moisture is lost more easily from the leaves than from the stems. Leaves constitute nearly half the green material and 75% of the protein. So, loss of leaf will reduce the feeding value very much. Cowpea, lab-lab and pillipesara are less liable to leaf shedding than other legumes. Berseem is not suitable for hay making mainly because of this problem of leaf shattering. The perennial legume lucerne is good for hay making.
- The residues of most cereal crops like paddy, wheat, sorghum, maize bajra, etc. are dried and stored as straw or stover. Straws are inferior in quality compared to hay because grain, which contains most of the nutrients is removed. However, use of dried straws is wide spread in India. In western countries, where natural drying is difficult because of the climatic pattern due to low sunshine, low temperatures and high humidity ; artificial drying is practiced using heavy machinery like driers, blowers etc. Hay and straw make excellent roughage for the ruminants.

Methods of hay making

- Field drying
- Barn drying

Field drying:

(a) Spreading forage crops in the field: After the dews dried up in the morning the hay crops in bloom stage is harvested and spreaded in layers of about 10 inches on leaved ground. The hay crop layers are turned upside down periodically for effective drying until the moisture content remains to an extent of not more than 18 percent.

(b) Windrows method: Hay crops are kept for sun drying on the field for one day then collected in small heaps. These are turned periodically until moisture remains to an extent of not more than 18 percent.

(c) **Tripod method**: The method is suitable in high rainfall areas. Hay crop is spreaded on tripod for sun during. Crop plants in this method does not come in contact with soil.

Barn drying (Mow curing): Crops are first dried in open field until moisture content not more than 30 percent. Crops plants are then spreaded on the floor of barn in small furrows through which hot air passed artificially for drying till the moisture comes below 20 percent.

Silage making: The process of making silage in soils(pit, trench) known as ensiling. Silage is the green stored in packed and compressed conditions so as to expel air out and then sealing up with a covering to prevent the contact with fresh air with minimum loss of nutrients in order to preserve it by fermentation is called silage.

- Conservation of green fodders under anaerobic conditions in the green form is called ensiling and the conserved green fodder is called *silage*.
- Silage is highly palatable, slightly laxative, easily digestible and loss of carotene during ensiling is very less. Organic wastes, weeds, coarse fodders and thick stemmed forages can be effectively conserved as silage.
- The surplus green fodder can be preserved as silage for feeding during lean period.

The device or container used to preserve silage is called silo. Silos can be permanent structures like towers, trenches, or bunkers prepared using bricks, cement, or stainless steel, or they can be pits dug in the ground and plastered with cowdung and clay or cement mortar.

Method of silage making

- Prepare a silo pit at required quantity.
- Make the pit with air tight, a lining of polyethylene sheet at the bottom sides and top of the silo should be fixed or laid down.
- Fill the pit with chaffed fodder as quickly as possible and compacted properly to eliminate air (by pressing 20-30 cm layer each time).
- Give attention on the sides while compacting, when it is done, the upper surface to each layer maintains a convex or dome like shape.
- The material at the centre of the dome should be 1.5 meters high from the ground level, at final layer.
- Cover the dome with polyethylene sheet and then put 8 cm thick layer of moistened straw and finally with a layer of soil (1.5 cm thick) plastered with mud.
- After few days again plastering is done to fill the cracks.

- Silage is ready in 6 weeks and can be stored for one year.

