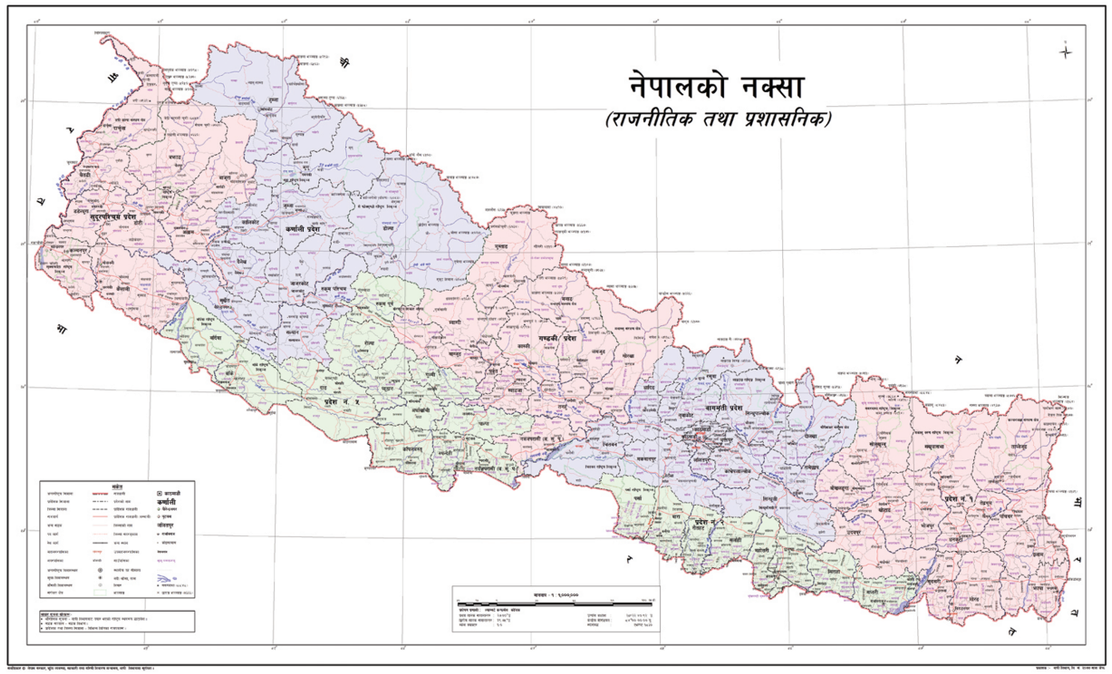

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Animal Science

Animal Nutrition and Fodder Production

9

Feedback Copy

Technical and Vocational Stream
Learning Resource Material

Animal Nutrition and Fodder Production

(Grade 9)

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, Dr. Tankanath Sharma, Jayakrishna Poudel, RustamThapa, Dr. Suraj Gurung, Dr. Milan Kumar Sharma, Dr. Labakumar Jha, Rabin Rai, Dr. Ganesh Gautam is highly acknowledged. The book is written by Dr. Hari prasad panta, Dr. Rajendra Prasad Yadav and Dr. Binod Kumar Yadav 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 in this form.

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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Ministry of Education, Science and Technology
Curriculum Development Centre

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Unit 1
Concept of Animal Nutrition and Feed Stuffs

Learning Outcomes

On completion of this chapter, the students will be able to:

- Enlist different nutritional terminologies
- Identify different quality of ration for different stages of animals.
- Separate carbohydrate, fat & proteinous nutrient.
- Know Neapales animal nutritional status, pasture area, distribution of agriculture land, pasture land & distribution of pasture land by region.

1.1 Animal Nutrition and its scope and importance

Nutrients are the chemical substances obtained from feed that allow proper functioning of the system that is carbohydrate, protein, fat, minerals, vitamins, water and feed additives. Animal body needs energy for proper functioning which it gets from the oxidation of food materials. Animal requires energy for its various body functions like rumination, digestion, absorption, circulation excretion, respiration even under resting condition. Therefore animals need good quality ration for maintenance, growth, production, reproduction, and work etc. The ration must have all essential nutrients (protein, carbohydrate, fats, minerals, vitamins and water) not only in sufficient quantity but also in good quality which an animal needs time to time for its specific requirement in question. Amount of food given to an animal at a time or in portion at interval in 24 hours is called ration.

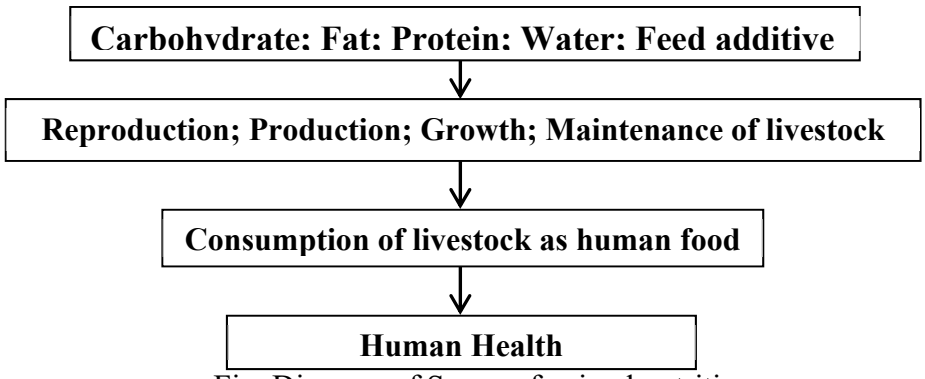


Fig. Diagram of Scope of animal nutrition

Importance of animal nutrition

Nutrient

- Provides essential nutrients specifically the trace minerals and vitamins necessary for well being and life.

Maintenance

- Supply energy to give heat for maintaining normal body temperature.
- Supply energy for normal functioning of liver, heart, lungs and others parts of the body.

Production

- For wool production e.g sheep need more protein for wool growth.
- For milk production e.g. all nutrient of milk comes from blood , which should be replace by food ingredients.
- For egg and meat production in poultry.
- Pig , goat and sheep for fattening for meat production
- Besides maintaining working animals need extra allowance of nutrient for work.

Reproduction

- Food requirement for development of foetus during pregnancy.
- For breeding animal to maintain good health and sex- libido bull in service.

Healing

- Repair daily wear and tear of body tissues.
- Make up for the loss of minerals from the body

Economic

- Good quality nutrient increase production of livestock which increase farmer economy.

Growth

- Good quality nutrient required for growth of growing animals.

1.2 Some terminologies of animal nutrition

Abomasum: True stomach of ruminant animals and fourth part of compound stomach of ruminants.

Absorption: The uptake of simple substances after digestion in digestive system to blood.

Acetic acid: One of the main volatile fatty acids produced in the rumen by fermentation of carbohydrates (CH_3COOH).

Abdomen : The belly that contains most of the digestive organs.

Absorbent: Is substance which takes up liquid.

Acetonemia: is called ketosis or chronic milk fever, occurs due to metabolic disorder in cattle and is characterised by abnormal amount of ketone bodies like acetone, acetoacetic acid and beta hydroxyl butyric acid in blood, urine and milk. It imparts a peculiar flavour in milk. It is associated with poor quality ration. Cows affected by it has loss of appetite, become constipacted, decreased production, listless and emaciated.

Acidosis: Is known as pregnancy disease. It is also a metabolic disorder of decreased alkanity of blood and tissues due to increased acids in system.

Adsorption: Is the adhesion of thin layer of gases, liquids to the surface of a solid substance e.g. amonia on boric acid.

Air: Fresh air has 78.04% nitrogen, 20.96% oxygen, 0.04% carbondioxide, 0.96% other gases and water vapours.

Alum: The aluminium potassium sulphate is used as local astringent to arrest haemorrhages from small wounds.

Antacid: Which counteracts acidity like sodium bicarbonate.

Antineurotic vitamin: is B_1 (Thiamine hydrochloride).

Acid base balance: To maintain proper ratio of acids and bases in blood to maintain proper pH in the system.

ADF: Is the acid detergent fibre used as a measure of cellulose+lignin in feeds in Van soest system of analysis.

Acid insoluble ash: Is the protion of ash not soluble in HCI mainly represents silica content in feeds.

Adenine: A derivative of purine base and is a component of nucleic acids and part of the molecule of NAD, NADP, FAD and adenosine.

Adenosine: The nucleotide of adenine which is a part of RNA & DNA.

ADP: The adenosine diphosphate-a nucleotide cofactor made up of adenosine and two phosphate groups. It is involved in energy transfer in biological reactions.

Adlibitum feeding: Feeding system in which animals eat free of choice without any restriction.

Adultrant: A substance added to another to reduce its purity.

Aflatoxin: The toxic material produced by fungi *Aspergillus flavous* in feeds during storage. These are four types B_1, B_2 G_1 and G_2 but that found in milk is known M_1

Albumin: Simple water soluble proteins get coagulated on heating.

Alfa: The lucerne- a leguminous nutritious fodder.

Alfa-alfa meal: Lucerne hay free from stem.

Alilmentry Canal: The digestive tract from mouth to anus.

