Applied Animal Nutrition

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Ministry of Education, Science and Technology
Curriculum Development Centre
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Technical and Vocational Stream

Learning Resource Materials

Applied Animal Nutrition

(Grade 11)

Secondary Level

Animal Science

Government of Nepal

Ministry of Education, Science and Technology

Curriculum Development Centre

Sanothimi, Bhaktapur

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Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline and self-reliance, creativity and thoughtfulness. It is essential to develop in them the linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills. It is also necessary to bring in them the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values so as to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This Learning Resource Material for Animal Science has been developed in line with the Secondary Level Animal Science Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops and seminars, interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Dr. Lekhnath Poudel, Prof. Dr. D.K. Singh, Dr. Shambhu Sah, Dr. Yam Bahadur Gurung, Dr. Shishir Bhandari, Dr. Asmita Subedi, Dr. Hari Prasad Panta, Dr. Lav Kumar Jha and Dr. Mina Pun is highly acknowledged. The book is written by Dr. Kiran Pokharel and the subject matter of the book was edited by Badrinath Timsina and Khilanath Dhamala. CDC extends sincere thanks to all those who have contributed in developing this book.

This book is a supplimentary learning resource material for students and teachrs. In addition they have to make use of other relevnt materials to ensure all the learning outcomes set in the curriculum. The teachers, students and all other stakeholders are expected to make constructive comments and suggestions to make it a more useful learning resource material.

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Table of Content

Unit-1 1
Introduction 1
Unit - 2 4
Characteristics of Feed Resources 4
Unit - 3 10
Chemical Composition of Different Feed Ingredients 10
Unit - 4 12
Basis of Classifying Feedstuffs 12
Feed 12
Unit - 5 14
Feed Additives 14
Unit - 6 15
Factors Affecting Nutritive Value of Feeds and Fodders 15
Unit - 7 19
Use of Conventional and Unconventional Feeds in Animal Feeding 19
Unit - 8 22
Use of Agro-industrial By-products 22
Unit - 9 24
Use of NPN Substance and Mineral Block, Molasses, etc. 24
Unit - 10 26
Importance of Bypass Degradable and Un-degradable Protein in Ruminants 26
Unit - 11 29
Feeding of Livestock and Poultry 29
Unit - 12 65
Feed Processing, Mixing and Storage 65
Unit - 13 67
Feed Formulation 67

Unit-1

Introduction

1.1 Types of feedstuffs

Feeds are grouped into eight classes on the basis of their composition in the way they are used for formulating diets.

By necessity these classes are arbitrary, and in borderline cases the feed is assigned to a class according to the most common use made of it in usual feeding practice. For instance, some bran samples may contain over 18 percent fiber and more than 20 percent protein and yet are classed as forages because they are normally used in this way.

Classes of Feeds by Composition and Usage

Code	Class Description	
1	Dry forages and roughages	Hay; straw; fodder (aerial part); Stover (aerial part without ears, without husks or aerial part without heads); other products with more than 18 percent crude fiber (dry basis); HULLS
		This class includes all forages and roughages cut and cured. Forages or roughages are low in net energy per unit weight, usually because of the high fiber content. Thus, such products as SEED COATS, PODS, rice BRAN, etc. are included in this group.
2	Pasture, range plants, and forages fed green	Included in this group are all forage feeds either not cut (including feeds cured on the stem) or cut and fed fresh.
3	Silages	This class includes only ensiled forages (MAIZE, ALFALFA, GRASS, etc.), but not ensiled FISH, GRAIN, ROOTS and TUBERS.

4	Energy feeds	Included in this group are products with less than 20 percent protein (dry basis) and less than 18 percent crude fiber (dry basis) as, for example, FISH, GRAIN, mill by-products,
5	Protein supplements	This class includes products which contain 20 percent or more of protein (dry basis) from animal origin (including ensiled products) as well as oil meals, GLUTEN, etc.
6	Mineral supplements	
7	Vitamin supplements (including ensiled yeast)	

1.2 Feed ingredients

Feed ingredients are produced following the extraction of high value food from raw materials which are considered unsuitable for human consumption. A wide variety of ingredients are available for use in feeds. They are:

1. Grasses
2. Legumes
3. Miscellaneous fodder plants
4. Fruits and vegetables
5. Root crops
6. Cereals
7. Oil-bearing seed and oil cakes
8. Animal products
9. Miscellaneous feed stuffs
10. Additives

1.3 Importance to animal performance

i) It keeps the animal in good health and improves reproductive efficiency.
ii) It is palatable and easy for digestion.
iii) It has cooling effect on the body.
iv) It is mild laxative, hence prevents constipation.
v) It provides fresh nutrients in their natural form.
vi) It doesn't put any stress on body or organ and leads to efficient utilization of feed nutrients.

Unit - 2

Characteristics of Feed Resources

The domestic animals in general are dependent on plants for the supply of their food material. They consume forage crops (dry and green), straw, concentrate and their bi-products for maintenance, growth and production.

There are various stuffs available for livestock feeding. These feedstuffs can be grouped into different classes on the basis of bulkiness and chemical composition. The feeding stuffs can be classified into two main heads:

a) Roughages

Roughages are bulky feeds containing relatively large amount of less digestible material that is, crude fiber more than 18% and low in TDN (total digestible nutrient) (about 60 per cent on air-dry basis).

Roughages are further categorized as follows:

1. Dry roughages e.g. straw, hay
2. Green roughages e.g. legume and non-legumes
3. Legume e.g. berseem, lucerne, cow pea etc.
4. Non-legume e.g. maize sorghum, bajra, oat etc.
5. Fodder tree e.g. legume & non-legume

b) Concentrates

Concentrates are feeds which contain relatively lesser amount crude fiber, that is less than 18% and have comparatively high digestibility with higher nutritive value having more than 60 per cent TDN. Concentrated feed is expensive as compared to roughages. Therefore, production cost goes up if the ruminants are regularly fed with such ration. In case of non-ruminants and poultry, however, feeding with concentrate ration is a common practice because they cannot digest and utilize the roughages in significant amounts.

There are various sources of concentrate feeds, such as:

- Animals sources e.g. fish meal, meat meal, blood meal etc.

- Plants sources further grouped into
  - Carbonaceous e.g. crushed maize, sorghum, bajra, barley etc.
  - Proteinous e.g. ground nut cake, soybean cake, mustard cake, til cake, linseed cake etc.
  - Agro-industrial by-product e.g. wheat bran, rice bran, rice chunni etc.

Roughage/dry

Dry roughages include hay, straw, and artificially dehydrated forages, which contain about 90 per cent of dry matter. Silages are formed from green forages such as grass, alfalfa, sorghum, and corn preserved in a silo at dry matter contents of 20 to 50 percent.

Roughage/green

Green, growing pastures provide forage that has high water content and only 20 to 30 percent of dry matter. There are two basic types of roughages:

(1) Grasses, and

(2) Legumes

The grasses are generally higher in fiber and dry matter than legumes. The legumes are generally higher in proteins, energy, vitamins, and minerals.

Fodder and tree

Fodder refers particularly to foods or forages given to the animals (including plants cut and carried to them), rather than that which they forage for themselves. It includes hay, straw, silage, compressed and pellet feeds, oils and mixed rations, and sprouted grains and legumes. Feed grains are the most important source of animal feed globally.

Traditional sources of animal feed include household food scraps and the byproducts of food processing industries such as milling and brewing. Material remaining from milling oil crops like peanuts, soya, and corn are important sources of fodder. Scraps fed to pigs are called slop, and those fed to chicken are called chicken scratch. Brewer's spent grain is a byproduct of beer making that is widely used as animal feed.

Compound feed is fodder that is blended from various raw materials and additives. These blends are formulated according to the specific requirements of the target

animal. They are manufactured by feed compounders as meal type, pellets or crumbles. The main ingredients used in commercially prepared feed are the feed grains, which include corn, soybeans, sorghum, oats, and barley.

Compound feed may also include premixes, which may also be sold separately. Premixes are composed of micro-ingredients such as vitamins, minerals, chemical preservatives, antibiotics, fermentation products, and other ingredients that are purchased from premix companies, usually in sacked form, for blending into commercial rations. Because of the availability of these products, farmers who use their own grain can formulate their own rations and be assured that their animals are getting the recommended levels of minerals and vitamins.

Fodder trees are the important sources of green forage during winter when availability of other green grasses is in scarce. They share almost 41% in animals' feed. Fodder trees are the most important sources of animal feed especially in mid hills.

Crude protein content of the various fodder trees ranges from 11 to 24%. Fodder trees also contain adequate amount of vitamins and minerals. Generally it is estimated that a mature fodder tree will provide 15-60 kg. yield on dry matter basis. If fodder trees plantation is managed properly, lopped tree leaves can contribute substantially to feed resources.

The tree leaves are fairly good source of protein and calcium. However, with many of the trees leaves, the limiting factor is their tannin content and poor palatability. Animals get adapted to various types of leaves very soon. Sheep and goat can eat most of the tree leaves. Leucaena, a very useful tree species, is being introduced on a large scale in the country for fuel and fodder purposes. Its leaves are very rich in protein, carotene and minerals and is very palatable and digestible.

Nutritional significance in animal feeding

Water

The water content of the animal body varies with age. The newborn animal contains from 750 to 800 g/kg water but this falls to about 500 g/kg in the mature fat animal. It is vital to the life of the organism that the water content of the body be maintained: an animal will die more rapidly if deprived of water than if deprived of food. Water

functions in the body as a solvent in which nutrients are transported about the body and in which waste products are excreted. Many of the chemical reactions brought about by enzymes take place in solution and involve hydrolysis. Because of the high specific heat of water, large changes in heat production can take place within the animal with very little alteration in body temperature. Water also has a high latent heat of evaporation, and its evaporation from the lungs and skin gives it a further role in the regulation of body temperature.

The animal obtains its water from three sources: drinking water, water present in its food and metabolic water, this last being formed during metabolism by the oxidation of hydrogen-containing organic nutrients. The water content of foods is very variable and can range from as little as 60 g/kg in concentrates to over 900 g/kg in some root crops. Because of this great variation in water content, the composition of food is often expressed on a dry matter basis, which allows a more valid comparison of nutrient content.

Function of water-

- Acts as a general lubricant and cleansing agent for different parts of animal's body.
- Maintain osmotic pressure
- Medium for ingredient to function,
- Solvent for absorption of nutrient and excretion of waste product.
- Regulate body temperature.
- Provide rigidity and elasticity to body cell.
- Need for mastication and deglutition of food.
- Help in chemical reaction brought out by enzymes which involve in hydrolysis.
- Help in gaseous exchange during respiration.
- Makes food palatable.
- Maintain acid- base balance of animal body.
- Medium for control physiological and biochemical reaction.
- Provide fluid appearance of blood.
- Essential for cell nutrient and transportation of nutrient inside the body cell

Carbohydrates

Carbohydrates are the major sources of energy. It is the major component of nutrient. Sources of carbohydrate to animal body are Crude fiber and soluble carbohydrate (Nitrogen free extract).Carbohydrate are found in three form i.e. monosaccharide, disaccharides and polysaccharides. On the basis dry matter plant contains 60-90% carbohydrate.

Function

- Maintains body temperature
- Induced some sweetness to milk.
- Important part of blood as blood sugar.
- A ready source of energy than other organic constituents.
- Excess of carbohydrate stored as fats , a reserved source of energy.
- Stored as glycogen in the body tissue and liver.
- Help in absorption of calcium and phosphorous in growing calves.
- Help in growth and multiplication of micro-organism in the rumen.
- Essential for fat oxidation.
- Add flavour to the diet
- Glucoronic acid detoxifies bacteria and other toxin.
- Hyaluronic acid forms the matrix of connective tissue.