Important steps in the preparation of good silage

- Cereal crops should be cut at 50% flowering stage for silage making. Crops like hybrid napier should be harvested 45-50 days after previous cut.
- The moisture content in the harvested material should be at 60-65%; if excess, it has to be brought down to 60-65% by shade drying or withering by air drying
- The material should be thoroughly chaffed using chaff cutters into small bits of 1-2 cm size.
- Legume fodders, if any, to be added for ensiling can be added to the chaffed material. Additives are added to promote lactic acid fermentation and discourage the activity of other organisms.
- About 3-4 kg of urea can be dissolved in water and the solution sprinkled on one tonnes of chaffed material. For every ton of green fodder, add either 30 kg of molasses, or 50-60 kg of kibbled grains of sorghum or maize or any cereal, or add 45 kg of citrus fruit pulp. Any one of the above should be added. Usually molasses is preferred.
- The material is filled into the silos in uniform layers and compacted to eliminate the air. It should be airtight packing. The packing should reach 1-2 m above the ground level of the bunker or pit in a dome shape.
- To make the silo airtight for continued anaerobic conditions, it should be sealed using any type of insulators like mud, plastic sheets, mud and dung mixture etc.
- After few days the material gets compressed leaving open space on the top. Cracks may be seen in case of mud plastering. These cracks should be immediately sealed.
- After a period of one and half to two months, the silage is ready for feeding livestock. During this period it is fermented. Due to the activity of enzymes and bacteria, organic acids like lactic acid, acetic acid, butyric acid, etc. and also ethylalcohols are formed.
- The pH is brought down to 4.0. Lactic acid fermentation is important for good quality silage. Aerobic conditions or more proteinaceous material used for silage, lead to butyric acid fermentation which is not desirable.
- Good quality silage is *golden yellow or greenish yellow* in colour, bright and moist in appearance with characteristic pleasant aroma. While using the silage, silo is opened

to remove sufficient quantity of silage and immediately made airtight. Once, open the silage should be removed and fed daily till it is finished.

- Silage made from material with high drymatter content, or dried material is called *haylage*, and that prepared from waste material is called *wastelage*.
- About 400kg of silage can be stored in one cubic metre space as against 66 kg of hay. If the preparation of silage is not proper, there would be more losses mainly due to aerobic fermentation, clostridia and effluents.

Exercise

Q1. Name the fodders used for hay and silage making?

Q2. Name the different types of silo pits used for silage making and determine their capacity?

Q3. Give the losses occurs in hay and silage making by different methods?

Q4. What are the advantages and disadvantages of silage making?

Exercise 7

Study of housing systems and space requirements

Introduction

A key component of dairy animal management is providing the appropriate housing that is based on scientific concepts in order to optimise their productivity..Every housing system has benefits and drawbacks of its own. Without adequate housing, animals are subjected to harsh weather conditions, such as wind, cold, rain, snowfall, and severe temperatures, all of which have a negative impact on their health, productivity and reproduction. Therefore, the farmer must choose the best housing system considering local geographical situations and availability of resources.

Objectives:

- To study the system of animal housing.
- To study the feature and construction details and space requirement of animal houses.

Systems of animal housing

The system of animal housing is mentioned in Figure1. The most widely prevalent practice of housing animals in India is to tie the cows with rope on a kaccha floor, thus they are exposed to extreme weather conditions leading to health problems and lower production except some organized dairy farms where proper housing facilities exist. Dairy cattle may be successfully housed under a wide variety of conditions, ranging from close confinement to little restrictions except at milking time. At present following two types of dairy housings is in general uses-a) Loose housing system b) Conventional housing system

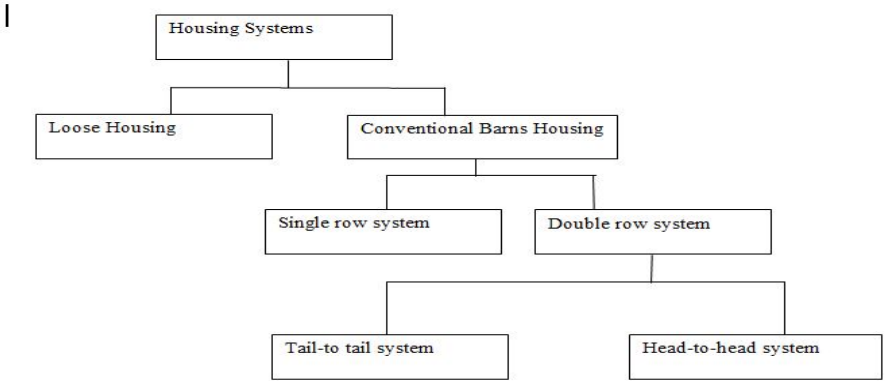


Figure1: System of animal housing

a. Loose housing system:

This housing system of housing in which animals are kept loose in an open paddock in group of 40-50 throughout the day and night except at the time of milking and some other specific purposes like treatment, breeding etc.This system consists of continuous manger along with covered standing space, common water trough and open paddock which is surrounded by brick wall or fencing of minimum 5 feet. There is separate milking parlous with facilities of milking of animals. A separatestructureofcalfpens,calvingpens,milkingbyres, bull pen etc. arealso required for housingof other categoriesof animal in this system.