Alkali: Substance which neutralizes acid to form a salt.

Ambient temperature: Surrounding temperature.

Amides: A group of organic compounds with $CONH_2$ group.

Amino acids: Subunits which polymerise to form protein and has carbroxyl and amino group. These are classified into essential and non essential group.

Ammonia: A colourless pungent alkaline gas (NH_3).

Amylase: An enzyme acts on amylum (starch) present in saliva and pancreas of monogastric animals.

Anabolism: Metabolic process in which complex compounds are made from simple materials in the tissue.

Anaemia: The deficiency of heamoglobin in blood. It may be nutritional, megaloblastic, macrocytic and hypochromic type.

Antibiotics: A group of drug used to kill or inhibit and growth of other micro-

organisms.

Ascorbic acid: Is a water soluble vitamin C found in citrus or green leafy vegetables, prevents scurvy.

Assimilation: Utilzation of nutritive material into living tissue.

Balance ration: The food which provides the entire essential nutrient (protein, fat, carbohydrate, minerals & vitamins) in such a proportion & quantities that are needed for the proper nourishment of the animals & to meet the requirement of animals in question (growth, maintenance, production, reproduction, work etc) in 24 hrs.

Brown hay: Sometime because of very unfavorable weather condition, good hay cannot be obtained by the ordinary method of curing. Under such circumstances, hay is allowed to dry until about 50% moisture has been removed and then it is packed in stack or piles. Fermentation take place and the hay may become very hot; the temperature should not be allowed to exceed 80 c. There are great losses in the nutritive value on account of fermentation. These losses range from 30-40%. Such hay are often palatable.

Basal Metabolism: Amount of chemical energy expanded for body maintenance measured under standard condition. It refers to physio-chemical changes of animal in a resting condition.

Bases: Substance which combines with acids to form salts.

Benzene: The aromatic hydrocabon (C_6 H_6) used as solvent.

Bhoosa: The chaffed straw-a by product of cereal (wheat) crop contains DCP-nil and TDN 40%.

Biotin: The water soluble Vitamin of 'B' group. The deficiency of it causes loss of hair, poor growth, dermatitis etc. It functions as conenzyme.

Blood meal: Dried and ground meal of blood containing 80 to 85% CP used in animal feeds.

Bolus: Round mass of feed passing through oesophagus in deglutition and regugitation.

Bomb Calorimeter: An instrument used to measure gross energy in feed.

Bone meal: The ground animal bones used animal feed as supplement of calcium (34%) and phosphorus (16%). Unsterilised bone meal may caused Anthrax and Salmonellosis.

Boric acid: A white powder or weak acid used for tapping ammonia in nitrogen estimation (H_3BO_3).

Bran: The outer covering coarse coat (pericarp) or husk of cereals containing 12% DCP and 67% TDN. It is rich in phosphorus and acts as a laxative feed.

Browsing: Feeding on small stems, leaves, flowers, fruits of shrubs and trees.

Buffer: The chemicals responsible for buffering action i.e. ability to resist changes in pH on addition of acid or base.

Butyric acid: Volatile fatty acid produced in rumen due to microbial degradation of feeds.

By pass protein: Dietary protein escaping rumen fermentation and passing to lower part of gastro-intestinal tract. It could be increased by treatment of proteinous feeds with formaldehyde or heat.

Cake: Compressed oil seeds into flat slabs to remove oil; rich in protein used as feed for cattle.

Calciferol: Known for vitamin D_2

Calcification: Condition to tissue in which there is deposition of calcium carbonate as a sequel to inflammatory condition.

Calorific value: is the quantity of heat produced when a known weight of the fuel is completely burnt. It is measured in calories per gm.

Calorimetry: Technique of measuring heat.

Calorimeter: An instrument for measuring heat.

Cane sugar: is sucrose.

Carbohydrates: Organic material containing chemically CHO, which includes

starch, sugars, celluloses and gums. These are formed in plants by photosynthesis and used as ready energy source in feed.

Carotene: A yellow compound of Carbon and hydrogen occurs in plants, fruits etc. is precursor of Vitamin A. Alfa, Beta and Gamma carotene may be converted into Vitamin A in the body.

Carotenoids: Carotene like yellow pigments or lipochromes deposited in animal tissue through food.

Casein: One of the group of several phosphoproteins, is a main protein in milk.

Catabolism: Any destructive process by which complex substances reconverted by living cells into more simple materials.

Caecum: An intestinal pouch located at the junction of the large and small intestine.

Cereals: The grains rich in starch like Barley, Maize, Oats, Rye, Wheat used in cattle feed. These aslo contain valuable protein and vitamins.

Chaffing: Chopping up of fodder plants into bits.

Chemical analysis: is the determination of composition of a substance may be qualitative or quantitative, e.g. proximate analysis of feed, Van-Soest's method of analysis of feed.

Chewing of cub: An activity of ruminants involving mastication for second time of food which has been previously swallowed into rumen.

Cholestrol: A white, fat soluble substance found in animal fats, oils, bile, blood, liver etc. It is important in metabolism and is a precursor of certain hormones.

Choline: Chemically is trimethyl ammonium hydroxide. It is colourless, viscid liquid and a constituent of lecithin. It is needed for normal growth and hence called postulated vitamin of 'B' group.

Chyme: A thick liquid of partially digested food. It passes from stomach to intestine.

Coefficient of digestibility (CD): Digestibility of a certain feed in percent.

$$CD = \frac{\text{Amount consumed – amount in faeces}}{\text{Amount consumed}} \times 100$$

Colic: A digestive disturbance causing pain in abdomen.

Colon: The greater part of the large intestine from caecum to the rectum.

Colostrum: First milk obtained after parturition, upto 3 to 4 days. It contains antibodies necessary for young calves to develop immunity.

Compaction: Closely packed feed in the stomach and intestine of an animal causing constipation.

Complete ration: Mixture of forages and grains in a food.

Constipation: The retention of faeces in the intestines because of difficult evacuation, due to feeding of coarse dry or indigestible feed or over eating.

Creep feeding: A system of feeding young animals before weaning. It is designed to exclude mature animals.

Crude Fibre: The part of feed containing cellulose, hemicellulose, lignin and other poly saccharides that serve as protective part of plant.

Crude protein (CP): is the total protein obtained by multiplying the Nitrogen percent with factor 6.25.

Cystine: One of the non essential amino acids with sulphur.

Cysteine: Sulphur containing essential amino acid.

Cynocobalamine: Vitamin B_{12}, synthesised by rumen microbes provided the dietary cobalt is adequate.

Curled toe: A paralysis caused by peripheral nerve degeneration due to lack of vitamin B_2 (Riboflavin).

Degradation: Conversion of complex compounds into simpler compounds.

Defaunation: Removal of protozoa from rumen; can be done drenching the starved animal with copper sulphate or by giving some detergents.

Dehulling: Removal of outer covering from grains.

Dehydration: The removal of water from a substance.

Dehydrogenation: Removal of hydrogen.

Dehydrogenase: An oxido reductase enzyme which catalyses the oxidation (removal of hydrogen atom) from a substrate.

D**.N.A (Deoxyribonudeic acid):** Nucleotides containing deoxyribose part of chromosomal structure.

Desiccator: A glass apparatus used to store the anhydrous samples. It contains calcium chloride to absorb moisture.

Diet: Food consumed by animal at a time to satisfy its appetite.

Digestion: The process of breakdown of feed into simpler substances for absorption and assimilation for transformation of food into living matter.

Digestible Crude Protein (DCP): It is common way of expressing the protein values and requirement for the ruminants; obtained by multiplying digestibility coefficient of protein with - CP in a feed (also known DP).

Digestible energy (DE) : Protion of gross energy of a feed digested and absorbed into body of an animals.

Dipeptide: A peptide which gives two amino acids on hydrolysis.

Disaccharide: Sugar consisting of two molecules of hexoses; e.g. maltose, sucrose, lactose.

Distilled water: Purified water obtained by vapourising and condensation.

Drought: Continuous dry weather.

Dry matter: Feed without water, containing carbohydrates (crude fiber+nitrogen free extract), crude protein, crude fat and ash.

Dyspepsia: is the impaired function of digestion.

Edible: Thing suitable for eating.

Embden Myerhof Pathway (EMP): Glycolytic pathway.

Energy balance (EB): The relation of the gross energy consumed to the energy

output.

EB = GE – FE – GPD – HP.

Ensilage: A green forage preserved by fermentation in a silo. The process of making silage is called ensiling.

Enzyme: An organic catalyst produced within an organism. It increaes the rate of reaction without altering the equilibrium constant for that reaction. Enzymes are highly specific in respect of nature of the reaction catalysed and substrates utlized.

Epsom Salt ($Mg\ SO_4$) : used as purgative.

Essential amino acids: That Amino Acid which are not synthesis in animal body. E.g. methionin, lysine, tryptophan etc

Essential fatty adds: Dietary essential fatty acids like linoleic ($C17\ H_{31}\ COOH$), linolenic, ($C_{17}\ H_{29}\ COOH$) and arachidonic ($C_{19}\ H_{31}\ COOH$) acids, which are unsaturated and required to cure scaly skin disease in animals.