Lipids

Any compound that are dissolved in ether or other organic substance are called fat(Ether extract). Lipid are made up of carbon, hydrogen and oxygen. Fat content in feeds varied like that of protein. More fat is found in oilseed like groundnut, mustard, cotton seed etc.

Function of fat

- Source of energy, oil produce 2.25time heat per kg on oxidation as do carbohydrate.
- Source of essential fatty acids linoleic acid, linolenic acid &arachidonic acid.
- Work as the carrier of fat soluble vitamins(Vitamin A,D,E & K)
- Component of structure of prostaglandins.

- Provides shining looks of egg & help calcification, cell formation in avian species.
- Provide glossiness of skin, hair, horn and nails.

Proteins

The proteins are outstanding importance in livestock feeding because they are essential for life. In addition to carbon, hydrogen and oxygen; the protein and other nitrogenous compound in plant and animals contain nitrogen. Most protein contains sulphur and few contain phosphorous or iron.

Function

- Structural constituent of the animal body. E.g. collagen and elastins are present in ligament and artery wall, sarcoplasma is the protein of myofibrils etc.
- Some proteins are hydrolytic, degradative, and synthetic in the form of enzymes.
- Some protein are found in the form of hormones e.g. gonadotropic, parathyroid, calcitonin etc
- In the form of antibiotic so protect animals from infection.
- Essential amino acids are those which supply in diet e.g Arginine, histidine, isolucine, lucine, methionine, phenyl alamine, tryptophan, valine, threonine etc.

Unit - 3

Chemical Composition of Different Feed Ingredients

The composition of selected feedstuff is with reference to selected amino acids, carbohydrate, and fat as source of energy. In utilizing the nutrient present in the plant various physiological and biological processes are involved in the animal body to transform the nutrient present in the animal body called chemical composition of animal and plant. Plant and animal contain similar types of chemical substance which are grouped together into different classes like water, protein, fat, carbohydrate and ash. The chemical composition of plant is affected by the soil composition, fertilization application, irrigation, seasonal variation, stage of growth, frequency of cutting, variety and strain whereas in the case of animals the composition is affected by the physiological stage and the species.

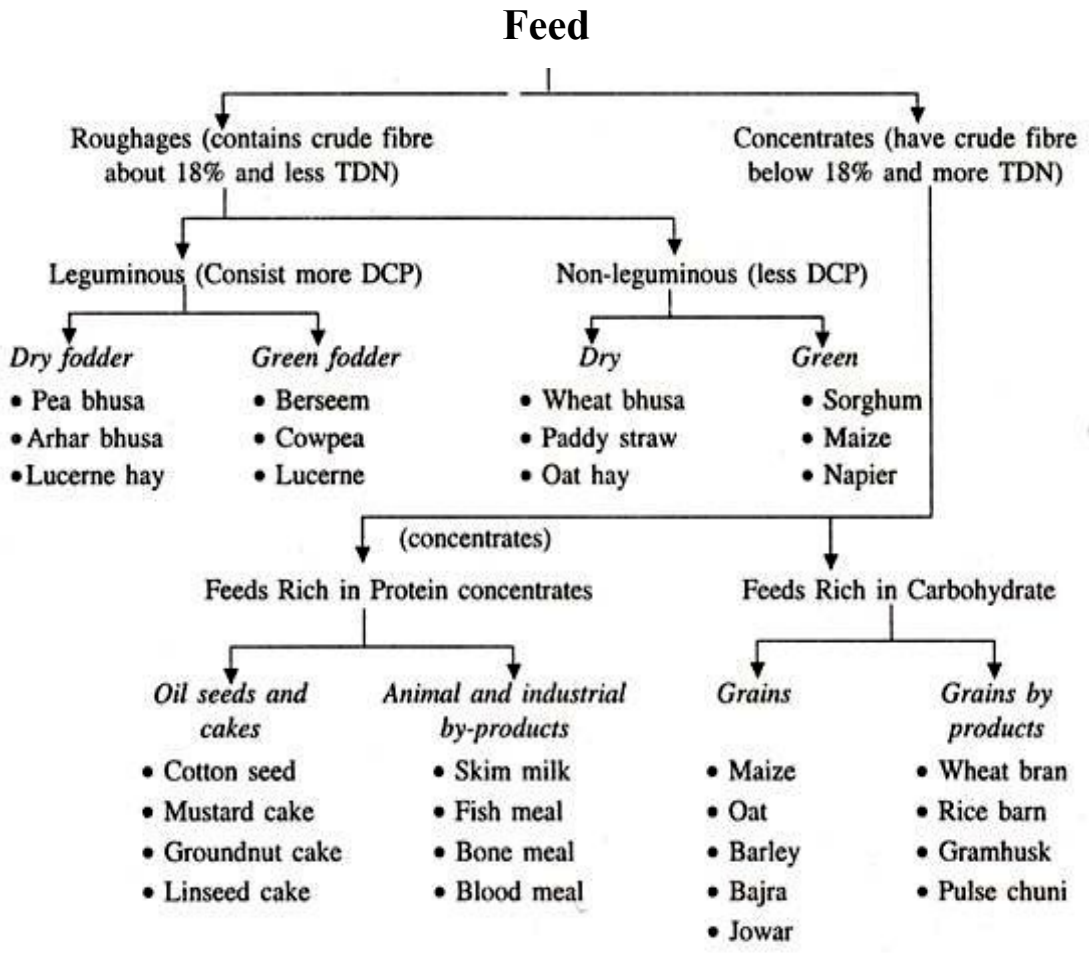
Plant/animals	water	CP	Fat	Carbohydrate	Ash	Ca	P
Berseem	90	2	0.3	6.3	1.4	0.16	0.03
Lucern	802	4.5	1	12.5	2	0.40	0.06
Maize	75	2	0.6	21	1.4	0.07	0.04
Wheat straw	10	3.5	1.5	76.5	8.5	0.15	0.07
Paddy straw	10	3.5	1.5	70.5	14.5	0.19	0.07
Newborn calf	74	19	3		4		
Dairy cow	57	17.2	20.6	0.2	5		
Pig	52	15.4	30		2.6		
Hen	56	21	19		3.2		

Feed Name	Crude Protein			Ether extract (%)	Carbohydrate	
	Total (%)	Dig for swine (%)	Chemical score		Crude fiber (%)	N-free extract (%)
Barley, grain	11.6	8.2	20	1.9	5.0	68.2
Corn, grain	9.3	7.5	28	4.3	2.0	71.2
Oats, grain	11.8	9.9	464	4.5	11.0	58.5
Rye, grain	11.9	9.6	50	1.6	2.0	71.8
Sorghum, milo, grain	11.0	7.8	-	2.8	2.0	71.6
Wheat grain	12.7	11.7	37	1.7	3.0	70.0
Average	11.4	9.1	-	2.8	4.2	6.8

Unit - 4

Basis of Classifying Feedstuffs

On the basis of crude fiber, feeds are classified as follows:



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b) Concentrates

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Unit - 5
Feed Additives

Feed additives are the non-nutritive substances usually added to basal feed in small quantity in order to improve feed efficiency and productive performance of the animals. Some commonly used feed additives are as below:

a) Antibiotics e.g. Terramycin, Zinc bacitracin, Flavomycin etc.

b) Enzymes e.g. Amylase, lipase, protease, pepsin etc.

c) Hormones eg. Estrogen, progesterone, hexosterol etc.

d) Thyroprotein e.g. Iodinated casein.

e) Probiotics e.g. Microbial species. Lactobacillus.

f) Biostimulators e.g. Extracts of living organs like spleen, liver, ovary, chick embryo etc.

g) Antioxidants e.g. Vitamin E (Tocopherols), BHT (Butylatedhydroxy toluene).

h) Mold inhibitors e.g. Propionic acid, acetic acid.

i) Pellet binders e.g. Gur, meal, molasses, sodium bentonite.

j) Coccidiostats e.g. Amprolsol powder, Furasol powder.

Unit - 6

Factors Affecting Nutritive Value of Feeds and Fodders

Antioxidants

Undesirable oxidation in feeds may be combatted in several ways. Care should be used to make certain that the ingredients included in the feeds provide adequate margins of safety of vitamins A, E, and other natural antioxidants; e.g., lecithin. The use of unstable fats and oils or other pro-oxidants in the feed should be minimized whenever possible. In order to make antioxidant useful in animal feeding, it must have the following qualifications:

(a) It must be effective in preserving animal and vegetable fats, vitamins, and other feed qualities subject to oxidative destruction;

(b) It must be non-toxic to man and to farm animals (i.e., chickens, swine, fish, etc.);

(c) It should be effective at very low concentrations; and

(d) It must be low enough in cost to be economically practical.

Of the chemical compounds that have been investigated thus far, antioxidants have been found to be outstandingly effective for feeds and feed ingredients and can be used both efficiently and economically. They are:

(a) Ethoxyquin (generic term: 1, 2-dihydro-6-ethoxy-2,2,4- trimethylquinoline)

(b) BHA (butylatedhydroxyanisole);

(c) BHT (butylatedhydroxytoluene)

Ethoxyquin, however, has been demonstrated to be the most efficaceous, followed closely by BHT and BHA.

Antibiotics

Antibiotics are another class of foodstuff that must today be considered in the formulation of livestock rations. The nature of the action on the animal of the various antibiotics (Aureomycin, Terramycin, penicillin, etc.) as ration components is still not entirely clear. It is presumed that they affect the nature of the intestinal microflora. It

is well known that their use often results in faster gains of young animals.

Many of the statements in the literature on antibiotics give erroneous impressions of the extent to which the use of these materials can be expected either to increase the rate of growth of the animal or to improve the efficiency of the ration consumed.

Commonly used antibiotics are:

- Bacitracin
- Chlortetracycline
- Erythromycin
- Oxytetracycline
- Penicillin
- Streptomycin
- Flavomycin
- Virginiamycin

Probiotics

Probiotics are live microbial feed supplements which are beneficial to the host by improving its intestinal microbial balance. The application of probiotics provides a potential alternative strategy to the traditional practice of sub therapeutic antibiotic use. In relation to probiotics, several studies observed the beneficial effects on animals including growth enhancement and disease prevention.

Probiotics are similar to competitive exclusion products. They are believed to improve the overall health of an animal by improving the microbial balance in its gut. The problem with probiotics is the lack of evidence as to their mechanism of action and of the effect on host animals. Probiotics are effective in certain cases, notably in newborn animals or those that have been treated with antibiotics, where they have the same effects as competitive exclusion products. They may also be useful in helping to boost weight gain and feed conversion rates.

Microbial feed supplements which positively affect gastrointestinal microbial balance. *Lactobacillus acidophilus, Streptococcus Faecium, Bacillus subtilus* and yeasts are used for this purpose. They should survive pass the acidic stomach and resist bile if they are to survive in intestine. They can compete with the existing gut micro flora.

Anti-fungal

Antifungal agents prevent fungal growth (Aflatoxins and Fusarium) in stored feed. Mold growth in stored grains is prevented by drying them to moisture to a level of 12% or less. Use of mold inhibitor is strongly recommended when moisture content of grains exceed 13 or 14%, RH 80-85% and temperature is 55F or above. Propionic acid or its salts like Sodium or Calcium propionate are used at the rate of 1% of stored grains. Propionic acid provides protection for a period of 90 days.