Advantage of loose housing system:

- This is housing system is flexible i.e. 10-15% more animals can be accommodated for short period without affecting their performances
- Cost of construction is cheaper.
- Common feeding and watering arrangement is possible.
- Clean milk production is possible because the animals are milked in a separate milking barn.
- An animal remains free, therefore behavioural expression makes heat detection easy and efficient.
- Sick animal can be easily identified.
- Labor requirement is less.
- Animals also get sufficient exercise which is extremely important for better health and production.
- Injuries to the joints, feet and udder are found to be less.
- This housing is suitable for low rainfall area and most part of country except temperate Himalayan and heavy rainfall area.

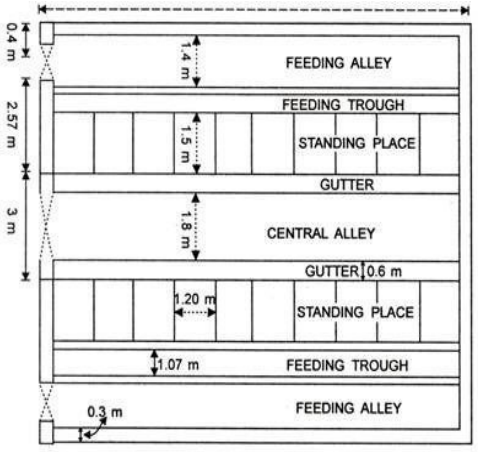
Disadvantages

- It is not suitable for temperate Himalayan region and heavy rainfall areas.
- It requires 10-12% more floor space than conventional barn.
- There is competition for feed and water so there are chances of fighting between the animals
- Attention of individual animal is not possible.
- A separate milking barn is needed for milking of animals.
- Spread of contagious diseases is likely to be more.

- ❖ Display of animals in herd is not proper.

b. Conventional housing system

The animals in this housing arrangement are confined together on a platform and restrained at the neck with neck chains or stanchions. Every activity takes place at the same location. Animals have good protection from unfavourable weather conditions. It works well in areas with high rainfall and moderate temperatures. The same barn is used for both feeding and milking the animals. These barns have full roofs, side walls that are closed, and windows or ventilators positioned appropriately to provide additional lighting and ventilation. Sheds can be set up in a single row if there are fewer than ten cattle or buffaloes. It is preferable to keep animals in double rows if there are more than ten animals. Animals in the double row arrangement can be positioned either head-to-head or tail to tail.



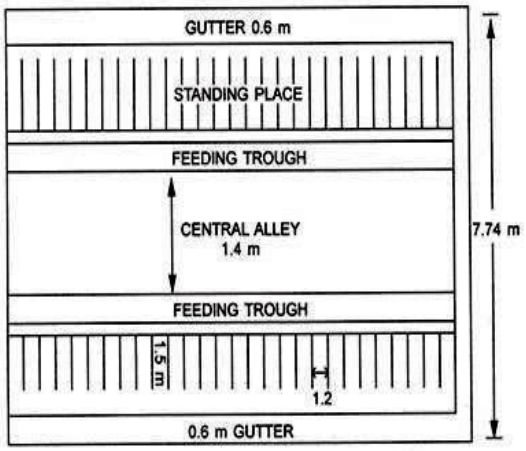


Figure2: Top view of tail-to-tail system

Figure3: Top view of head to head system

Table 1: Difference between tail to tail and head-to-head housing system

Parameters	**Tail to tail system**	**Head to head system**
Feed distribution	Difficult	Easy
Clearing gutter or middle alley	Easy	Difficult
Supervision at milking	Easy	Difficult
Possibility of stealing milk at milking time	Difficult	Easy
Detection of injury on hind quarter	Easy	Difficult

Look of animals at a glance	Easy	Difficult
Fresh air and direct sunlight to animals	More	Less
Floor space for barn	More	Less
Cost of construction	More	Less
Gutter exposed in sun rays and kept quit	Less	More
Easier for cows to get in to stalls	No	Yes
Danger of spread of disease	Less	More
Back tracking of feed trolley	Required	Not required
Safe for health of cow	Yes	No

Objectives:

- To study the positional details of various structures of a farm including the buildings, path ways, fodder areas, worker rooms etc.
- To the study the sizes and numbers of different functional units that are required in the farm.