Ether extract: It is a measure of lipid content of feeds which contains plants pigments (chlorophyll, xanthophyll, carotene) fats, oils, fatty acids, waxes.

Faecal energy (FE): The food energy lost through faeces.

Feed: A single article of food which consume by animal.

Feed block: A block of food stuffs left on pastures specially in hilly area for sheep to lick at will. It contains carbohydrate, protein, urea, minerals, vitamins.

Feed conversion/feed effeciency (FCR/FER): The unit of feed consumed per unit of gain in weight.

Feed-Supplement: A feed used with another to improve the nutrient balance.

Feeding Standards: Tables showing the amount of nutrients required for various needs of animals.

Fish meal: A dreid and partially ground residue from fish excluding the edible part. It is mainly fed to pigs and poultry.

Fish oil: Oil extracted from undecompsed dried fish, source of vitamin A & D.

Fistula: PVC like device with different diameter placed at rumen or stomach to draw samples from such organs for experimental purposes.

Flour: Soft finely ground level of the grain e.g. Sorghum grain flour CF <1%, 16% protein

F.M.N.: Flavomono nucleotide; The proteins containing riboflavin as prosthetic group in the form of phosphate

Fodder: Green plants eaten by animals, especially used to the grass collected from trees.

Forage: Green plant eaten by animals especially collected from ground.

Folic acid (folacin): A water soluble Vitamin 'B' whose coenzyme is tetrahydra folic acid.

Food: Mixture of two or more feeds consume by human

Fructose: A hexose monosaccharide found in ripe fruit and honey – fruit sugar.

Gall bladder: A pouch like sac in which bile produced by liver is stored until it is required in the process of digestion.

Gall Stones: Soft brownish bodies consisting of cholesterol, bile pigment and lime. These often cause jaundice.

Glucocorticoid: Steriod hormone from the adrenal cortex which stimulates formation of carbohydrate by breaking down fat and protein (Gluconeogenesis).

Glucogenesis: The process of glucogen formation from glucose.

Glycerol (Glycerine): A trihydric alcohol.

Glycogenesis: Formation of glycogen from carbohydrate materials.

Glycogenolysis: Conversion of glycogen to glucose.

Glycolysis: Conversion of carbohydrate to simpler compounds.

Gossypin: Toxic protein of cotton seed.

Gossypol: A yellow toxic phenolic pigment found in cottonseed (upto 2.4% on dm basis).

Grass Tetany/Grass Staggers (Hypomagnesemia): A condition of ruminant characterized by a low level of magnesium in blood. It causes nervousness and twitching of muscles, rapid breathing, staggering and fall (Hypomagnesemic tetany).

Gut: Part of alimentary canal having primary digestive function.

Gypsum: A source of calcium (23%) and used as in animal feed ($CaSO_4$ $2H_2O$)

Haemoglobinometer: An apparatus to measure haemoglobin in blood.

Haemoglobin: A complex proteinous compound containing iron and gives the red colour to the red blood corpuscles. It absorbs oxygen from the air in lungs and transports oxygen to the tissues in the body.

Hay: Green forages cut, dried to the extent that mositure remains below 18% and conserved.

Haylage: Haylage is low moister silage (40 to 45%moisture) and is made from grass/or legume that is wilted to 40-45%moisture content before ensiling.

Haysel: Hay making season.

Herbage: Plants which have slender stem and leaves are used for feed.

Hemicellulose: Complex carbohydrates more digestible than cellulose.

Holocellulose: Water isoluble mixture of polysaccharides obtained after removal of lignin from plant cell wall.

Hormones: Chemical substance secreted by endocrine glands in small amount and carried by blood stream to target organs to evoke specific physiological response.

Honey Comb: Second part of ruminant's stomach called reticulum.

Hopper: Container for feed.

Hydrocarbon: An organic compound made of carbon & hydrogen only.

Hydrocyanic acid (HCN), a poison, also called prussic acid, produced as a glucoside by several plant species; e.g. sorghum, sudan grass.

Hydrolysis: Chemical decomposition in which a compound changed into other

compound by taking up element of water.

Hydrometer: An instrument for determining the specific gravity of liquid/water.

Hygiene: Measures to conserve health and to prevent preventable disease.

Hyperacidity: A state of excessive acidity.

Hyperglycemia: Condition of an increase on blood sugar content of the blood.

Hypocalcaemia (milk fever): A metabolic disease occurs in heavy milk producing animal after parturition, due to calcium deficiency.

Immiscible: Not mixable with other liquied.

Indigestion: Lack of digestion.

Lecithins: Lipids containing phosphoric acid and cholin in addition to glycerol and fatty acids.

Legume: Plants of leguminosae family which have Rhizobium nitrogen fixing bacteria in nodules of their roots. Such plants are succulent nutritious and palatable.

Leucline: An essential monoamino monocarboxylic amino acid.

Laxative: A substance which enhances the passing of food through gut.

Leaf protein: Protein made from leaves by pressing, and extracting the juice and then coagulating it by heating.

Lignins: An indigestible compound which is found along with cellulose on the cell wall. These are believed to have chain like structure containing basic unit phenylpropane.

Limestone: calcium carbonate, source of calcium in livestock ration.

Maize gluten meal: It is dried residue from maize after removal of the larger part of starch and bran by process of wet milling. It contains 60% crude protein.

Malformation: An abnormal development.

Malnutrition: A state of inadequate nutrition.

Maltase: An enzyme which acts maltose to produce glucose.

Mash: A mixture of feeds in crushed state.

Mastication: The proceechewing of food.

M.E.: Metabolizable energy. It is digestible energy minus the energy loss in urine and methane.

Manganese (Mn). An essential trace element which activates a number of phosphate transferases and decarboxylases connected with Kreb's cycle.

Meadow grass (Poa Spp): A weed of temperate climate.

Messanger (RNA): Ribonucleic acid formed on a template of deoxy ribose nucleic acid in the nucleus which moves to the ribosomes and specifies sequence whereby amino acids are linked together to form protein.

Metabolic size: The size of an animal is proportional to its metabolic rate. Metabolic size = (Body weight) 0.75.

Metabolism: The sum of the chemical changes (anabolic & catabolic) occur in the body as food is asimilated, energy is produced broken down body tissue are repaired.

Metabolic water: The water produced inside the body by metabolic processes of tissues mainly by oxidation of nutrient which comprises to 5-10% of total intake.

e.g. One molecules of glucose on oxidation gives six molecules of water.

$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$

Manometer: Device used to measure gas pressure.

Molasses: A thick treacle produced as by product of sugar refining. It contains about 25% water and rich in soluble sugars, used to improve palatabiltiy of feed stuffs of poor quality. It is also laxative.

Nucleic acid: Polynucleotide polymer consisting of purine or pyrimidine as bases with sugar like ribose or deoxy ribose and phosphoric acid. They play a important role in synthesis of proteins in animals.

Nutrient: Group of food constituents of the same general composition that aids in the support of animals life. e.g. water, energy, protein ,minerals & vitamins

Net energy: The net reminder of useful energy after all the losses accounted for faeces, urine, methane & heat increment are subtracted

Net energy = Metabolizable energy – thermic energy (heat increment)

Non-conventional feed stuff in livestock feeding: those feeding materials which are not traditionally used as animals feed but which inherit potential for use. These materials either due to lack of production, processing technology, presence of toxic principles or lack of appropriate feed technology are by & large considered being waste materials. E.g. salseed meal,bagasses, animal fat, animal manure, biogas slurry etc

Nitrotove ratio (NR):

$$NR = \frac{TDN - DCP}{DCP} \qquad \text{or, } NR = \frac{\text{Dig. Carbo.} + \text{Dig. fat} \times 2.25}{DCP}$$

Oat (*Avena sativa*): Cereal grain containing 12% CP and 70% TDN.

Oat meal: Feed stuffs containing ground oats with husks.

Oat hay: Dry green oat containing 8% CP.

Oesophagus: Tube like structure which passes food from mouth to stomach.

Omasum: Third compartment of the ruminant stomach, also called manyplies.

Organic matter: All nutrients except ash present in feed collectively known as organic matter, or, organic matter = Dry matter – Ash.

Oesteomalacia: A condition of softening of bone, pain, tenderness, muscular weakness.

Oxaloacetate: An intermediate compound formed from sugars essential for the oxidation of carbohydrate, fat and proteins for energy.

Oxidation: A chemcial process involving gain of oxygen, loss of hydrogen. Burning is also called oxidation.

Paddock grazing: Pasture divided into paddocks and then grazing cattle in rotational manner.

Parakeratosis: The reddening of skin followed by eruptions which makes scaly

skin due to deficiency of Vitamin A. and essential fatty acids.

Pellagera: A disease characterised by red tongue, ulcers in mouth, dermatitis, loss of appetite, nausea etc. occurs due to deficiency of nicotinic acid/niacin.

Perosis: The diseases of chicken due to deficiency of manganese. It is responsible for crippling diseases of chicken known as perosis or slipped tendon.