Coccidiostat

Coccidiostats are used for the control of naturally occurring coccidiosis, mainly in calves and lambs. The ideal coccidiostat suppresses the full development of the life cycle of the coccidia, allows immunity to develop, and does not interfere with production performance. To be effective, coccidiostats must be given beginning early in infection. In any group of animals, there will be several different species of coccidia at different stages of the life cycle, some at the drug-susceptible stage (before 13–15 days in calves) and some beyond the drug-susceptible stage (after 16–17 days), which explains why coccidiostats appear to be effective in some epidemics and ineffective in others. In an epidemic in calves, new cases may develop for up to 12 to 15 days after the commencement of feeding of an effective coccidiostat to in-contact calves. However, precise commencement of infection is unknown and the pre-patent period cannot be established; the most that can be done is to medicate the feed and water supplies with a coccidiostat of choice, treat new cases that develop, and avoid the stressors of overcrowding and nutritional disorders.

Growth promoters

Different categories of feed additives for farm animals are referred to as growth promoters. They are commonly regarded as favorable alternatives to antibiotic growth promoters in livestock production. Growth promoters include predominantly organic acids, probiotics, prebiotics, synbiotics, phytogenics, tannins, feed enzymes and immune stimulants. Addition of growth promoters to feeds of farm animals may have a number of beneficial effects, including:

- Rapid development of a healthy gut microflora
- Stabilization of digestion

- Increased growth performance
- Stimulation and rapid maturation of the immune system
- Reduced incidence of diarrhea
- Improved feed efficiency
- Lower mortality rate

Unit - 7

Use of Conventional and Unconventional Feeds in Animal Feeding

Conventional feeds

Feedstuffs that have traditionally been used in animal feeds and in the ration of commercially produced animals are conventional feedstuffs. These are of serious shortages in animal feed and have high economic value. The whole ration is fortified with adequate minerals and vitamins either in chemically pure or through ingredients known to be rich in these nutrients. With the cost of feed soaring high and the availability of conventional ingredients becoming scarce, intensive and continuous efforts are being made to determine the nutritive value of agro industrial byproducts to replace more costly ingredients.

Examples are Cereals, wheat, maize, oats, etc

Unconventional feeds

Increase in livestock and human population and decrease in land under cultivation has resulted in acute shortage of feeds and fodder for livestock which further increases due to natural calamities like droughts and flood. The feeds which are traditionally not used for feeding animals are called unconventional feeds. Their use in livestock ration is increasing day by day due to shortage of animal feeds. The main source of such feeds is agricultural and forest by-products. Such feeds are not used either because of traditional beliefs of livestock owners or due to less palatability and presence of incriminating factors in them. It also happens that certain un-conventional feeds are being traditionally fed to animals in particular region but the same may be neglected in other regions. Recent studies indicated that quite a large number of agricultural by-products and industrial waste materials could be used for livestock feeding.

Unconventional feeds are described under the following categories:

1. Protein sources
2. Energy sources

3. Miscellaneous unconventional feeds

A livestock ration must provide a suitable energy source and be in proper balance with respect to-

(i) proteins,
(ii) minerals,
(iii) lipids,
(iv) carbohydrates, and
(v) vitamins and growth factors

Characteristics of unconventional feeds-

According to reports, unconventional feed resources like conventional feed resources have several characteristics worthy of note.

- They are the end products of production processes and consumption that have not been used, recycled or salvaged.
- They are mostly of organic origin and can be obtained either in a solid, slurry or liquid form.
- The economic value of these non-conventional feed resources is usually less than the cost of their collection and transformation for use and consequently, they are discharged as wastes.
- Fruit wastes such as banana rejects and pineapple pulp by comparison have sugars which are energetically beneficial.
- The majority of feeds of crop origin are bulky poor-quality cellulosic roughages with high crude fiber and low nitrogenous content which are suitable for feeding mostly ruminants.
- Some of these feeds contain anti-nutritional components which have deleterious effects on the animals and not enough is known about the nature of the activity of these components and ways of alleviating their effects.
- Unconventional feed resources have considerable potential as feed materials and for some; their value can be increased if there were economically viable technological means for converting them into some useable products.

There are factors that relate to the feedstuffs comprising the feed. These include:

(a) Composition

The commodity must have a composition that allows it to be compounded into a balanced diet.

(b) Physical form

Many feedstuffs must be modified for proper formulation into diets. A common example in salmon diets is the lint that remains in cottonseed meal. It readily plugs the dies when small diameter feeds are to be prepared.

(c) Palatability

Several potential feedstuffs contain compounds that are offensive to the olfactory receptors of the animals.

(d) Factors affecting bio-availability of nutrients

(e) Stability during storage

This primarily relates to the vitamin stability and also the stability of the lipid portion that may oxidize in either dry or frozen storage.

(f) Toxic factors

Unit - 8

Use of Agro-industrial By-products

Agro-industrial by-products are mostly derived from agricultural processing industries such as *cereal grain milling, oilseed extraction, brewery, malt production, fruit and vegetable processing*. These represent a vast potential source of animal feed, which are currently not fully exploited. Although the nutritional value of most agro-industrial by-products is widely known, their utilization is hindered by several factors such as poor control of processing techniques, fluctuating supply, limited access to available suppliers, poor marketing channels, difficulty in transferring existing technologies and lack of legislation on their trade and use. Numerous studies have proven that agro-industrial by-products can be safely used as animal feed, without compromising animal product safety and animal and human welfare.

Some of the agro-industrial by-products used in livestock feeding are-

- cotton seed;
- ground nut and palm kernel cakes;
- protein sources such as molasses, pulse, rice brans which have shown surprising results in increasing energy in ruminants.

The nutritional values of some commonly used by-products can be found below:

By-product	DM	CP	Fat	CF	NDF	ADF	ADL	ME (ruminants)	OMD (rumimants)
Rice bran	90.1	14.8	17.2	8.4	25.2	11.2	4.1	13.1	76.9
Maize bran	88.7	11.9	4.6	12.3	44.2	14.5	2.2	11.0	74.8
Molasses	73.0	5.5	1.0	0.1	0.8	0.5	0.3	9.6	79.7
Soybean meal (dehulled)	88.1	53.5	1.8	4.9	11.0	5.9	0.5	13.6	92.4
Cotton seed cake	92.2	45.0	8.9	10.6	23.7	15.0	5.4	13.2	81.7
Maize	90.0	8.0	4.5	2.4	15.5	3.2	0.5	13.6	88.7
Soybean	91.2	42.4	20.9	3.7	9.1	4.8	0.6	15.5	82.2

Table: Nutritional value of various by-products.

Soybean and maize values are displayed to use as standard source of protein and energy respectively. Agro-industrial by-products require natural resources to produce and have economic and environmental costs associated with them, therefore agro-industrial by-products integration in animal nutrition feed ingredients could be an excellent way of reducing land and air polluting and a best way of recovering from cost of production. Comparing to other feeds used to feed livestock, Agro-industrial by- products have several advantages, such as:

- Relatively cheap or no cost,
- Feed shortage during periods of scarcity and uneven distribution,
- They do not compete for human food resources.
- In addition to this, as it can be observed in the table, they have comparable values to the crop they are derived.

Unit - 9

Use of NPN Substance and Mineral Block, Molasses, etc.

Urea molasses mineral block

Urea can be fed in several forms. It may be included in solid blocks which also provides vitamin and mineral supplementation and contains a readily available source of energy, usually starch.

Urea molasses mineral blocks which contain molasses 45%, urea 15%, mineral mixture 15%, salt 8%, calcite powder 4%, bentonite 3% and cotton seed meal 10% with the following specifications:

Characteristics	Requirement
Moisture (%), Max	3.5
Crude Protein (%), Min	58.0
Crude Fibre (%), Max	2.0
Total Ash (%), Max	34.0
Acid Insoluble ash (%), Max	3.0
Calcium (%), Max	4.0
Phosphorus (%), Min	1.5
Sulphur (%), Min	1.0
Urea (%), Max	15.0

Note: The values for characteristics 2 to 9 are on moisture free basis.

- Animals are allowed free access to the blocks. Intake being restricted by the blocks having to be licked and by their high salt content.
- If there is some danger of excessive urea intakes, remove the block crumble or there be readily available source of water allowing the animal to cope with the high salt intakes.

Advantages of Urea Molasses Mineral Blocks (UMMB)

- Ingredients are easily available in almost all parts of Indian and its preparation is very easy and cheaper than conventional sources of protein (Oil cakes)
- Density of UMMB is much higher than the ingredients, which facilitates long distance transportation, at a cheaper rate.
- UMMB blocks are suitable for supplementing dry fodder based diets for sustainability of ruminants during droughts and floods.
- UMMB licks are hard enough to control gradual intake limited to about 700 g in adult bovines and 800 -1000 g in growing bovines of about 200 kg body weights.

Precaution to be followed while feeding UMMB

- UMMB should not have more than 10% moisture and should be stored at a dry place protected from rodents. It should be offered to the animal in the dry manger and wetting should be prevented. Under moisture conditions it may become soft to facilitate swallowing.

Unit - 10

Importance of Bypass Degradable and Un-degradable Protein in Ruminants

Bypass Protein

Bypass protein is also called rumen escape or un-degradable protein. It is the portion of the protein from a feedstuff (corn, soybean meal, blood meal, etc.) that escapes from being broken down or digested in the rumen by microbes (bacteria, protozoa, etc.). This portion of the protein is then digested in the small intestine much like in single stomach animals such as swine or poultry.

The main benefit of bypass protein is essential amino acids are metabolized in the small intestine instead of the rumen, thereby providing a source of essential amino acids for production, in the case of show animals, muscle synthesis. Once the protein makes it to the small intestine, then it can be better utilized for protein synthesis.

Rumen degradable protein

Rumen degradable protein (RDP) is defined as that portion of dietary protein that can be degraded in the rumen, the largest of the multi-compartmental stomach, by microorganisms (both bacteria and protozoa) that use the protein to manufacture high quality microbial cell proteins, also known as microbial crude protein (MCP).

Rumen un-degradable protein

Rumen un-degradable protein (RUP) is defined as that portion of dietary protein that escapes degradation by ruminal microorganisms and is passed into the small intestine for digestion and absorption. The proportion of total feed protein that is un-degradable is not constant from one feedstuff to another. Although frequently referred to as bypass proteins, they technically do not bypass the rumen, but are simply not utilized by the microorganisms as a substrate to make MCP.

Metabolizable protein

Metabolizable protein (MP) is defined as the true protein absorbed in the small intestine and is composed of RUP and MCP.

When balancing diets, some feedstuffs deliver primarily energy, while others deliver

more protein. If high-energy co-products are used to supplement low-quality forage or hay, an additional co-product that will deliver adequate protein to feed the rumen microorganisms may be necessary.

Generally, crude protein (CP) is a gross measure of the nitrogen (N) contained in a feedstuff. Rumen microorganisms are unique in their ability to manufacture high-quality proteins for use by the animal from relatively low-quality feedstuffs, as long as they have an adequate supply of N, and a source of energy. Crude protein valuations of feedstuffs, however, do not account for rumen degradation and re-synthesis of MCP for use by the animal. Therefore, the use of metabolizable protein (MP) values has been adapted to describe animal protein requirements. This method accounts for the separate nutrient requirements of the microorganisms and those of the animal.