Floor space requirement for different age groups of animals

Type of Animal	**Closed area/ animal (m^2)**	**Open area/ animal (m^2)**	**Maximum no of animals per pen**	**Heightof shed (cm) at eaves**
Younger Calves	1.0	2.0	30	175 cm in medium and heavy rainfall areas and 220 cm insemi-arid and arid areas
Older Calves	2.0	4.0	30	
Adult cows	3.5	7.0	50	
Adult Buffaloes	4.0	8.0	50	
Down calvers	12.0	12.0	1	
Bulls	12.0	120.0	1	
Bullocks	3.5	7.0	-	

Ewe/Nanny	1	-	60	300 cm in dry areas and 220 cm in heavy rainfall areas
Lamb/Kid	0.4	-	75	
Ram/Buck	3.4	-	1	
Milch Doe	1.4 m X 1.2 m	-		

Feeding/ watering space for different age groups of animals

Type of animal	**Space/ Animal (cm)**	**Total manger length***	**Water trough length***	**Manger/water trough dimension (cm)**		
				Width	**Depth**	**Height****
Adult cattle and buffalo	60-75	6,000-7500	600-750	60	40	50
Calves	40-50	4,000-5000	400-500	40	15	20
Adult sheep and Goat	40-50	4,000-5000	400-500	50	30	35
Lambs and Kids	30-35	3,000-3500	300-350	50	20	25

*Total length in the pen for 100 animals (cm)

**Height of inner wall of the manger/water trough, i.e. Height at the throat of the animal

Exercise:

Q1. Classify the different system of housing for cattle?

Q2. Draw the layout plan for 20 cows in head-to-head and tail to tail system?

Q3. Identify and write down the differences between head-to-head and tail to tail system?

Q4. Mention the floor space requirements for different livestock species.

Exercise 8

Study of grassland and rangeland in region

Introduction

Grassland is defined as natural vegetation composed mainly by the members of gramineae family of plants that are grazed by livestock. Grasslands are the largest ecosystem and it is among the most endangered natural habitats on the Earth. These are found in tropical, subtropical and temperate regions and typically occupy regions between forests and deserts. Grasslands are found in most eco-regions of the Earth and occur naturally on all continents except Antarctica. Pandeya (1988) referred the closely related terms in this context viz. grassland – a land with more than 80% occupied by grasses; rangeland – a piece of vegetation wherein grazing occurs or can occur; and pasture - a piece of land in which grasses are grown for feeding.

Objectives:

- To study different types of grassland on earth
- To compare the production potential of various grass covers in India
- To study the various causes of degradation and its remedies for sustainable development of rangelands

Importance of Grasslands

Grasslands are of vital importance for farmers of marginal, small and semi-medium operational holdings (area less than 4 ha) who own about 87.7% of the livestock for milk and other dairy products in arid and semi-arid regions of the country. This is the only source of their livelihood which mainly depends on the extent and condition of the available grasslands. The increased human population and their consumption demands have created tremendous pressure on our existing grasslands. In view of the dependence of the rural population on it, protection, restoration and sustainable use of grasslands are needed.

Types of grasslands on the Earth

Many workers have described some of the important types of grasslands found on the Earth. Among them, some of these are mentioned here in brief.

Prairies: Prairies are found on all of the continents comprising almost 24% of the world's plant cover and originally occupied about 44% of Europe and slightly less than 10% in

Australia. The grassland types include the Agropyron-Andropogon-Stipa type, the Andropogon-Calamovilfa-Stipa type and the most typical Andropogon-Panicum Sorghastrum type.