Phosphatase test: Test used to determine efficiency of pasteurization. The alkaline phosphatase becomes inactivated by proper pasteurization.

Piperazine: The drug used for removal of round worms.

Polyneuritis: An inflammationn of nerves in different parts of body at the same time.

Polysaccharides: Carbohydrates having more than three monosaccharide units like starch ,cellulose, hemicellulose, glycogen.

Polyuria: Excessive excretion of urea

PPM: Part per million i.e. 1 mg in 1 kg or 1 litre.

PPB: Part per billion, i.e. 1 microgram per kg.

Ppt: Precipitate

Prehansion: Grasping and taking in of food to mouth.

Premix: A mixture of micro nutrients prepared separately with the intention to add it later in a larger bulk feed/ration.

Proximate analysis: Known as Weende Analysis (developed in 1885 at Weende Exp. Stn. in Germany) to determine gross composition of feed.

Production ration: Food given in excess of maintenance requirement, to produce milk, gain in weight etc.

Progesterone: Hormone secreted by corpus luteum of ovary to prepare uterus for maintaining pregnancy.

Proline: One of the non essential amino acids.

Protein: Complex organic compounds containing C, O, N. (approx. 16%), H and

also 'P' and S. These contain several amino acids in poly peptide chains in a complicated method.

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Gain in body weight (gm)}}{\text{Protein consumed (gm)}}$$

Rancidity: Hydrolytic or oxidative chemical changes in fat producing off smell (fish smell) due to spoilage of fat.

Rapeseed (*Brassica napus*): An oil seed known as mustard seed oil cake is used as feed for ruminant but not good feed for poultry as it contains glucosinolates.

Ration: Amount of food given to the animals at a time or in proportion at interval in 24hours is called ration.

Regurgitation: The process of gushing back the rumen content into mouth of ruminants for proper chewing.

Reticulum: The second stomach of ruminant which receives hards food material passed on from rumen. It is also called honey comb.

Riboflavin: Vitamin B_2, prevents curled toe in chicks. Deficiency causes cracking of skin and lesions.

Rhizobium: Symbiotic nitrogen fixing bacteria found in the nodules of roots of leguminous crops.

Ribonucleic add (RNA): Nucleotides containing ribose sugar units and phosphate group with an organic base adenine, guanine, cytosine attached to each sugar unit.

Rice bran: Seed coat and germ removed from rice grain in the manufacture of polished rice. It has 6% DCP and 52% TDN.

Rice husk: The outer covering of paddy grain obtained during milling of rice. It has 5% CP and 40% crude fibre.

Rice Polishing: A fine byproduct obtained during polishing of rice kernels, after removal of hulls and bran.

Rickets: A disease in young animals due to deficiency of Vitamin D in which bones become weak, develop swelling on joints and limb tends to bend. It may also be

due to lack of Ca & P.

Rotational Grazing: See paddock grazing; method of managing grassland in which successive plots are grazed in an alternate manner, followed by a rest period regrowth of grass.

Roughage: Pasture, silage, hay, straw/bhoosa, green, grasses used as forages for feeding animals. There have more than 18% crude fibre and low NFE (about 40%).

Rumen: Largest of four compartments in the adult ruminant, also called pauch. Its content is rumen liquour containing bacteria, protozoa and fungi, capable of digesting cellulose of crude fibre in feed.

Ruminant: Animals able to regurgitate previously eaten food for further chewing, eg. cow, buffalo, sheep, goat, camel.

Saflower seed cake (*Crthamus tinctorius*): It is not very platable but used for feeding livestock. Decorticated and solvent extracted cake contains CP – 34%, CF – 24%, E.E 1.5% and ash 1.5%.

Saliva: A clear somewhat viscid fluid containing mucus, minerals (chiefly $NaHCO_3$) in ruminants but has very little starch digesting enzyme in non ruminants saliva, secreted by salivary gland.

Salivary gland: The gland produce saliva which is situate in buccal cavity of animals.These consist of three pairs-one pair of parotids, found in front of each ear, a pair of submaxillary glands situated on each side of lower jaw and a pair of sublingual located under the tongue.

Salseed meal: A by product obtained after extraction of fat from sal (Shorea robusta) seeds. It contains 10 to 20% crude protein but not good for feeding because it has tannins.

Salt: Compound of base and acid, usually in feeding used for NaCl.

Saturated: Unable to hold in solution any more of chemical.

Scavengers: Animals feeding on garbage.

Scratch feeds: Coarsely ground grains or whole grains.

S.E.: Starch equivalent – related to Kellner's feeding standard measure of energy in a feed.

Sediment: Precipitate; impurities in milk.

Self fed: One of the systems of feeding whereby animals have free access to different components of ration.

Sesame (*Sesamum indicum*) seed meal: Dehulled expeller seed meal has CP–40%, C.F. 6% and E.E. 12%, It is rich in methionine, cysteine and tryptophan. Whole seeds are toxic as these centain oxalic acid and phytic acid.

Self feeder: Equipment designed to supply feed continuously so that animals may eat at will.

Silage: Green fodder preserved in silo by compressing it to exclude air and subjected to fermentation for development of adequate acidity (Lactic & acetic acid) for conservation.

Silica (SiO_2): Silicon dioxide, have no nutritional advantage. It is abundantly found in earth crust.

Sodium (Na): Metallic element and essential found in body fluid in animals. It is supplied through common salt (NaCl). Deficiency lowers the performance.

Soilage: Freshly cut green forage fed to animals.

Soiling: Harvesting of green fodders.

Sorghum: A tropical cereal. Its seed is used as feed for animals and green fodder in summer season (Kharif crop). Grain has 5% CP, 2.8% CF, 2% EE; 85% TDN. Green fodder has 1% DCP and 16% TDN.

Starvation: Deprival of food resulting in morbid effect.

Stomatitis: Inflammation of mucosa wall in stomach.

Sulphur: A non-metallic chemical element, occurring as pale yellow crystals, required by living organisms as a constituent of protein (Keratin in animals) and some oil. The optimum ration of the N and S in the ration of ruminant is 10:1.

Sulphur Amino-acids: Amino acids (Cystine, methionine and cysteine).

Supplement: Additional feed used to improve the ration to make it nutritionally adequate.

Succulent: Roughages that content 60-90% moisture are called succulent feed. e.g pasture, green fodder, tree leaves and root crop.

Tapioca meal: Synonyms are Manioca in latin America, Cassava/cassava root in Englis territories. The dried meal of tapicoa roots contain 1.8% CP, 1.3% fat, 85% NFE and 1.8% fibre.

TDN: Total digestible nutrient is a simply figures which indicates the relative energy value of feed to an animal. It is ordinarily expressed in kg or percentage. TDN can be determine only by a digestion trial where the percent digestible nutrient are computed on the fresh basis directly by multiplying the percentage of each nutrient present in the feed ingredient in question (protein , fibre, N-free extract & ether extract) by the corresponding digestion coefficient.

Percentage of TDN = Dig. protein% + Dig. Fibre% + (Dig. NFE% + Dig. Ether extract% × 2.25)

Thermometer: An apparatus to measure temperature.

Thiamine: Vitamin B_1, found in egg yolk, greens, peas, beans, liver, kidney, pork muscles. Deficiency causes beri-beri and polyneuritis in birds.

Temporary pasture: Vegetation grown and grazed for less than one full year.

Tetany: An animal disorder related to calcium deficiency known by marked convulsions, stiff legs, muscles, nervousness. (Grass tetany-magnesium deficiency).

Thymus: Gland like organ located in upper part of chest. It is probably associated with immunity.

Thyroid: Gland in the neck which helps regulate many processes of metabolism, growth and development.

Tocopherol: Known as vitamin E. (Fat soluble vitamin)

Trace elements: Chemical elements required by a plant or animals in very small

quantity for its metabolism. Such elements are often essential for the functioning of enzymes, hormones and vitamins. These are zinc, boron, manganese, cobalt, molybdenum and copper, (Micro-nutrient).

Trace mineral: Any one of several mineral elements that are required by animals in very minute amounts, same as micro mineral or trace mineral.

Tracer element: Radio active element used in biological and other research work to trace the fate of a substance.

True protein: Protein which does not have NPN.

Trypsin: A proteolytic enzyme found in pancreatic juice. It works at pH between 7 to 9. Leguminous plants like soyabean and guar have tripsin inhibitor activity which depresses the growth in animals.

Trypsinogen: An inactive precurosr of trypsin becomes activated when comes in contact of enterokinase.

Tryptophan: An essential amino acid.

Urine: is excretion by the kidneys, stored in urinary bladder. It helps to maintain water balance, pH of body fluid, electrolyte level, osmotic pressure by removal of metabolic waste products.

Urea molasses mineral block: A lick prepared for ruminant fed on poor quality roughages to supply urea thereby ammonia for rumen bacteria.

Uromol: A mixture of urea and molasses in 1:13 ratio prepared by heating for 30 minutes. Urea is utilized slowly as a nitrogen so urce and carbohydrates as a ready source for growth and multiplication of micro organisms of rumen.

Vitamins: A class of organic substance required by animals in minute quantities essential for metabolism, growth and development. Deficiency causes diseases, impaired growth.