Feedstuffs are not equal in the extent to which CP is degraded in the rumen (RDP) and used by microorganisms. Differing amounts of dietary protein remain undegraded (RUP) in the rumen and pass into the small intestine where they may be absorbed and used by the animal directly. The total amount of protein delivered to the small intestine for absorption is the sum of microbial crude protein (MCP) and RUP. Alone MCP may be sufficient for lower levels of production and mature cattle. However, young developing and growing calves or lactating cows may require additional protein (usually RUP) derived from dietary sources to achieve performance expectations.

Based on the combination of feedstuffs considering, it is important to be aware of the RDP / RUP balance of these co-products, as well as the ratio of RDP:TDN, and not just the percent of crude protein. When supplementing low-quality forages, supplemental RDP may be important. Therefore, balancing supplement RDP and TDN is also important. The suggested optimal ratio of RDP:TDN is approximately 8–13%. Generally, providing supplements with RDP:TDN ratios greater than this level ensures that an adequate level of RDP is available to rumen microorganisms, thus enhancing the utilization of low-quality forage by the animal.

Urea is not really a protein, but is a highly soluble source of non-protein nitrogen (NPN), and thus provides an abundant source of Nitrogen (N) to rumen microorganisms. Urea is likely most appropriate in high-grain, or concentrate diets because of the high rate of starch degradation in the rumen. The starch provides a

carbon supply while the urea delivers N, and fermentation is more closely balanced. Utilization of urea and other NPN sources in forage or other low-protein diets may be less effective and potentially dangerous because of the rapid release of ammonia. Additionally, diet RUP levels may be insufficient. For these diets, natural proteins (those from plant-base sources) produce more favorable results and are safer to feed.

Generally, dry pregnant cows and even lactating cows with low levels of milk production can subsist on fairly low protein diets, i.e., less than 10% CP. However, as the level of production increases and cows lactate more heavily, their MP requirements increase, which may require an RUP increase, as well. The increase in RUP requirement can also occur in young, fast-growing calves whose total protein requirements at times can be more than twice that of their dams.

Unit - 11

Feeding of Livestock and Poultry

Feeding of colostrum in calves:

- Normally calves are allowed to suck colostrum or milk from the mother's udder for a few moments to induce letdown of milk and later they are separated from the mother, to facilitate the milk man to physically milk the cow. At the end of the milking again the calf is allowed to suck the residual milk from the udder, which may not be sufficient to the calf.
- But in organized farms, calves are separated and fed with measured quantities of milk in buckets or pails.
- The calves are trained to drink milk with its mouth turned upwards so that the ingested milk flows directly into omasum and abomasums through esophageal groove.

Colostrum

- It should be given fresh as milked from the mother within two hours and minimum for the first three days after birth.
- It provides antibodies which are absorbed intact in the first few days of the calf's life.
- It should not be warmed since it will coagulate, due to the presence of higher quantity of protein (17%) as against 3.5% in normal milk.
- It contains immunoglobulins (IgM, IgG, IgA) which are essential for new born calves and can pass through the intestinal membranes freely during the first 12 hours of its life.
- The immunoglobulins are absorbed in the body by the process of pinocytosis.
- It also contains anti-tryptic enzyme which may help in the protection of whey protein from the proteolysis.
- It is also rich in Vitamins (A, D and E) and minerals (Ca, Mg, Fe and P).
- It also has a laxative effect in removing muconium. The colostrum should be fed at the rate of one tenth of body weight of the calves.
- If dam's colostrum is not available, two eggs may be mixed with milk along with

30 ml castor oil and it can be given to the calves.

- In addition, it is necessary to inject the calf with dam's serum for augmenting the antibody titer in the body, particularly the buffalo calves.

Milk feeding in weaned calves:

- Weaning of calves within 4 days of birth is important because it is essential to have exact data on dam's milk production for future selection and progeny testing.
- After weaning, the calf is trained to drink milk from a pail either through hollow pressure rubber tubing or a nipple.
- Milk has a high nutritive value and should be given to calves after 4 days of age. Milk is a complete feed for calves.
- The calf must receive sufficient milk during the first three months.
- A minimum of 110 liters of whole milk should be fed over a period of 4-5 weeks along with a calf starter having good quality protein and low fiber.
- A minimum of 160 liters of whole milk up to the age of 7-10 weeks in addition to colostrum is an alternative suggestion.
- Economical feeding on restricted milk quantity slows rate of growth which delays maturity age.
- Milk should be given warmed to body temperature and preferably with a trace mineral supplement to make up for its deficiency of Fe, Cu, Mg, Mn and Zn.
- Green fodder upto 100 g dry matter may be offered daily from the age of 15 days onwards to provide a stimulus for the development of rumen and as a source of carotene.

Young stock:

- From third month onwards cultivated green forages like Bajra-Napier grasses, sorghum fodder, guinea grasses etc can be given at the rate of 2 kg per day, and gradually increasing it to 5 to 10 kg at 6 months of age. Green leguminous forages like lucerne or berseem should be wilted in sun for 2 -3 hours before feeding it, to minimize bloat. Similarly concentrate mixture is increased from 0.75kg at 4^{th} month to 1 kg at 5^{th} month and 1.5 kg at 6 months of age.
- After 6^{th} month male and female calves are kept in separate paddocks and

maintained on high quality roughage rations plus minimum concentrate so as to economize the maintenance cost.

- Assuming a daily weight gain of 500 g from the 6th to 24th month of age, two kg concentrate mixture with 16% Digestible Crude Protein and 70% Total Digestible Nutrients and 15 t0 20 kg of green fodder should be provided to each calf.
- The following feeding schedule should be followed for raising calves from 3 months to maturity.

Category	Concentrate (kg)	Roughage (kg)
Indigenous cattle/buffaloes	1 – 2	Green grass/maize fodder-10 kg or Legumes 1-2.5 kg + Dry fodder -2 kg or Green fodder – 3 kg + Straw – 2 kg
Crossbred	1.6 – 2.0	Green grass/maize fodder or alike fodders 5 - 10 kg up to 4 months and 10- 15 kg from 4-6 months.

From 6 - 12 months of age		
Category	Concentrate (kg)	Roughage (kg)
Indigenous cattle/buffaloes	1-2	Green grass/maize fodder-15 to 20 Kg or 15 to 20 Kg of Legumes+ 5 Kg dry fodder or Green fodder 5 kg + Straw 2 to 3 kg
Crossbred	2.0 – 2.5	Green grass/maize fodder or alike fodders - 15 to20 kg

From 1 year to age at conception		
Category	Concentrate (kg)	Roughage (kg)

Indigenous cattle/buffaloes	1 to 2	25 to 30 kg of green maize fodder / or other grasses

Importance of proper feeding of calves from weaning to breeding

- The level of nutrition influences onset of puberty in cattle and buffaloes. At this age, the individual feeding is discontinued.
- The male and female calves are separated. The animals of same sex are reared in small groups.
- Proper feeding is necessary if heifers are to be prepared for breeding at the right age.
- Inadequate diet during this period of growth may reduce the milk production potential when they start producing milk.
- Care must also be taken not to allow heifers to become too fat. Heifers that become fatty at this stage will not produce well during lactation, besides fatness may lead to reproductive problems.
- The animals should be supplied with required quantity of mineral mixture and common salt. Under the situation when green fodder is not available, the animals should receive 'vitamin A' supplemented concentrate mixture.
- A diet deficient in energy, phosphorus or vitamin A may delay the onset of oestrus.
- The way a heifer is fed is very important as it can greatly affect:
  - Age at first service
  - Ability to conceive (to become pregnant)
  - Age at first calving
  - Lifetime milk production
  - Length of productive life
- In general terms, if an animal grows at a faster rate, it will reach sexual maturity earlier. Puberty occurs at a particular live weight rather than at a fixed age.
- Puberty occurs when heifers weigh between 45 - 50% of mature body weight and under good feeding and management they usually attain 45 - 50% of mature

body weight at 13-15 months of age. Breeding should occur when heifers reach 50-60% of mature body weight.

- Growth rate should be sustained during pregnancy such that heifers weigh 80-85% of mature body weight at first calving and are large enough to calve without difficulty at about 20-24 months of age

Pregnant and lactating cow:

Daily nutrient requirements for maintenance, pregnancy and lactation for cattle and buffaloes

For maintenance of mature Cows/Buffaloes:

Body Weight (kg)	Dry feed (kg)	DCP (g)	ME Mcal	TDN kg	Ca g	P g	Carotene mg	Vitamin A 1000 IU
200	3.5	150	6.0	1.7	8	7	21	9
250	4.0	170	7.2	2.0	10	9	26	11
300	4.5	200	8.4	2.4	12	10	32	13
350	5.0	230	9.4	2.7	14	11	37	15
400	5.5	250	10.8	3.0	17	13	42	17
450	6.0	280	12.4	3.4	18	14	48	19
500	6.5	300	13.2	3.7	20	15	53	21
550	7.0	330	14.4	4.0	21	16	58	23
600	7.5	350	15.5	4.2	22	17	64	26

For maintenance and pregnancy (last 2 months of gestation):

Body Weight (kg)	Dry feed (kg)	DCP (g)	ME Mcal	TDN kg	Ca g	P g	Carotene Mg	Vitamin A 1000 IU
250	4.9	270	10.8	3.0	14	12	51	21
300	5.6	290	12.4	3.4	16	14	56	25
350	6.4	320	13.2	3.7	21	16	67	27
400	7.2	350	14.1	4.0	23	18	76	30
450	7.9	400	15.9	4.4	26	20	86	34
500	8.6	430	17.3	4.8	29	22	95	38
550	9.3	465	18.8	5.2	31	24	105	42
600	10.0	500	20.2	5.6	34	26	114	46
650	10.6	530	21.6	6.0	36	28	124	50

Feeding of milch animals:

- The nutrient requirement of a lactating cow /buffalo can be conveniently divided into two parts, viz. requirement for maintenance and milk production. If the lactating animal is in first and second lactation, extra allowance is needed to take care of growth and production.
- Similarly pregnant animals are to be offered extra nutrients during the last two months of gestation. The aim is that by the end of gestation period the cows should not only gain their initial body weight but also put on an extra 25 to 30

kg of body weight. This is necessary to enable the animal to withstand the stress of parturition and to maintain the persistency of milk production during the subsequent lactation period. The provision of extra nutrients should be given in the form of concentrate mixture and not as forage because roughages are not as efficient as concentrate in increasing the body weight. The rest of the ration must contain sufficient green feeds so that the colostrum secreted after parturition should be rich in vitamin A.

- During the last 3 days prior to calving, the amount of concentrate mixture should be reduced and a little warm bran is fed to keep the animal in laxative condition before calving.
- After parturition, the cow /buffalo should be given fresh warm water and a mash consisting of 1 kg wheat bran, 1-1.5 kg ground/cooked grains, 0.5 kg jaggery and 25 g each of common salt and mineral mixture. This mash may be continued for 3 to 4 days after calving; then after, the regular feed is gradually introduced to the cow.
- In feeding high-milk yielder, quality feed, ie., nutrient dense feed need to be given. Ration should contain a minimum 25% DM from forages. Forage should be of superior quality and 30 to 50% of this should be from leguminous crops. Ration may be in the form of complete feed. Frequency of feeding is three to four times a day. To ensure proper nutrient intake, optimum roughage concentrate ratio need to be maintained.