Steppes: The Steppe biome is a dry, cold, grassland that is found in all of the continents except Australia and Antarctica. It is usually found between the desert and the forest. Steppe vegetation is characteristics of high plateau of Turkey, Iraq and Afghanistan. Heteropogon, Andropogon, Aristida and Stipa are important associates in these grasslands. Themeda-Tetrachne type (mountain veld) and Poa-Festuca-Danthovia-Ehrharta type grasslands are dominant on higher altitudes

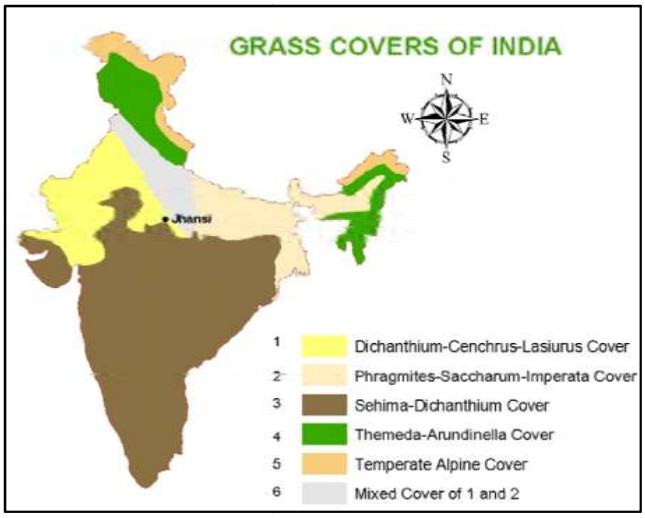
Annual grasslands: In several areas, annual grasslands are important. These are predominant in a Mediterranean climate with hot dry summers and wet, relatively warm winters. These are dominated by Avena, Bromus and Festuca.

Savannas: The grasslands intermixed with woody plants are designated as savannas. Savanna is grassland with scattered individual trees. Savannas cover almost half the surface of Africa and large areas of Australia, South America, and India. Savannas are always found in warm climates where the annual rainfall is from about 20-50 inches per year. Important grass genera include Panicum, Setaria, Themeda, Aristida, Eragrostis, Andropogon, Heteropogon, Sporobolus and Hyparrhenia. Savanna grassland occurs throughout the tropical rainforests of India, Burma and Indochina.

Other grasslands: Other important types of grasslands include desert, mountain, arctic and sub-arctic grasslands. Desert and semi-desert grasslands exist intermixed with desert shrubs throughout the world. These types of grasslands are also found in Asia surrounding the Gobi and Thar Desert. The important alpine vegetation is found on Himalayas, Alps and Rocky Mountain which includes the species of genera Astragalus, Bromus, Elymus, Festuca, Koeleria, Oryzopis, Poa and Stipa. In Indian subcontinent, grasses like Dichanthium-Cenchrus-Lasiurus, Chrysopogon, Themeda-Arundinella, Sehima-Dichanthium and Phragmites-Saccharum-Imperata are important in grassland regions

Types of grasslands in India

The great variation in climate, soil and physiography makes the grass covers highly heterogeneous in India. Dabadghao and Shankarnarayan (1973) recognized five major grass cover types based on extensive survey of 500 sites throughout India (Fig below).



Sehima - Dichanthium:

It spreads over the Central Indian plateau, Chota Nagpur plateau and Aravallis and 2 covering an area of 1,740,000 km. The elevation ranges between 300-1200 m. There are 24 species of perennial grasses, 89 species of annual grasses and 129 species of dicots including 56 legumes viz., Dichanthiumannulatum, Sehima nervosum, Bothriochloapertusa, Chrysopogon fulvus, Heteropogoncontortus, Iseilemalaxum, Heteropogoncontortus, Bothriochloapertusa, Dichanthiumannulatum.

Dichanthium - Cenchrus - Lasiurus:

It spreads over an area of 436,000 km, including northern parts of Gujarat, Rajasthan, Aravalli ranges, south-western Uttar Pradesh, Delhi and Punjab. The elevation ranges between 150 -300 m. There are 11 perennial grass species, 43 annual grass species, and 45 dicots with 19 legumes viz., Cenchrus ciliaris, C. setigerus, D. annulatum, Cymbopogon jawarancusa, Cynodondactylon, Eleusine compressa, Lasiurus sindicus, Sporobolus marginatus, Dactylocteniumsindicum and Sporobolus marginatu.