Volatile fatty acids: Acetic, butyric and propionic acids.

Voluntary intake: The quantity of food animals consume at free will.

Water soluble vitamins: Vitamin B complex and C.The vitamin which are soluble

in water.

Wean: Removal of young one from dam, so that she can not nurse to young one any more.

Wedge shape: The conformation considered ideal for dairy cattle. Hind quarter broader than fore quarters (side wedge, front wedge, top wedge and rear wedges are angular shape of body).

Wet feeding: Food moistened with water in the form of a porridge for feeding to animals.

Wheat bran: Seed coat of wheat-mild laxative and good source of phosphorus, used as byproduct of cereal in feed.

Xerophthalmia: Eye disease associated with vitamin A deficiencey. It may lead to blindness.

Xylose: Carbohydrate found in pentosans as xylans.

Yeast: Unicellular fungi like structure, source of Vitamin B. Complex and rich in protein. It is used for fermentation of carbohydrate.

Zerograzing: Soiling system of feeding, harvesting fodder in green stage and feeding it to animals in paddocks.

1.3 Situation of animal nutrition in Nepal

In Nepal we have a large numberof fodder tree species from which leaves and twigs can be used for livestock feeding. 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. There are more than 136 species of fodder tree found in Nepal. 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 trees 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 are very palatable and digestible

- Total pasture area of Nepal: 17, 57,345 ha.
- Concerned agencies for pasture development: Department of Livestock Services, Livestock Development Project, Community Livestock Development Project, Hills Leasehold Forestry Project, National Agriculture Research Council.
- Approximate animal feed sources:

Agricultural bi-products	31.5%
Forest	50%
Pasture	18.5%

- Geographical distribution of grasslands and introduction to important fodder crops and trees in Nepal
  - Land-major limiting factor for forage production
  - 20% of the total land (39, 55, 000 ha) useful for agriculture
- Distribution of agricultural land

High mountains	8%
Mid hills	40%
Terai	52%

- Pastureland: 17,57,345 ha
- Av. allocation of agricultural land/head - 0.17 ha
- " " " pastureland/head- 0.08 ha
- Population growth rate- 2.24%
- Household nos. (Census 2001)- 42, 53, 230

- Av. household members- 5.5 persons

- 70% (approx.) farmers have access to less than 1 ha of land; among them 40% (approx.) farmers' families hold less than 0.5 ha of agri. land i.e. land/household.

- Distribution of rangelands/grasslands:

High mountains	50%
High hills	29%
Mid hills	17%
Siwalik and Terai	4%

- Distribution of rangelands/grasslands by region:

  Mid-western region- 50%

  Western region- 25%

  FW, Mid and Eastern region-25%

Teacher's Instruction

- Practice student to feed different stages of livestock
- Show the picture of different feed ingredient
- Visit different geographical region of Nepal
- Draw the map of Nepal & show the rangeland, pasture, agricultural land distributed in Nepal.
- Show the PowerPoint presentation of Nutritional terminologies.

Unit 2
Feed stuffs

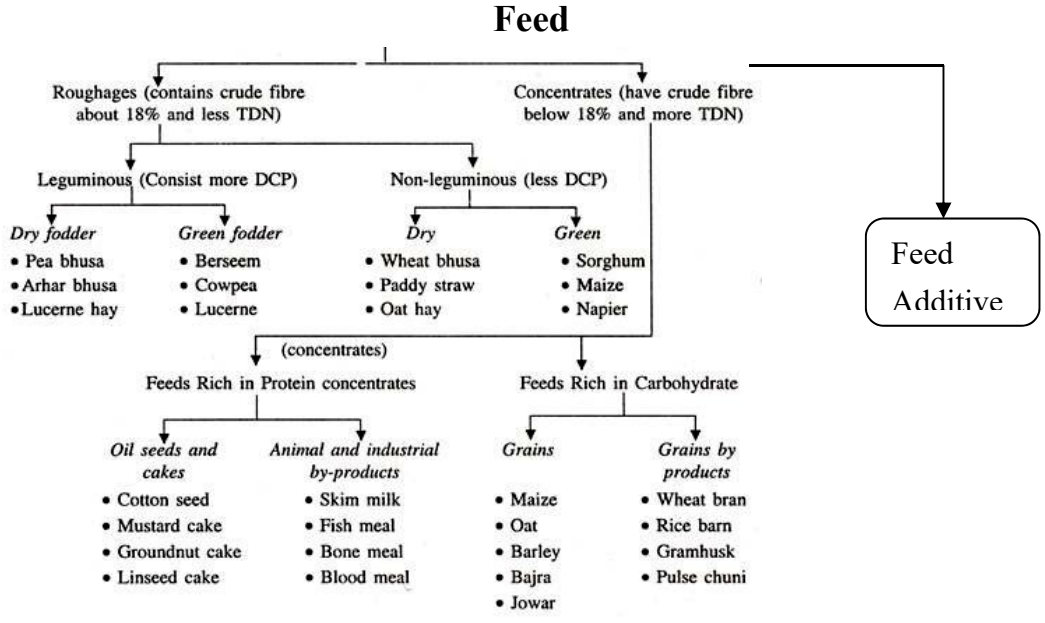
Learning Outcomes

On completion of this chapter, the students will be able to:

- Differentiate roughages and concentrate feed.
- Explain chemical composition of forage.
- Describe carbohydrate, fat & proteinous nutrient.

Feed stuff: A single article of food which isconsumed by animal which are often classified as forages and concentrates, but these divisions are not always clearly definable. Concentrates usually mean high quality, low fiber feeds and include the cereal grains, milling by-products, protein sources, and fats. Concentrates have a high digestible energy content per unit of weight or volume. The energy is derived mostly from starches, sugars, other readily available carbohydrates, and fats or oils. Forages are characterized by being more fibrous (greater than 20 percent ADF) or bulky and generally represent the vegetative portion of a plant.

2.1 Classification of feed stuffs



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.

2.2 Composition of feed stuffs

Composition of selected feedstuff 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 have 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		
Sheep	74	16	5		4.4		
Pig	52	15.4	30		2.6		
Hen	56	21	19		3.2		
Man	59	18	18		4.3		

Source: Ranjhan, Animal nutrition and feeding practices Pp 10.

Cereal Grain and Cereal by product

Simple stomache animals depend mainly upon cereal grains for energy source. The proportion of cereal grain and its byproduct may sometimes reach up to 90% in their diet. Energy rich concentrates have less than 18% protein content.

- The dry matter content of the grain depend upon the stage of maturity, harvesting method and storage condition , however generally it ranges from 80-90 percent.
- Cerals grains are essentially carbohydrate concentrate the main component of dry matter being starch, which is concentrated in endosperm. Starch is found in the form of granules , whose shape and size vary with type of plant species. Cereal starch consist of about 25% amylase and75% amylopectin.
- The crude fibre content of the harvested grain is highest in those with husk or hulls such as rich or oat and it is lowest in naked grain such as wheat and maize.
- The crude protein content of grain is 8-12%.
- All cereals are deficient in vitamin D and calcium .

Protein rich concentrate

Oilseed cakes and meals are the residues remaining after the removal of oil e.g. bean , groundnut cake, cotton seed , linseed, mustard etc. About 95% of nitrogen in oilseed meal is true protein. The meal with high protein content , which tends to aggravate their generally low calcium content.

Animals' protein concentrates

These ingredients find their greatest use in simple stomach animals. The most widely used animals protein concentrate are fish meal, meat meal, meatcum bone meal, dried meal. Fish meal contains high level of lysine, methionine and tryptophan. Meat meal contain high calcium about 8% and phosphorous 4%. Blood meal has high protein value but the digestibility and quality lower than the other animals protein.

2.3 Roughages and Concentrate

There are various feed stuffs available for livestock feeding. These feedstuffs can be grouped into different classes on the basis of bulkiness and chemical

composition. The feed stuffs can be classified into two main heads:

a) Roughages

b) Concentrates

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:

- Dry roughages e.g.straw, hay

- Green roughages e.g. legume and non legumes

- Legume e.g. berseem, Lucerne, cow pea etc.

- Non-legume e.g. maize sorghum, bajra, oat etc.

- Fodder tree e.g. Legume & non-legume

Fig. Roughages

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 can not digest and utilize the roughages in significant amounts. There are various sources of concentrate feeds, such as:

Animal 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.**

Fig. Concentrate feed

Teacher's Instruction

- Practice student to classified feed stuff.
- Show the picture of different roughages & concentrate.
- Tabulated the composition of feedstuff.
- Draw the map of Nepal & show the rangeland, pasture, agricultural land distributed in Nepal.
- Show the PowerPoint presentation of roughages and concentrate feed.