Nutrient requirement per kg of milk production:

Fat %	DCP (g)	ME (M cal)	TDN (kg)	Ca (g)	P (g)
3.0	40	0.97	0.270	2.5	1.8
4.0	45	1.13	0.315	2.7	2.0
5.0	51	1.28	0.370	2.9	2.2
6.0	57	1.36	0.410	3.1	2.4

7.0	63	1.54	0.460	3.3	2.6
8.0	69	1.80	0.510	3.5	2.8
9.0	75	2.06	0.500	3.7	3.0
10.0	81	2.16	0.600	3.9	3.2
11.0	85	2.34	0.650	4.1	3.4

Feeding of breeding bull:

Feeding of bull calves

- Animals which are earmarked to be raised as future breeding sires, should generally be kept on a liberal amount of milk for the first six months or more of their life. Milk is also supplemented with calf starter from two weeks of age onwards along with good quality hay.

S. No.	Age of bull calves	Quantity to be given (kg)		
		Concentrate	Green fodder	Dry fodder
1.	6 to 12 months	2.5	5 - 7	Adlibitum
2.	1 to 2 years	3.0	7 - 10	Adlibitum

- Young males to be used for draft purpose should only be castrated at 12 to 15 months of age and their feeding schedules should be identical to that of heifers. To economize the cost of feeding more green fodder and hay can be fed (upto 15 -20 kg /day).

Feeding bulls in service:

- Breeding bulls are to be fed good quality fodders and concentrates to keep them active. In addition the bulls should be regularly exercised to keep it in prime condition.

Nutrient requirement of breeding bulls

Live weight (kg)	DCP g	TDN kg	ME Mcal	Ca g	P G	Carotene mg	Vitamin A 1000 IU
400	380	3.6	13.0	18	13	40	16
500	450	4.5	16.2	20	15	53	21
600	530	5.4	19.4	22	17	64	26

- When berseem/lucerne/cowpea are available they can be fed along with the straw or other good quality roughages like oats without any concentrate. However, when straws form the basal ration, concentrate are to be fed.
- When non-leguminous green fodders, like oat, maize, sorghum, good grazing etc, form the basal roughage there is no need to feed concentrate mixture.

Feeding of draft animal:

- When food supply is adequate, a working animal first draws upon the carbohydrates and fats in the feed. If the supply is inadequate, the body fat is used for the purpose and as a last resort muscles and other protein tissues are used. Thus, as long as there is a sufficient supply of carbohydrates in the feed, an ox at work needs no more protein than required for maintenance except probably when the work done is very hard.
- When the animals are not working, they should be fed as per the maintenance requirement. For light work, the animal should be fed with 30 kg green maize and 10 kg cowpea. For heavy work, 10 kg extra cowpea may be fed to take care of extra protein requirement. When cultivated fodders are available 20 kg berseem/lucerne with 20 kg oats may be fed.
- In addition 30 g of mineral mixture and 30 g of salt should be fed daily.
- When wheat/paddy straw form the basal ration, then a concentrate mixture containing 12% DCP and 75% TDN should be fed at the rate of 1, 1.5, 2 and 2.5 kg respectively to 200, 300, 400 and 500 kg animal along with *ad libitum* bhusa. For heavy work 2, 3, 4 and 5 kg of concentrate mixture should be fed along with wheat straw. 2.5 kg green fodder may be fed to satisfy the vitamin A

requirement.

Alternative Feeding Schedule for working bullocks-

Light work

- Roughage: Ad libitum straw (6-10 kg)
- Concentrate(12% DCP, 60% TDN): 1-2.5 kg/day

Medium work

- Roughage: Ad libitum straw (6-10 kg)
- Concentrate(12% DCP, 60% TDN): 1.5-4 kg/day

Heavy work

- Roughage: Ad libitum straw (6-10 kg)
- Concentrate(12% DCP, 60% TDN): 2-5 kg/day

Feeding all categories of sheep and goat:

Feeding of pre-weaned lambs from birth to 90 days of age

- The development of lambs in the first four months is faster than the kids.
- Doubling or tripling of the birth weights is reached much earlier in lambs than by kids.
- The most critical period in the life of a lamb is during first 48 hours. If a lamb is unable to nurse within half an hour after birth, it should be assisted to suckle to get the advantage of colostrum.

Creep feeding

- Lambs up to 12 weeks of age, suckling the sheep should be supplemented with creep ration which they start to consume at about 2 weeks of age.

Creep mixtures:

Ingredients	I	II	III
Maize flour	67	50	30
Barley flour	-	17	-
Oat flour	-	-	37
Groundnut cake	10	10	10

Wheat bran	10	10	-
Rice polish	-	-	10
Fish meal	10	10	-
Meat meal	-	-	10
Mineral mixture	2	2	2
Sodium chloride	1	1	1

- Along with creep mixture, adequate amount of Vit A supplement should be given. At 90 days of age, about 300 g of creep mixture is consumed by a lamb.
- After the development of rumen, good quality leguminous fodder/hays, may be given.
- The lambs should be allowed to suckle the dam twice daily and kept separately where creep mixture, roughage, mineral mixture and water are available at free choice.

Feeding of lambs from 10th day till weaning

- After 10th day of age lambs should be fed good quality legume along with concentrate mixture to about 50-100 gm/day along with salt and mineral mixture.
- It should be supplemented with vitamin mixture and antibiotic preparation like tetracyclines.

Feeding schedule:

Body weight (kg)	Concentrate mixture (g/day)	Roughage* (g /day)	Remarks
12 -15	200	400	8 hours grazing can be substituted in place of roughages
16 -25	250	600	8 hours grazing can be substituted in place of roughages
26 -35	300	700	8 hours grazing can be substituted in place of roughages

- Grasses such as Cenchrus species, Legumes pastures such as Stylo, Sirato, Groundnut haulms, grass and legume mixture may also be given.
- It is better to keep the lambs in the stall for mutton production specially in the monsoon period because the animals do not relish to graze the wet grasses and are also prone to diseases. Free choice mineral blocks are to be provided in the sheds. Cross bred sheep attain 30 kg body weight by 6 months of age, while native breeds may take 9 months.

Feeding of growing, fattening lambs and breeding rams

When good quality fodders are available, the following concentrate mixture can be used.

Ingredients	Parts
Wheat/Rice bran	40
Maize	25
Groundnut cake	32
Mineral mixture	2
Sodium chloride	1

The above mixture should be fed as per the following recommendations:

Body weight	Concentrate mixture/day
10-15 kg	50 gm
16-25 kg	100 gm
26-35 kg	150 gm

If the quality of fodder is not good then the concentrate mixture should be given as 300g, 400g and 600 g respectively.

Feeding of fattening lambs

- The feedings schedule for fattening lambs is dependent on the age and weight expected at the time of marketing. Generally simple concentrate mixture consisting of
  - Cereal grains - 2 parts
  - Bran - 1 part
  - Oil cakes - 1 part
- Supplemented with mineral mixture and vitamin mixture can be used.
- This concentrate ration should be fed at the rate of 110-450 gm/day/ depending on the weight of ram to be fattened.

Feeding of breeding rams

- Rams used for breeding purpose should not be too fatty, which may influence rate of fertility and mating behavior.
- If breeding ram is fatty, the allowance of concentrate mixture should be stopped completely and ram should be fed on dry fodder.
- This procedure should be followed for 8 weeks before ram is allowed to mate with ewes.
- Before 2 weeks of mating again normal feeding schedule is followed.
- During summer months concentrate mixture consisting of
  - crushed grams – 2 parts
  - Wheat bran – 2 parts
  - Sodium chloride – 1 part, can be given.
- During winter months crushed grams should be replaced by available crushed oil seeds cakes.

Feeding of pregnant ewes and ewes after lambing

- Gestation period of ewes is about 143-151 days, on an average 147 days.
- During the first half of gestation period the growth of foetus is not so rapid and thus the maintenance requirement of nutrients can take care of pregnancy during

early half of gestation period. But a precaution should be taken to avoid underfeeding during this period.

- During later half of gestation period, the rate of growth of foetus increases with the result increasing nutrients requirement for its nourishment and that's why extra allowance of feed should be given during this period. For this purpose following concentrate mixture can be used.

Ingredients	Parts
Maize/Jowar/Bajra	30 parts
Groundnut oil cake	20 parts
Rice Bran	40 parts
Molasses	7 parts
Mineral Mixture	2 parts
Sodium chloride	1 part.

- This concentrate mixture should be given to about 150-250 gm/day in addition to 8-9 hrs of grazing on good pasture or grasses.
- If grazing is not practiced, this concentrates mixture should be supplemented with vitamin preparation @ of 25g/100 kg. of feed.
- The excessive energy intake during last 6 weeks of gestation leads to fattening which results in birth difficulty in single bearing ewes. Whereas low energy intake can result in low birth weight with reduced viability in lambs, perhaps pregnancy toxemia may result in ewes.
- The advantage of extra allowances of feed given during the last half gestation period are as below:
    - It increases birth weight of lambs.
    - It reduces number of weak or crippled lambs.

- It reduces chance of lambing paralysis which occurs just before lambing.
- It increases milk of ewes and thereby avoids tendency for disowning their own lambs.

Feeding ewes after lambing

- Immediately after lambing the concentrate ration for ewes should be reduced this may otherwise lead to conditions like swollen udder and other udder complications.
- During this period good quality hay, legume should be given along with a little quantity of concentrates (about 50-100 gm).

Feeding of adult sheep and lactating ewes

Feeding of adult sheep

- The adult sheep should be allowed to graze free of choice on pasture or grass land and should be supplemented with 100 gm of concentrate mixture.
- If legume or hay is available then concentrate mixture need not be given.
- When legumes are fed alone the chances of developing digestive disturbance increases and so some dry fodder like straws should be given along with legume fodder.
- When sufficient pasture land is not available and straw is available then feeding of straw along with 300-400gm of concentrate mixture should be done.

Feeding of lactating ewes

- During first 10 days after lambing legume hay may be fed.
- After 10 days up to weaning 250 g of concentrate mixture may be supplemented with good quality legume hay.
- After 3 months, maintenance allowance is sufficient.
- The requirements of energy and protein are higher during lactation.
- Feeding during the first 4 weeks of lactation is critical and affects lactational performance of the ewes and thereby growth and survival of lamb.
- Both energy and protein should be balanced in a diet of lactating ewe.
- Therefore feeding of 800 g good legume hay or 100-g/day-concentrate mixture for 75 days after lambing in addition to 8 hours of grazing is recommend for feeding of lactating ewes.

- Fats: A minimum of 3% fat in sheep rations is essential.
- Salt licks containing important major and minor minerals are kept in their shed as a free choice lick..

Composition of salt lick

Ingredient	Composition (%)
Rock salt	40
Sulphate of Ammonia	20
Dicalcium phosphate	20
Urea	10
Molasses	10

Salt is added at 0.5% to complete diet or 1% to the concentrate mixture.

- They consume more salt per unit of body weight than the cattle
- In addition to the above information, the following on different systems of rearing sheep and how to improve their nutrition may also included

Systems of sheep rearing:

- Extensive system
- Intensive system
- Semi-intensive system

Extensive system

- In this system, the availability of energy throughout the year, in particular from January to June and protein for more than half of the year is less than the animal requirements.
- Over grazing of the available grazing land and overstocking leads to problems of soil erosion and land degradation. This leads to low animal productivity. Sheep and goats weigh only 15-16 kg at 9-12 months of age, lower dressing percentage (35-40) and narrow bone:meat ratio (1:3.5-4.0). The reproduction is

also affected with high mortality in lambs and kids.