Phragmites - Saccharum - Imperata:

It covers an area of 2,800,000 kmin the Gangetic plains and the Brahamputra valley. The elevation ranges between 300 -500 m. There are 10 perennial grasses, 26 annual grasses, and 56 herbaceous species including 16 legumes such as Imperata cylindrica, S. spontanerum, Phragmites karka, Desmostachyabipinnata, Bothriochloa intermedia, Vitevariazizanioides, Imperata cylindrical, and Saccharum arundinaceum.

Themeda - Arundinella: It covers over 230,400 km and include the States of Manipur, Assam, West Bengal, Uttar Pradesh, Himachal Pradesh and Jammu and Kashmir. The

elevation ranges between 350 -1200 m there are 37 major perennial grasses, 32 annual grasses, and 34 dicots with 9 legumes namely, Arundinella benghalensis, A. nepaolensis, Bothriochloa intermedia, Chrysopogon fulvus, Cymbopogon jwarancusaApluda mutica, Arundinellakhaseana, Pennisetum flaccidumApluda mutica, Bothriochloa intermedia.

Temperate - Alpine: It spreads across altitudes higher than 2100 m and includes the temperate and cold arid areas of Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, West Bengal and the north-eastern states. There are 47 perennial grasses, 5 annual grasses and 68 dicots including 6 legumes viz., Agropyron conaliculatum, Chrysopogongryllus, Dactylis glomerata, Danthonia cachemyriana, Phleum alpinum, Carexnubigena, Poa pratensis, Poa pratensis and Dactylis glomerata.

Production level (t/ha) of various grass covers of India

S. N.	Grass Cover	Harvestable actual	Biomass potential
1	Sehima-Dichanthium type	3.5	6.0
2	Dichanthium-Cenchrus-Lasiurus	3.3	5.0
3	Phragmitis-Saccharum-Imperata	5.0	5.0
4	Themeda-Arundinella grass cover	2.2	4.0
5	Tempetrate-Alpine Cover	4.0	6.0

Approaches to management of rangelands/pastures

From perusal of literature on status of grasslands, we may draw inference that natural and anthropogenic factors are responsible for rangeland degradation particularly in semi-arid tropics. Climatic reasons such as erratic and high intensity of rainfall leading to soil erosion, high evaporative demand, and lack of moisture consequently effecting vegetative cover; edaphic factors such asimpoverished soils having limited moisture storage capacity and poor infiltration in problem sodic soils; and anthropogenic and socio-economic factors such as increasing population, overstocking rates leading to overgrazing, fire, lack of fodder resources and uncontrolled grazing, faulty methods of forage cultivation and poor-resource-base of farmers are some important reasons which have led to degradation of rangelands (Table 2).

Table 2: Causes of degradation and remedies for sustainable development of rangelands

Causes of degradation	Remedies
Natural	
Climatic- Erratic, fluctuating and high intensity rainfall, high evapotranspiration/ rainfall ratio, natural disasters.	Development of water-harvesting techniques
Topographic- Steep slopes, ravine lands	Introduction of silvi-pastoral system
Edaphic- Degraded & problematic lands	Addition of organic manure & amendments, silvi-pastoral system, introduction of tolerant species
Anthropogenic and socio-economic	
High human & animal population overstocking rates	Government policy of population control Rearing only improved & productive livestock, discarding low productive breeds.
Overgrazing	Fencing or selective grazing, alternate feeds
Deforestation	Silvi-pastoral systems
Low fertility level	Use of organic fertilizers, introduction of legumes, nitrogen fixing trees
Low productivity status	Introduction of quality and productive forage species, use of organic fertilizers.
Low moisture status	Evolving water harvest techniques, use of moisture conservation measures
High demand of fodder	Use of alternate feed (oil cakes, straw, palatable weeds, green tops etc.)
Faulty methods of forage cultivation	Use of improved agroforestry models

Exercise:

Q1. Briefly describe about the types and distribution of rangelands in the world?

Q2. Describe the characteristics and management of Indian rangeland?

Q3. What are the different causes for degradation of natural grassland?

Q4. Briefly describe about the role of Silvi-pasture technology in grassland productivity?