Unit 3

Nutrient composition of feed stuffs and their Functions in animal body

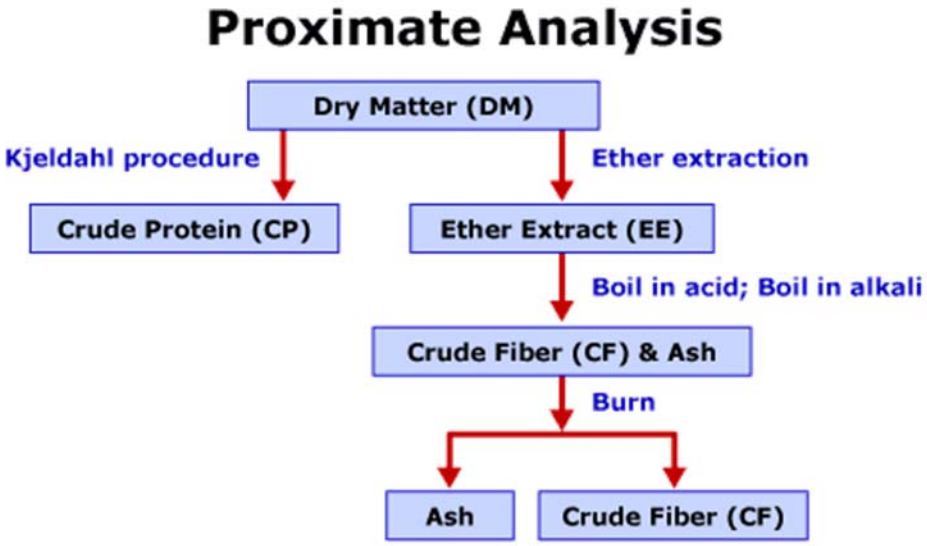
Learning Outcomes:

On completion of this chapter, the students will be able to:

- Define different nutritional terminologies
- Identify the different types of feed stuffs used to feed animals.
- Describe the functions and classification of carbohydrate, fat & proteinous nutrient.

The principle of proximate analysis of feedstuff is the fraction of feed which determine the nutritive value of feedstuff. For describing various feeds and fodders, in 1865, Henneberg and Stohmann , at Weende Experiment Station In Germany purposed a scheme of chemical analysis of feeds and fodder.

Weende's system of proximate analysis



3.1 Water

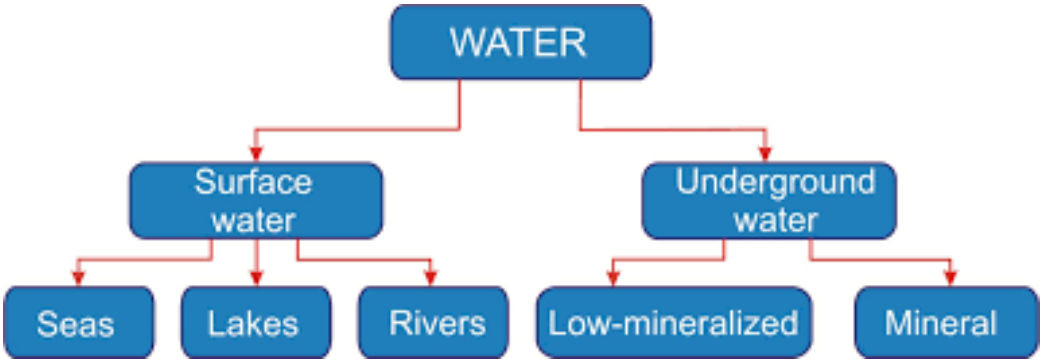
The water content of the animal body varies with age. The newborn animal contains from 750 to 800 g/kg water but this falls to about 500 g/kg in the mature fat animal.

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.

Sources of water

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 foods is often expressed on a dry matter basis, which allows a more valid comparison of nutrient content.

Classification of water



Function of water

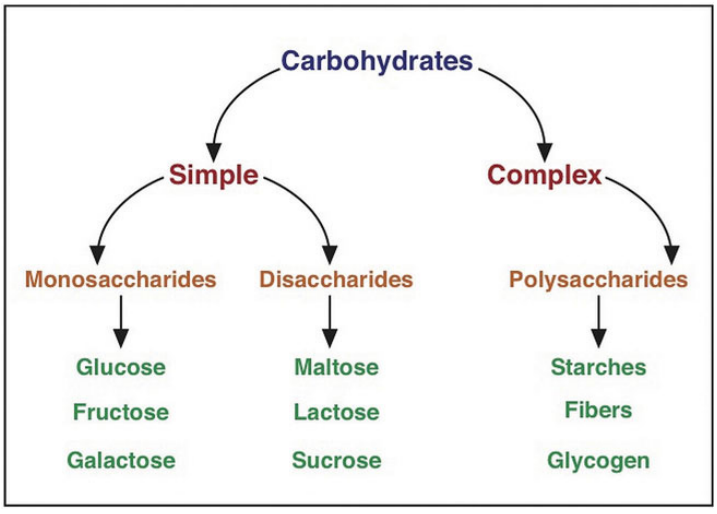
- Acts as a general lubricant and cleansing agent for different parts of animal's body.
- Maintain osmotic pressure
- Medium for ingredient to function,

- 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

3.2 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 of dry matter plant contains 60-90%carbohydrate. It is generally made up of carbon , hydrogen and oxygen.

Classification of Carbohydrate



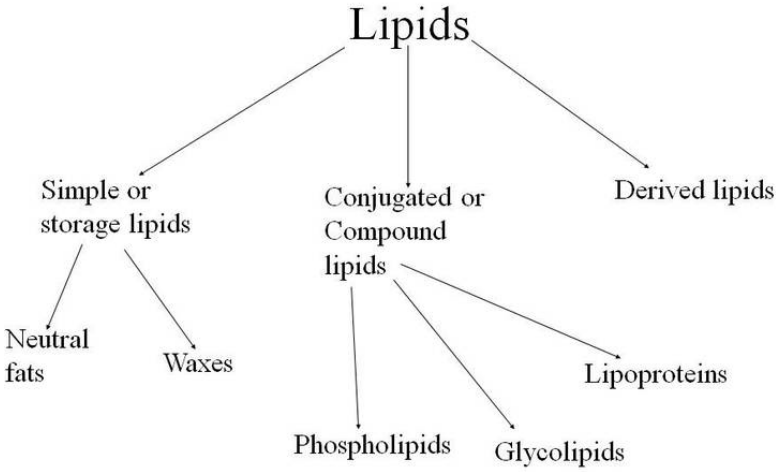
Function

- 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

3.3 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.

Classification of Lipid



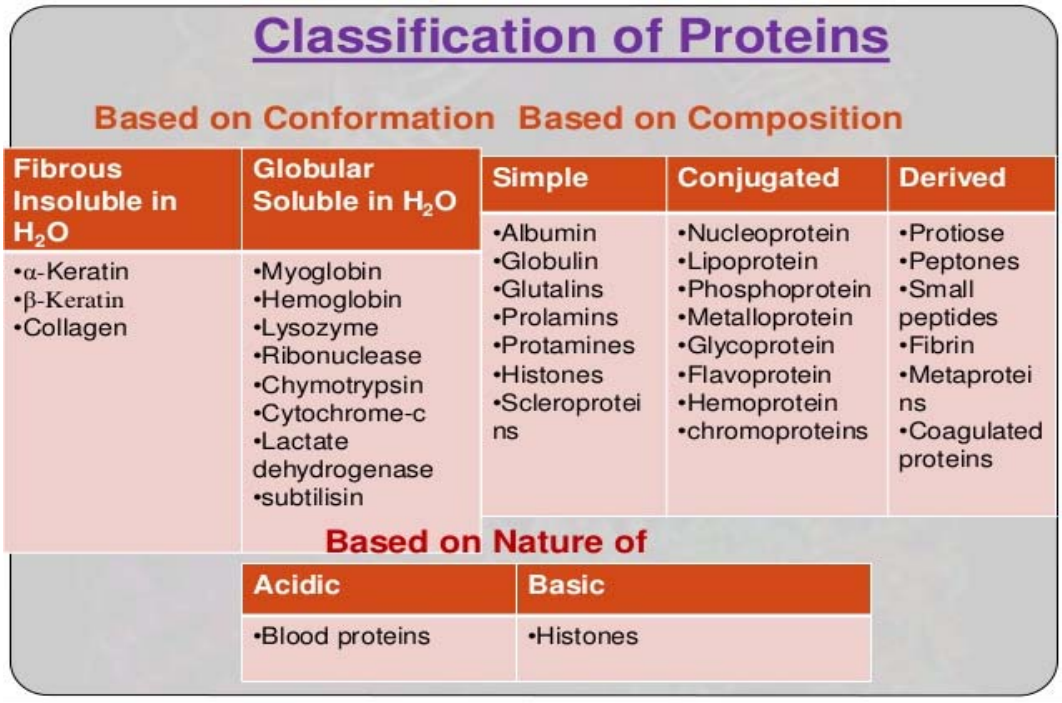
Function of fat

- 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.

3.4 Proteins

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

Classification of protein



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.

Teacher's Instruction

- Practice student to classified water, carbohydrate , protein & fat
- Show the picture of different functions of carbohydrate, fat, water & protein in animal's body.

Unit 4
Minerals and vitamins in livestock feeding and their functions in animal body

Learning Outcomes

On completion of this chapter, the students will be able to:

- Enlist different minerals and vitamins
- Explain the sources, function & deficiency symptoms of minerals and vitamins.