Measures to improve productivity under Extensive system-

- Reseeding with more productive and nutritive grasses like Cenchrusciliaris, Lasiurussindicus, Dicanthiumannulatum
- Intercropping legumes like Cowpea, Dolichos Lablab, Clitoriaternata ,Stylosantheshemata etc. with grasses like Cenchrusciliaris will increase biomass yield, palatability and the grass-legume mixture can sustain 4-5 sheep/ha/annum.
- *Silvi-pasture:* During the period from December-June, when the grazing material from pasture lands becomes scarce and the quality deteriorates, the fodder trees and bushes serve as valuable sources for feeding sheep and goats. A three tier silvipasure having fodder trees like Prosopis cineraria, Azhadirachtaindica, Morus alba, Leucaenaleucocephala, Gliricidia Maculate, Sesbania etc., fodder bushes like Zizyphusnummularia and Dicrostachysmutans with ground cover of grasses like Cenchrusciliaris can be practiced.

Semi-intensive system

- It is a combination of free range grazing and stall-feeding.
- Integration of sheep rearing with arable cropping is also included where either the sheep or goat are tethered or cut and carry system of available fodder is employed.
- The poor nutritive value of native pastures and crop residues makes it necessary to improve the nutrient intake for better animal performance.
- Free grazing on range land for 8-10 h / d and supplementation with 1.5 to 2.0 % of body weight with concentrates allowed to graze on available grazing lands or pasture lands and supplemented with legume hays, legume leaf meal or concentrate mixture at 1.5 t0 2.0 % of body weight till they attain 25 to 30 kg finishing weight at 5 to 6 months of age.. For example if a ram lamb weighs 20 kg, then the concentrate will be 20 x 0.15 = 300 g or 20 x 0.02 = 400 g/ day
- Supplementation with concentrates has been shown to increase dressing percentage, lambing and kidding percentage, increased birth weight of lambs and kids and reduced mortality, and increased wool yield.
- Optimum level of fodder trees and shrubs when used as supplements should be

about 30 to 50 % of the ration, on DM basis.

- In addition to grazing the pregnant ewes/does during last 30 days of pregnancy and lactating ewes/does during first 60 days of lactation be supplemented with 300g/h/d concentrate mixture containing 12 % DCP and 65 % TDN to ensure 2.5 to 3.0 kg birth weights.
- To attain a weaning weight of 14 to 16 kg at 60 days of age, the lambs/kids should be provided ad lib suckling, creep ration and green/dry leguminous fodders during pre-weaning period

Intensive system

- The intensive system of sheep and goat production includes grazing on highly developed pastures or complete stall feeding on cultivated fresh or conserved fodders, crop residues and concentrates. Although goats prefer to browse as compared to grazing, they are quite capable of making efficient use of cultivated pastures for meat and milk production similar to sheep.
- Stocking rates of 16 to 60 sheep or goats per hectare are feasible depending on the type of grass, level of fertilization and presence or absence of legumes and fodder trees.
- This system requires high labor and capital investment.
- Judicious use of available feed and fodder resources, crop residues, agro-industrial byproducts is possible under this system.
- The energy expended for grazing/browsing can be conserved for body weight gains.
- Several studies have shown ADG (g) and feed efficiency (kg DMI/kg gain) of 100-200 and 12-18, respectively in sheep and goats under intensive system of management.
- This system is ideally suited to feed sheep and goats on complete diets containing tree leaves, crop residues, improved legume hays or grass hay and concentrates in the ratio of 50:50.
- In lambs maintained on complete diets, ADG of 100-150 g, FCE,, 14-15, finishing body weight of 25 kg at 6 months and 30 kg at 9 months were attained.
- Several least cost feed formulations involving leguminous fodders (cowpea,

dolichos, clitoria), tree and shrub leaves (Khejri, Ardu, Pala), cheaper energy supplements (Jowar, Bajra, etc.) and low cost protein supplements (mustard cake, guar meal, sunflower cake) have been developed for economic and sustainable production.

I. Composition of creep ration (DCP 18-20 % and TDN 70-75%)		II. Concentrate mixture for supplementation (DCP 12- 14 % and TDN 60-65 %)	
Maize	20%	Maize	20%
Gram	20%	Gram chuni	32%
Groundnut cake	35%	Groundnut cake	15%
Wheat bran	23 %	Wheat bran	30 %
Mineral mixture	2.5 %	Mineral mixture	2.5 %
Common salt	0.5 %	Common salt	0.5 %

III. Complete diets based on crop residues (CP: 12-14 %, TDN: 60 - 65 %)

- Crop residue : 25 % (Sehimanervosum hay / Heteropogancontortus hay / Sorghum straw / Maize stover / Bagasse / Sunflower straw / Cotton straw / Groundnut hulls)
- Groundnut haulms : 25 %
- Maize grain : 18 %
- Groundnut cake :12 %
- Wheat bran : 17 %
- Mineral mixture : 2 %
- Salt : 1%

Flushing or feeding of breeding ewes, feeding of sheep for wool and meat:

Flushing or feeding of breeding ewes

- Flushing is the special nutritional care for improving nutritional status of ewes 3-4 weeks before mating by providing additional concentrate mixture.
- It is very much important to have better nutrition and body condition before ewe is allowed to mate with ram.
- The effect of flushing is more evident in ewes that were underfed.
- Thus with flushing ewes have better body condition and will increase fertility by way of increased incidence of oestrus and increased ovulation rate.
- The majority of sheep in arid and semi-arid regions are bred 2-3 weeks after the onset of rains as grazing conditions are improved by this time.
- To obtain increased lambing rate, breeding ewes should be given 250 g concentrate mixture or 500 g of good quality hay/head/day 3-4 weeks before breeding is addition to usual hours of grazing.

Feeding of sheep for wool and meat

- Sheep are reared mostly on grazing and poor pastures where good cropping is not possible either due to fertility of soil or due to inadequate irrigation facility and also low rain fall, resulting in unable to sustain the rain fed crops.
- In cultivated areas, sheep flocks are grazed on fallow land and stubbles left after harvesting of main crops.
- Sheep are able to collect their feeds by close clipping and often they follow cattle and buffaloes on the pasture with good herbage cover.
- Young tender grass blades are liked by sheep, which they sort out avoiding coarse and ripen parts of the plants.
- Sheep grow at a much higher rate on the feeding of energy rich high concentrate diet than the grazing alone.
- Supplementation with concentrates after grazing is more economical than intensive fattening.
- Sheep have tremendous feeding capacity and voluntary DM intake range from 2-5% of body weight.

- Inadequate feeding and unbalanced feeding are the chronic limitations of sheep rearing in most of the tropical countries.

Feeding of goats

Starter or creep ration

From birth up to 3rd day, the kids are given mother's milk i.e. colostrum. After 3rd day the quantity of milk to be given to kids is reduced to about 100 ml/day. Along with mothers' milk, green tender grasses, pasture or some legume fodders like lucerne, berseem, cowpea are fed. Expected body weight after 7 days is between 1-5 kg. There after creep feed is given, which contains 14-18% DCP and 65-70% TDN.

Creep feed -

1	Maize	60
	Groundnut oil cake	20
	Fish meal	10
	Wheat bran	07
	Mineral mixture	02
	Sodium chloride	01
2	Gram Chunnies	20
	Maize	22
	Groundnut oil cake	35
	Wheat bran	20
	Mineral mixture	2.5
	Sodium chloride	0.5

During 7 days - 40th days of age 4-5 times feeding is done and from 40-60 days 3 times creep feeding is done. At the end of 60 days i.e. weaning age the body weight of young one between 3-4 times more than the birth weight i.e. ranging to about 7-10 kg.

Grower ration

After weaning period, the goats are turned to grower ration containing 9-10% DCP and 60-65% TDN. The grower period is of one year duration during this period goat attains about 1/3rd of its natural body weight. Thus expected body weight at the completion of 1 year is 18-20 kg.

Maize	50
Wheat bran	30
Groundnut oil cake	10
Molasses	07
Mineral mixture	02
Sodium chloride	01

Finisher ration

The finishing period of goat, depends upon the market tendency, so as to sell it at different body weights. Generally goats are marketed at the average body weight of 20-30 kg. During finishing period the rate of growth is very low and that's why the maintenance ration satisfies the nutrient requirement. The DCP content of finisher ration is 5-6% and TDN 60-65%.

Maize	15
Jowar	15
Groundnut oil cake	20
Wheat bran	40

Molasses	07
Mineral mixture	02
Sodium chloride	01

When fatty carcasses are needed for selling, roughage should form 20-25% of total dry matter requirement, whereas for lean meat production roughages should form 30-40% of total dry matter requirement. For producing fatty carcasses, high-energy cereal grains should be included in the concentrate mixture.

Feeding of replacement stock

Most of the male and female kids are selected for breeding purpose; those are called as replacement stock. Feeding of such stock is adjusted so as to reach the sexual maturity and desirable body weight at 1 year of age. The desirable body weight at one year for smaller breeds is 15-18 kg., whereas for larger breeds it is 20-25 kg. When sufficient good quality pasture is available for grazing, no supplementary feeding with concentrates is desirable, whereas during lean period about 250-500 g of concentrate mixture with 10-12% DCP and 68-70% TDN should be given to replacement stock. The concentrate mixture should be necessarily supplemented with mineral mixture or otherwise mineral licks should be provided in shed.

Feeding of dry goats

For the non-lactating i.e. dry goats, if sufficient grazing facilities are available, the maintenance requirements get satisfied by 8-9 hours of grazing on good quality pasture. However, during shortage of pasture, 200 g of concentrate mixture with 5-6% DCP and 55-60% TDN should be fed. For milch type dry goats 30% of dry matter should be fulfilled by concentrate mixture.

Feeding of pregnant does

When doe is pregnant, a great care is needed regarding feeding specially during last one third period of gestation as this is the active period of total development and nearly about 70-80% gain in foetus mass in achieved during this period. Requirement of

protein, calcium and phosphorus are increased during this period.

Daily Nutrient Requirements of Pregnant Does-

Body Weight (kg)	Dry matter Intake (g)	Dry matter (% body weight)	Digestible Crude Protein (g)	Totla digestible Nutrients (g)	Calcium (g)	Phosphorus (g)
15	700	4.7	42	385	2.1	1.4
20	865	4.3	52	475	2.6	1.7
25	1025	4.1	62	564	3.1	2.1
30	1170	3.9	71	645	3.5	2.3
35	1320	3.8	80	725	4.0	2.7
40	1460	3.6	88	802	4.4	2.9
45	1590	3.5	96	875	4.8	3.2
50	1725	3.4	104	984	5.2	3.5
55	1850	3.4	112	1018	5.5	3.7
60	1975	3.6	120	1086	5.9	3.9

Therefore a ration containing 12.5% DCP and about 55-60% TDN should be given to about 300-500 g, however for pregnant but lactating goats 300-400 g of concentrate mixture/kg of milk produced should be given in addition to maintenance amount of 150 g/day. Free choice mineral licks should be made available.

Nutrient requirement of growing kids:

Male kids

Daily gain (g)	DMI (% B. Wt)	DCP (%)	TDN (%)
50	3.4	6.5	63
100	4.25	6.5	63
150	5.2	6.5	63

Feeding of lactating goats

For an adult doe in lactation about 400 g of concentrate mixture must be given for every liter of milk produced and over and above that 150 g should be added for maintenance. A concentrate mixture for lactating goats should contain about 9-10% DCP and 60-65% TDN.

Daily Nutrient Requirements of Lactating Does-

Body weight (kg)	Milk Yield (kg)	Dry matter Intake (g)	Dry matter (% body weight)	Digestible Crude Protein (g)	Total Digestible Nutrients (g)	Calcium (g)	Phosphorus (g)
20	0.5	865	4.3	51	468	4.3	2.9
	1.0	1185	5.9	74	640	5.9	3.9
25	0.5	968	3.9	56	523	4.8	3.2
	1.0	1290	5.2	79	695	6.4	4.3
30	0.5	1060	3.5	61	573	5.3	3.5
	1.0	1380	4.6	84	745	6.9	4.6
35	0.5	1155	3.3	66	623	5.8	3.9
	1.0	1470	4.2	89	795	7.3	4.9
40	0.5	1245	3.1	70	673	6.2	4.1
	1.0	1565	3.9	93	845	7.8	5.2
45	0.5	1320	2.9	75	713	6.6	4.4

	1.0	1640	3.6	98	885	8.2	5.3
50	0.5	1410	2.8	79	763	7.0	4.7
	1.0	1730	3.5	102	935	8.6	5.7
55	0.5	1490	2.7	84	803	7.4	4.9
	1.0	1805	3.3	107	975	9.0	6.0
60	0.5	1570	2.6	88	848	7.8	5.2
	1.0	1890	3.1	111	1020	9.4	6.3

It should be necessarily supplemented with mineral mixture of standard quality.

Balanced ration for lactating goats

Maize	12 parts
Dal Chuni	35 parts
Wheat bran	30 parts
Groundnut oil cake	5 parts
Molasses	4 parts
Mineral mixture	2 parts
Sodium chloride	1 part

Feeding of bucks

They require about 3-3.5% concentrate mixture of total body weight. Average breeding bucks need 500 g to 1 kg concentrate and yearlings about 250 g.

Feeding all category of pigs/piglets, gilt, sow, finisher, boar etc.

Dry sows

Pregnant sows should be fed according to condition. The amount depends on the sow's size and body condition, type of housing, environment, feeding method and health. If the intake is too high during pregnancy and sows become overfat, intake should be reduced while they are lactating. A feeding level of 2-2.5 kg of grain-based feed is suitable for most dry sows. The heavier the sow, the more maintenance that is required and, thus, the greater amount of feed required. The potential exists to improve reproductive performance and longevity by providing extra protein to replacement gilts to support their structural development.

Lactating sows

Separate lactating (wet sow) and dry sow diets should be used if storage facilities permit. A lactating sow's requirements depend on her weight, her milk yield and its composition, and her change in body weight and composition. More than 80 percent of a lactating sow's energy requirement is for milk production. It takes 4 kg of milk to produce 1 kg of litter gain.

In general, a sow needs approximately 85 MJ per day and 55 g of available lysine to support a litter of 10 piglets. This can be achieved by feeding 6 kg of a diet with 14.0 MJ DE and an available lysine digestible energy (DE) of 0.55 g/MJ. First-litter lactating sows should be offered a separate diet or supplement to account for their lower appetite compared with older sows.

In general, many herds gradually increase feed from about 2-2.5 kg a day around farrowing to ad lib at four to seven days, though this depends on the herd. A general rule for the maximum amount is 2 kg a day for the sow and 0.5 kg for each piglet, so as not to overfeed a sow with only a few piglets.

Increasing intake

Delayed oestrus after weaning is a breeding herd problem commonly seen in summer. Lactating sows reduce their feed intake in hot environments. Not only can this affect milk production and, thus, the piglets' growth, but sows weaned in poorer conditions have longer wean-to-oestrus intervals, particularly first-litter sows. Minimizing the

heat load on the sow, through shade, ventilation, water drippers on the skin and other methods, and stimulating the feed intake of the lactating sow through feeding techniques can reduce these problems. Suggested techniques include:

- Feeding more than once a day and feeding in the cooler hours of the day
- Feeding a higher quality, denser diet. The sow will not need to eat as much of a dense diet to obtain the required nutrients. Using oil in the diet for energy provides a concentrated energy source and produces less heat in the animal during digestion than carbohydrates such as grains
- Providing wet feed. However you cannot let the feed go sour, and you need to clean out uneaten food if more than about six hours old and keep the troughs clean
- Providing fresh feed, ensuring you keep stored feed cool and minimize moulds
- Increasing feed palatability. Adding flavoring is a possibility to achieve this
- Checking that the feeder design is not restricting intake. Ensure that large sows can access the feed easily.

Provide access to water without restriction, ensuring it is cool water with a flow rate of 2 L per minute or a trough.

Creep

Suckling pigs need fresh diets from about 10 days of age. The diet should contain no less than 16 MJ DE/kg, and be palatable and readily digestible. They should be fed the same diet for the first week after weaning.

Weaner

This diet needs to cater for the young pigs′ digestive capacity but must be cost effective because of the length of time over which this diet is fed. The diet should be fed to established weaners without restriction until 20-25 kg live weight (about 8-10 weeks of age). The diet's energy level should be at least 14.5-15.0 MJ because their stomach capacity is limited. As feed intake is a major limit to growth during this phase, the feed must be digestible, palatable and fresh. Troughs must be checked regularly for soiling.

Grower

This is the period for rapid lean growth, so the diet should be high in energy (14.0-14.5MJ DE) with an available lysine/DE ratio of at least 0.65g/MJ. Diets should be offered without restriction from about 20 kg until 45-60 kg live weight (about 14-16 weeks of age).

Finisher

Finishers' diets (possibly more than one) should be fed from 45-60 kg at a feeding scale that optimizes growth rate, feed efficiency and carcass quality. The scale is determined by the market requirements, price differential between the fat classes, genetic potential of the pigs, sex (easntire males can tolerate higher levels of energy intake) and environmental temperatures (as the requirement for energy is higher in the cooler months).

For many commercial pigs, the scale will be to feed without restriction. As a guide, if feed restriction is required, they should be fed a maximum of 30-34 MJ of energy per day. That is, if a diet contains 13.5 MJ DE/kg, they must be offered 2.2-2.5 kg of feed daily to meet these needs. The available lysine/DE ratio should be about 0.55 g/1 MJ.

Split sex feeding

Split-sex feeding improves feed-use efficiency by more closely matching diet specifications to the different nutritional requirements of male and female pigs. As feed represents about 60 per cent of the total cost of production, this practice presents a major opportunity to improve profitability. Male and female pigs differ in their potential to convert feed into lean meat. Females reach their maximum point of lean growth at a lower live weight and feed intake than males.

Female pigs (especially those beyond 50 kg live weight) deposit protein slower, have a higher (worse) feed-use efficiency and deposit more fat than males at similar intakes of the same specification diet. Females also need less energy for basic body functions, which adds to the difference in carcass fat between the sexes.

If the same finisher diet is fed to both sexes, then either the males will not reach their genetic potential (if females are to achieve acceptable fat levels for the market) or

females will be fat at slaughter and attract penalties. Male pigs need a higher energy and higher protein (amino acids) diet during the finisher period compared with females.

The level of benefits from split-sex feeding in terms of improved finisher-herd feed conversion, growth rates and carcass composition vary between herds and are influenced by genotype.

Feeding all category of poultry (chicks, growers, layers, finishers, broilers)

Feeding of chicks

Young chicks require a diet rich in protein and certain vitamins, with a carefully balanced mineral content. Two pounds of chick starter dry mash will feed one chick up to about six weeks of age. After that, in the case of the birds to be reared to maturity, a cheaper ration with increasing amounts of whole grain may be used. Birds to be killed as broilers, however, should be kept on a more concentrated diet to promote the rapid growth essential to profit in broiler raising. While one may mix chick starter at home, the simplest plan is to purchase 200 pounds of commercial chick starter mash for each 100 chicks. Choose a brand that is flaky or mealy, avoiding the less palatable finely ground mixtures that tend to paste inside the chick's mouth. The dry mash should be stored in a cool dry place and fed fresh daily.

Start feeding the chicks as soon as they want to eat. Place dry mash on clean egg-case flats (cup type) or on clean cardboard, at several points around the brooder, with possibly a little cracked wheat or chick scratch grain sprinkled over the mash. After two or three days, when all the chicks have learned to eat, place the dry mash in self-feeders. The usual method is to keep dry mash continuously before the birds, though some people prefer to lift the feeders for an hour at a time during each half day. Provide a constant supply of fresh drinking water in clean chick fountains. Place hard insoluble grit or fine gravel in pans or hoppers separate from the feed. In addition to the dry mash a little cracked wheat may be fed at three weeks, and a little whole wheat after four weeks.

	Chick Starter No. 1 lbs.
Coursely Ground Wheat	30.0
Coursely Ground Oat Grouts	18.0
Medium Ground Barley	15.0
Finely Ground Oats	10.0
Wheat Bran	5.0
Meat Meal (60% Protein)	5.0
Fish Meal (67% Protein)	5.0
Milk Powder	3.0
Alfalfa Leaf Meal	5.0
Linseed Oil Cake Meal	1.5
Fine Oyster Shell or Limestone	1.5
Fine Iodized Salt	0.5
Fish Oil (200 D)	0.5
Manganese Sulphate (see below)	
	100.0

Feeding of growers

After the chicks are five to six weeks old they may be changed gradually to a coarser and cheaper mixture, e.g. ½ starter mash and ½ growing mash during the sixth and seventh week.

Growing Mash (in self-feeders)		
Ground Wheat	100 lbs.	Oyster shell and gravel, or limetone grit, in separate pans or feeders
Ground Barley	100 lbs.	
Ground Oats	75 lbs.	

Meat Meal	25 lbs.	
Fine Salt	3 lbs.	

Whole Grains (in self-feeders)

(Whole Wheat, Whole Oats, and other available Grains)

To promote the growth of late hatched pullets or of market poultry, give milk to drink as well as water. Milk may be used to replace the meat meal in the grower mash, if a separate hopper of bone meal is provided. Reduce or omit meat meal or milk if pullets are maturing too rapidly. If pasture is dried up or lacking, add 20 pounds of alfalfa meal and 2 pound of 200 D fish oil to the above growing mash.

Feeding of layers

Egg production, to be profitable, must continue at a reasonably high level through most of the year. Hens turned loose to forage in the spring and only grain fed, soon lay themselves thin, cease laying, moult and spend the summer and fall growing new feathers; moreover any eggs they lay are likely to be of "barnyard" quality and low grade. Laying hens require some form of protein supplement in addition to grain and chop. Similarly they need more vitamin and mineral materials than grains contain. Most poultry raisers recognize the importance of the diet in winter egg production. Generous summer feeding is equally important, since profit depends upon a steady production of eggs. A farm supplied with wheat and coarse grains, well-cured alfalfa or clover hay, and plenty of skim milk, provides practically everything required in the laying diet. Some form of Vitamin D supplement is needed for winter or indoor conditions. Hens aren't likely to drink enough milk in cold weather to supply their protein requirement; this may be met by the use of laying concentrates or balancers, meat meal, fish meal, cooked meat or fish, etc. In any case the flock should have an ample daily feeding of alfalfa or clover leaves, or else limited pasture. Laying hens require a constant supply of oyster shells or limestone grit; also bone meal in a separate hopper when milk is used as the main protein supplement. Provide fresh clean drinking water at all times, or as soon as the daily amount of milk is consumed.