1. Introduction

Animal body contains about 3 percent minerals, which are constant constituent of animal tissues. There are about 30-40 mineral elements which occur largely in the various parts of their body. Calcium and phosphorus account for three-fourths of the elements in the body (49 percent calcium, 27 percent phosphorus, and 24 percent other elements). A predominant part of the mineral material in the animal body is located in the skeletal tissues (Benergee, 2003). He has described the role of minerals in the following headings:

A. In tissue growth and repair

- For the formation of bones and an tissue in growing animals
- For the formation of hair, hoof and horns
- A small amount is present in all soft tissue, which quantitatively may be small but are vital for life processing
- Blood cells also contain a small amount of minerals or the normal functioning of the blood cells. Hemoglobin of RBC contains iron without which blood will not be able to carry oxygen or carbondioxide.

B. Mineral acts as body regulators or aid in the formation of body regulators

- For the maintenance of proper osmotic pressure in the body fluids.
- For the maintenance of neutrality of the blood and lymph.
- To maintain a proper physiological balance between the various mineral ingredients in the blood and also for digestion

- As a co-enzyme, minerals are also important for metabolism

C. In milk production

- To make good losses of minerals secreted in the milk in milking animals.

Twenty-one minerals are considered to be nutritionally essential, or probably essential, to the animal. Depending on the quantities required by the animal, they can be grouped into major minerals and trace (minor) elements. Of the major minerals the most important are calcium, phosphorus, sodium, chlorine, potassium, sulphur and magnesium. The important trace elements are copper, cobalt, iron, iodine, zinc, manganese and selenium. Most of the major minerals and trace elements are widely distributed in the herbage and the other feeds eaten by the animal, and occur in sufficient quantities to meet animal requirements. Balanced commercial feeds usually contain sufficient minerals to meet the needs of dairy cows under normal conditions (McDowell, 1983).

However, the possibility of clinical, or more likely subclinical, mineral deficiencies may occur even if conditions deviate from the "typical". Clear-cut and well-defined symptoms can usually be observed if an animal suffers from a clinical deficiency of a mineral. On the other hand, subclinical deficiencies could adversely affect the rate of growth and the level of production without causing obvious deficiency symptoms. Apart from actual mineral deficiencies, mineral imbalances may also occur. These imbalances, through interaction, can induce deficiencies by the formation of insoluble compounds which cannot be utilized by the animal (Bredon and Dugmore, 2009).

Mineral deficiencies, and in some cases imbalances, cause metabolic disturbances and can produce specific deficiency diseases. Fertility, and hence calving percentage, can be affected. Milk production is obviously dependent on the health and the well-being of the dairy cow and any metabolic disturbance will affect milk production (Bredon and Dugmore, 2009).

Slow-growing and low-producing animals will not require the same amounts of minerals as high producers. Therefore deficiencies which are subclinical in low producers, often become clinical in high-producing animals. Often the farmer is

unaware of the existence of mineral deficiencies, and it is not easy, nor is it always possible, to diagnose a deficiency of any particular mineral. Improved live-mass gains or increased milk production in apparently healthy animals often have been demonstrated when their feeds were supplemented with minerals. These responses occurred when no evidence of a deficiency existed but, judging by the beneficial effect of mineral supplementation, there must have been a subclinical deficiency (Bredon and Dugmore, 2009).

So far, the emphasis has been on mineral deficiencies, but it must not be forgotten that an excess of some minerals can also have a disastrous effect on the animal. There are well-known areas in the world where cattle cannot be kept because of a high selenium concentration in the soil, and hence in the herbage, which is toxic to the animal. An excess of molybdenum, as a result of over-application to a pasture, can render the pasture unusable for many years. An induced copper deficiency is caused by excessive soil molybdenum. Excesses of copper, iodine or fluorine can also be very toxic to animals. The problem is very complex, and if considerable care is not exercised when supplementing feeds with minerals, especially trace elements, more harm than good can result (Bredon and Dugmore, 2009).

Table: the essential mineral elements and their approximate concentration in the body

Macro-elements	percentage	Micro-elements	Ppm mg/kg	Possibly essential
Calcium	1.5	Manganeses	0.2-0.5	Arsenic
Magnesium	0.04	Iron	20.8	Barium
Sodium	0.16	Copper	1.5	Bromine
Potassium	0.3	Iodine	0.3-0.6	Cadmium
Phosphorus	1.0	Zinc	10.50	Strontium
Chlorine	0.11	Fluorine	2.5	
Sulfur	0.15	Vanadium	50-500ppm	
		Cobalt	0.02-0.04	
		Molybdenum	1-4	

Selenium	1.7
Chromium	0.08
Tin	1.5-2.0

Source: G. C. Benergee, 2003

1.1 Evidence of Existence of Deficiency

According to Radostits et al. (2003) general evidence will include either evidence of deficiency in the diet, or abnormal absorption, utilization or requirement of the nutrient under consideration. Special evidence may be obtained by chemical or biological examination of the feed.

Diet

The diet for a considerable period prior to the occurrence of the disease must be considered because body stores of most dietary factors may delay the appearance of clinical signs. Specific deficiencies are likely to be associated with particular soil types, and in many instances soil and geological maps may predict the probable occurrence of a nutritional disease. Diseases of plants may also indicate specific soil deficiencies, e.g. 'reclamation disease' of oats indicates a copper deficiency in the soil. Domination of the pasture by particular plant species may also be important, e.g. subterranean clover selectively absorbs copper, legumes selectively absorb molybdenum, and *Astragalus* spp. are selector plants for selenium. Farming practices may have a marked bearing on the presence or absence of specific nutrients in livestock feed. For example, heavy applications of nitrogen fertilizer can reduce the copper, cobalt, molybdenum, and manganese content of the pasture. On the other hand, many applications of lime reduce plant copper, cobalt, zinc and manganese levels, but increase the molybdenum content. Effects such as these are sufficiently severe to suggest that animals grazing the pasture might suffer trace element deficiency. Modern haymaking methods, with their emphasis on the artificial drying of immature forage, tend to conserve vitamin A but may result in a gross deficiency of vitamin D. Soil and pasture improvement by exaggeration of the depletion of nutrients, particularly trace elements, from marginally deficient soil may give rise to overt deficiency disease. Thus, local knowledge of fanning and

feeding practices in a particular area is of primary importance in the diagnosis of nutritional deficiency states.

Abnormal absorption

Even though a diet may contain adequate amounts of a particular nutrient, some other factor, by decreasing the absorption of the nutrient, may reduce the value of the dietary supply. For instance, excess phosphate reduces calcium absorption, excess calcium reduces the absorption of iodine, and absence of bile salts prevents proper absorption of the fat-soluble vitamins. Chronic enteritis reduces the absorption of most dietary essentials. The list of antagonisms that exist between elements grows all the time, most of them being interferences with absorption. For example, excess calcium in the diet interferes with the absorption of fluorine, lead, zinc and cadmium, so that it may cause nutritional deficiencies of these elements, but it also reduces their toxic effects when they are present in the diet m excessive amounts.

Abnormal utilization of ingested nutrients

This may also have an effect on the development of conditioned deficiency diseases. For example, molybdenum and sulfate reduce copper storage, vitamin E has a sparing effect on vitamin A, and thiamine reduces the dietary requirements of essential fatty acids.

Abnormal requirement

Stimulation of the growth rate of animals by improved nutrition or other practices may increase their requirement of specific nutrients to the point where deficiency disease occurs. There seems to be little doubt that there is a genetic variation in mineral metabolism and it has even been suggested that it may be possible to breed sheep to 'fit' actual deficiency conditions, but the significance of the inherited component of an animal's nutritional requirement is unknown and probably small. It should not be overlooked, however, when policies of upgrading livestock in deficient areas are initiated.

1.2 Evidence of a Deficiency as the Cause of the Disease

Evidence is usually available from experimental work to indicate the clinical signs

and necropsy findings one can expect to be produced by each deficiency. Several modifying factors may confuse the issue. Deficiencies under natural circumstances are unlikely to be single and the clinical and necropsy findings will be complicated by those caused by deficiencies of other factors or by intercurrent infections. In addition, most of the syndromes are both variable and insidious in onset and the minimal nature of the necropsy lesions in many nutritional deficiency diseases adds further difficulty to the making of a diagnosis. Special clinical and laboratory examinations of the animals are valuable aids to diagnosis in many instances. However, the ranges of blood or tissue concentrations of minerals and vitamins, or their biochemical markers, in normal animals and those values which indicate deficiency have not been well-established. In other words, the cut-off values above which animals are normal and below which they are abnormal or deficient have not been adequately determined in naturally occurring nutritional deficiencies. Experimentally induced nutritional deficiencies provide an indication of the changes that occur in the concentrations of a particular nutrient marker, but variations due to age, genotype, production cycle, length of time on the inadequate diet, previous body stores of the element and other stressors commonly complicate the results and render them difficult to interpret accurately and with repeatability. In most cases, nutritional deficiencies affect a proportion of the herd or the flock at the same time and the clinicopathological examination should include both normal and clinically affected animals. Comparison of the laboratoryresults of normal and abnormal animals allows for more accurate and reliable interpretation and the making of a diagnosis (Radostits et al., 2003).