RATIONS FOR LAYING AND BREEDING FLOCKS

	Breeder or Winter Laying 1. Milk to drink	Summer Laying Ration 2. Milk to drink	**Breeder Rations (Dec. - June)** (Using commercial breeder concentrate mixture)		**Winter Laying Rations** (Using commercial laying concentrate mixture)	
			3. Breeder Concentrate	4. Milk plus concentrate	5. Laying Concentrate	6. Milk plus Concentrate
I. DRY MASH MIXTURE (in self feeder)						
Ground Wheat	100 lbs.	100 lbs.	Concentrate with chop, per manufacturer's instructions	Reduce amount of concentrate to ½ mfgr.'s instructions	Concentrate with chop, per manufacturer's instructions	Reduce amount of concentrate to ½ mfgr.'s instructions
Ground Barley	100 lbs.	100 lbs.				
Ground Oats	75 lbs.	75 lbs.				
Meal Meal (50%)	10 lbs.	15 lbs.	----	----	----	----
Fish Meal	10 lbs.	----	----	----	----	----
Fine Salt	3 lbs.	3 lbs.	----	½% of mash	----	½% of mash
II. SUPPLEMENTS **(fed daily) (per 100 hens)**						
Alfalfa or Clover	Daily	Daily*	Daily	Daily	Daily	Daily
Skim-milk to drink	2 gals.	3 gals.	----	2 gals.	----	2 gals.
Fish Oil (200	1/3 cup	2 tblsp.*	2 tblsp.	¼ cup	2 tblsp*.	¼ cup*

D)						
III. WHOLE GRAIN (fed daily)						
100 Pullets (A.M.)	4 lbs.	----	4 lbs.	4 lbs.	4 lbs.	4 lbs.
100 Pullets (P.M.)	10 lbs.	10 lbs.	10 lbs.	10 lbs.	10 lbs.	10 lbs.
100 Yearlings (P.M.)	10 lbs	10 lbs.	10 lbs.	10 lbs.	10 lbs.	10 lbs.
*Omit in summer if birds have pasture (also omit morning whole grain in summer to encourage dry mash consumption).						
IV. MINERALS: A constant supply of oyster shell and gravel, or limestone grit, in separate hoppers. Also - for rations 1, 2, 4 and 6 above - place bone meal in a separate hopper.						
V. MOIST MASH (if fed): For 100 hens take 4 pounds of dry mash and moisten to a crumbly state with milk or water, first adding the fish oil to the liquid. Once started, it is advisable to continue feeding daily, in addition to the dry mash, throughout the laying season. (If moist mash is not fed, mix the fish oil with the whole grain and feed in a trough.)						
WHOLE GRAIN: Various mixtures such as 3 bu. wheat, 2 bu. oats, 1 bu. barley may be used.						
GREEN FEEDS: Well-cured alfalfa or clover leaves or chaff are excellent. Carrots, cabbage, beets or mangels may be fed in moderation (not over 5 lbs. per day for 100 breeding hens).						

Pullets should be housed separately from yearling or older birds. Keep pullets gaining in body weight each month of the fall and until about March. If they lose weight, neck moult or possibly a complete moult will follow, with consequent loss in egg production. To maintain body weight, feed in troughs all the whole grain the birds will eat in the evening, and about half that amount the next morning in dry litter or troughs; keep fresh dry laying mash before them, daily; and if necessary feed moist mash at noon. Excessively high production from pullets in fall and winter may lead to numerous double-yolked and shell-less eggs, feather-picking, prolapse, and cannibalism, as well as loss in weight and moulting. If production reaches 60 per cent, feed more whole oats, putting the oats in a trough before the birds all the time, in addition to the regular feed.

Feeding of breeding stock

A ration suitable for egg production is not necessarily satisfactory for the breeding flock. To obtain high hatchability, the riboflavin content of the feed must be greatly increased. This is provided in milk, or specially prepared commercial breeder concentrates or balancers. Extra Vitamin D is required over the amount in laying rations. See Ration No. 1, 3 and 4 (page 29) for suggested amounts of milk, fish, oil, etc. Note that the daily feeding of clover or alfalfa leaves is recommended in all cases. Any change in feed must be made gradually. The flock should receive the breeder diet a full six weeks or two months prior to saving the first eggs for hatching.

Feeding of broilers

Fattening of poultry is likely to be disappointing unless the birds are in good flesh to begin with. Flesh is produced during the growing season, and if lost through improper or insufficient feeding it is difficult to regain. This means that market poultry should be well fed all summer. The cockerels might well be enclosed in a large yard to separate them from the pullets. Give the cockerels one feed of moistened mash daily in addition to the growing mash and whole grain. Provide plenty of green or succulent feed during the growing season; also plenty of milk or water to drink.

Allow two to three weeks for the final fattening period. Wheat, oats and barely are satisfactory feeds for fattening.

	Ration No. 1	Ration No. 2	Ration No. 3
Ground Wheat	50 lbs.	100 lbs.	50 lbs.
Ground Oats	100 lbs.	100 lbs.	50 lbs.
Ground Barley	50 lbs.	100 lbs.	100 lbs.
Fine Salt	2 lbs.	3 lbs.	2 lbs.

Grind all the grains as finely as possible. Use No. 3 C.W. oats and barley; if lower grade sift out hulls.

For crate-fattening, mix mash with skim-milk or buttermilk to make a batter that will pour nicely. If milk is not available, add 7 pounds meat meal to each 100 pounds of grain and use water to make the batter. Feed lightly at the start, then all the birds will eat twice a day. Give water to drink after each feeding. For pen fattening feed wet mash two or three times daily. Boiled potatoes may be added to the wet mash. The liberal use of skim-milk or buttermilk in fattening rations will tend to produce chickens that can be classed as "milk-fed". Whether fattening in crates or pens, allow twenty minutes for wet mash feeding, and do not leave any in the troughs from one meal to the next.

Unit - 12

Feed Processing, Mixing and Storage

Feed processing:

Various steps involved in feed compounding

- Selection of locally available ingredients based on price and nutrient density
- Quality check of raw materials
- Formulation of balanced ration
- Weighing the ingredients according to formulation
- Processing such as Grinding, flaking, etc
- Uniform mixing
- Quality check of processed feed
- Packing and storage of mash feed
- Further processing for preparation of other forms of feed (pelletting, crumbling etc.)

Purposes of feed processing

- To alter the physical form or particle size
- To prevent spoilage
- To isolate specific parts of a seed or plant
- To improve palatability
- To inactivate toxins or anti nutritional factors

Grinding:

- Grinding is the first and important processing method

Advantages of grinding

- The particle size reduction, increases the surface area exposed to enzymes, resulting in better digestion.
- Grinding helps mixing of ingredients and prevents segregation.
- Pelleting can be done only if the feed is ground uniformly.
- Selectivity of feeds is not possible by the animal and so the nutrient intake will the optimum.

- Palatability is improved
- Feed intake is increased
- Improves digestibility
- Improves growth rate
- Improves feed efficiency
- Consumers like uniformly ground feed
- Grinding of some ingredients contributes to ease to handling.

Types of grinding

- Coarse - sieve size 3/8, 4 and 8
- Medium - sieve size 14 and 28
- Fine - sieve size 48 and 100.

Types of mills

- Hammer mill – Impaction
- Attrition or Buer mill – cutting, crushing and shearing
- Roller mill – cutting, crushing and shearing

Hammer mill

- It is commonly used for particle size reduction of
    - Grains
    - Oil cakes
    - Forages

Unit - 13

Feed Formulation

A least cost ration incorporates all the available feedstuffs having good nutritive value and being available at a reasonable low cost. It can also be defined as an economic ration for animal production (dairy, beef, sheep, goats, poultry etc.) that provides nutrients in balanced proportion with lowest possible cost per kg or 100 kg. It is the ration containing all essential nutrients that are needed to meet the requirements of the animal (growth, maintenance, production, reproduction, work etc.) without affecting quality and with least cost.

Aim

- To minimize the cost of ration while meeting the nutrient requirements of animals without affecting their productivity.

Advantages

- Incorporation of non-conventional feedstuffs is easy.
- The speed and accuracy of the linear programming by computer saves time and labour.
- As the program is flexible, inclusion of feed ingredients as per availability and quality can be made quickly.
- Gives more productive efficiency with least cost.
- Increases profitability of the livestock farm.
- Farmer can also afford to make use of it more effectively because it is cheaper in nature.

Procedure

- List all the available feeds, fodders and other available ingredients.
- Enlist the components of each ingredient.
- Feed the computer with the cost of all available feed ingredients.
- Give instructions to the computer for the type of ration desired depending upon the requirements of animal (growth, maintenance, production, reproduction, work or starter, grower, layer etc; high energy, high protein, low energy, low

protein etc.)

- Give instructions to the computer regarding the amount of feed ingredients (for example say DM of 20 kg or DCP of 1.5 kg). Similarly, amount of certain feed ingredients in the ration can be fixed like fish meal (say 10 %) and mineral mixture (say 2 %).
- Now, the computer will take the least cost feed ingredients for formulating least cost ration.
- It is a linear program based model that includes the following stepwise approach: *i e. Proximate values (DM and nutritive value i.e. CP / DCP and TDN / ME).*

Limitations of computer based model

- Certain constraints need to be imposed on ingredients (maximum and minimum levels) or otherwise, it may take all low cost ingredients with poor nutritive value. Such a ration would not result in high milk production at least cost and hence, milk production may get adversely affected.
- Computer cannot encounter the toxic material in the ingredients.
- Computer will not count the additive effect of feeds.
- Computer cannot judge the digestibility and palatability of ingredients. It may be a least cost ration, but with poor palatability.
- Needs skill and good programming.

Example

- Formulate a ration for a buffalo weighing 500 kg yielding 10 kg of milk/day with 7 % butterfat and in Generally, rations are first formulated for one nutrient (say DCP) and then, the other nutrients (say TDN) are checked to see whether the feedstuffs used will meet the requirement or whether alternative feeds need to be included in the ration.

Feedstuff	DM	DCP	TDN
NB-21 fodder	25	1	>16
Paddy straw	90	0	40
Concentrate mixture	90	16	70

Solution

1. Calculation of nutrient requirements of the animal

Requirements	DM(kg)	DCP(kg)	TDN (kg)
For maintenance	12.5 - 15.0	0.30	3.70
For production (10kg with 7% fat)	-	0.63	4.60
Growth allowance (20 % - 1st lactation)	-	0.06	0.74
Total requirements		0.99	9.04

2. Finding out the amount of nutrients supplied by green and dry fodder

Feedstuff	Amount on	DCP(kg)	TDN (kg)
	Fresh basis	Dry basis	
NB-21 fodder	20	5.0	0.2
Paddy straw	6	5.4	0.0
Total quantity	26	10.4	0.2

3. Balance of nutrients to be supplied through concentrate mixture

	DM(kg)	DCP (kg)	TDN (kg)
Total requirement	15.0	0.99	9.04
Green & dry fodder	10.4	0.20	5.60
To be supplied through conc.	4.60	0.79	3.44

4. Amount of concentrate mixture required to meet the DCP requirement

Amount of DCP to be supplied thru concentrates = 0.79 kg

Amount of DCP present in the concentrate mix = 16 %

$$\text{No. of kg of concentrate mixture} = \frac{0.79}{16} \times 100 = 4.9375 \text{ kg.}$$

5. Amount of TDN supplied through concentrate mixture

Amount of TDN present in the concentrate mix = 70 %

Amount of concentrate mixture to be offered = 4.9375 kg

$$\text{Amount of TDN supplied through concentrate mix} = \frac{4.9375}{100} \times 70 = 3.456 \text{ kg}$$

6. Verification

Nutrients supplied through	DM (kg)	DCP (kg)	TDN (kg)
NB-21 green fodder	5.00	0.20	3.200
Paddy straw	5.40	0.00	2.400
Concentrate mixture	4.44	0.79	3.456
Total	14.84	0.99	9.056
Actual requirement	12.5 – 15.0	0.99	9.040

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