1.3 Evidence Based on Cure or Prevention by Correction of the Deficiency

The best test of the diagnosis in suspected nutritional deficiency is to observe the effects of specific nutrient additions to the ration. Confounding factors are frequently encountered. Spontaneous recoveries may occur and adequate controls are essential. Curative responses may be poor because of an inadequate dose rate, because of advanced tissue damage, or because the abnormality may have been only a predisposing factor or secondary to a complicating factor that is still present.

Another common cause of confusion in therapeutic trials is the impurity of the preparations used, particularly when trace elements are involved. Finally, the preparations used may have intrinsic pharmacological activity and produce some amelioration of the disease without a deficiency having been present.

2.0 Importance of Minerals

The importance of adequate mineral nutrition to avian growth and development is well known (Romanoff, 1967). The avian egg and embryo developing within represent a closed system in which the entire supply of nutrients, including vitamins and minerals necessary to support complete embryonic development, is deposited by the hen into the egg at the time of its formation. This process involves the transport of nutrients from storage site within the tissues of the hen to the ovary and the developing oocyte for deposition into yolk or the oviduct for subsequent deposition into the albumen, shell membrane and shell portion of the egg (Whitehead 1991).

The P maintenance requirement must be considered as the irreducible part of endogenous losses which is highly related to the no re-absorbed salivary P. The P maintenance requirement is related to dry matter intake. The requirements for growth are slightly lower than for calves but markedly higher than for lambs, this must be taken into account for a re-assessment of growing requirement in kids. Calcium and phosphorus requirements for pregnancy mainly result from the number of foetuses and must be take into account during the six last weeks of pregnancy. Calcium and phosphorus content of goat milk (1.3 g Ca/L, and 0.95 g P/L, respectively) are very close to those of cow milk. True absorption coefficient (TAC) of P is higher for goats than for other ruminant species; the value of 70 % is adopted for calculations. In the goat, the TAC of Ca is markedly depressed by high level of dietary Ca, the retained value of 30 % is only suitable when dietary Ca is not in excess. Using specific data for mineral nutrition of goats lead to higher dietary recommendations for P and Ca especially for growing animals.

Copper is essential for many physiological functions including iron metabolism, immunity and protection of tissues from oxidative stress. Liver plays a key role in maintaining copper homeostasis and adjustment to fluctuation of copper supply is

mainly achieved by liver storage and biliary secretion. The copper requirements of the growing pig are below 10 mg/kg feed. They are normally covered by the feedstuff copper provision and any supplementation is theoretically superfluous. However, because of the growth promoting effect of copper, 150 to 250 ppm supplements are often added in diets of weaned piglet. When this supply of copper is omitted at the end of the post-weaning period, such a dietary copper supply does not influence the copper content of the meat consumed by humans. However, it induces an increase of copper content in pig slurry and, consequently, an accumulation of copper in soils.

The reduction of dietary copper supply close to the requirements is the main way to better control this environmental risk. However, to achieve this goal, the dietary factors that may significantly influence the availability of copper should be accurately known and ranked. Some chelating agents, such as phytates, fibres or fat as well as the level of other minerals such as Zn and Ca may interfere on copper availability. However their actual impact remains to be assessed. In addition, relevant indicators of copper status should be chosen to implement these investigations.

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In order to reduce P excreted by pigs, P dietary supply should be better adjusted to their requirements and strategies to improve P availability should be implemented. A feeding system relying on P apparent digestibility is proposed. The impact of the proportion of phytic P in total P and of plant and microbial phytase on P digestibility was quantified. Apparent digestibility was a more efficient approach than total P to formulate pig diets, even if the impact of other known factors of variation of P digestibility remains to be quantified. The bases for the factorial determination of apparent digestible P requirements by weaned piglets, fattening pigs and lactating and gestating sows according to their characteristics and performance were updated. A reduction of P supply to sows is still possible, but new experimental data regarding the management of bone stores throughout lactation and gestation are required.

An excessive level of Phosphorus (P) in poultry feeds is environmentally unfriendly and costly. A meta-analysis was performed to propose poultry responses to P supply. Sixty two publications with 1271 observations in broilers, turkeys and ducks were collected. Optimal values for Daily Body Weight Gain and Feed Conversion Ratio varied from 6 to 7 g of total P by kg of diet, with a Ca/P ratio ranging from 1.4 to 1.6. Higher values were obtained for turkeys. P apparent retention decreased with total P in the diet and increased with microbial phytase supply, thanks to phytic P improved availability. This increased P retention leads to lower P excretion in the environment. Furthermore, P and microbial phytase supplies increased bone mineralization with an optimal average P intake of 250 to 300 mg/d for 0-3 weeks-old broilers. The present study was performed on total P in the diet. However, feeds are usually formulated on available P basis. Therefore, the following step of this work will be to translate the obtained results and equations into available P by including additional effects of feedstuffs, phytases, Ca/P ratio, Vitamin D. Moreover, this work underlines that if numerous data are available for young broilers, few are for turkeys and ducks especially during the finishing periods, for which further research might bring foreseeable improvements.

Recent re-assessments of dietary phosphorus (P) supply for ruminants have been published in France as well as in other countries (USA, The Netherlands, Nordic

Countries…). All converge to a decrease by about 15 % of dietary P supply. After a brief reminder of their basis, this article comments on the main consequences of the application of these dietary allowances (DA) that must allow a substantial decrease of P in animal wastes. A decrease of DA associated with differences in P rumen release among feedstuffs update the studies on microbial P requirements. The recent available data do not show any important modification in the metabolism of rumen bacteria related to P supply under normal conditions of saliva production. Special attention must be paid to the assessment of the real P supply by the diet, essentially by its forage fraction. In fact, a decrease of DA associated with an overestimation of P supply could lead to a situation of P deficiency. The strategy of mineral supplementation of the rations must be the same as previously. The formula and quantity to feed the animals remain based on the mineral insufficiencies of the diet. Some oversimplification of these practices (e.g. half quantities of the complement given before with the same concentration in other components) must be discarded because of the risk of a markedly unbalanced supply of other minerals and vitamins. In order to reduce pollutant load with respect to animal performances and health, these new DA must be adopted in a rational way.

The tables published by INRA-AFZ in 2004 supply several new feedstuff characteristics concerning phosphorus (P), which have been integrated in new (phosphorus unit systems) for different animals, particularly for ruminants, pigs and poultry. The utilization of such systems was studied here in the formulation of compound feeds for growing pigs by linear programming. The new system (INRA-AFZ, 2004) was compared to the previous one (INRA, 1989). Several models were proposed in order to take the action of vegetal and microbial phytases into account. First, a linear effect of microbial phytases on the liberation of digestible phosphorus was studied. Then, microbial phytasic activity was tested through a non-linear relation with an interaction between vegetal and microbial phytases. Moreover, the amount of excreted P was considered in the model. Its economic consequences varied between the situations. With this new feeding system, pig diets are formulated closer to the animal's needs in terms of digestible P and with a lower level of mineral supplementation. The quantity of total P in the diets and, therefore,

animal P excretion are reduced.

3.0 Functions

Minerals have many vital functions in the body. First of all, the skeletons of vertebrate animals are composed chiefly of minerals (nearly all calcium and phosphorus). Minerals are also necessary constituents of soft tissue and the fluids of the body (Morison, ……). Phosphorus is a vital ingredient of the chief protein in the nuclei, or life centers, of all body cells. It is also a part of certain other important proteins, such as the casein of milk. The phospholipids, which are phosphorus containing fat like substances, are essential part of all living protoplasm. The power of the body blood to carry oxygen is due to hemoglobin, the iron protein compounds in the red blood corpuscles.

The soluble minerals compounds in the blood and other body fluids are essential in giving these fluids their characteristics properties and in regulating the life process. The acidity or alkalinity of the digestive juice is due to mineral compounds. Thus the acidity of the gastric juice in the stomach, which is necessary action of the enzyme pepsin, is due to hydrochloric acid, formed from sodium chloride other chlorides present in the blood. The osmotic pressure makes possible the transfer of nutrients and waste products through the cell wall is largely depends on the concentration of mineral salts in lymph and in the cells. The maintenance of an approximately neutral reaction in the body tissues, prevention of the acidity or alkalinity, is due chiefly to a delicate adjustment of the mineral compounds in the body fluids. A serious lack of calcium in the blood occurs in milk fever of cow, causes convulsion and tetany.

For the various life processes, not only must there be sufficient supplies of various essential minerals, but also there must not be a large excess of any of them .Thus, the regular beating of the heart depends on proper proportion of calcium and phosphorus in the blood. The kidneys are usually able to protect the animal against any excess of various mineral in the body by excreting the excess in the urine. However, food continually furnishes an excessive amount of certain minerals, the body may be unable to keep the blood composition normal and injury will result (Church, 1978).

3.1 Principal Function of Minerals:

The principal functions of minerals are: 15 essential elements serve body in many different ways. As constituents of the bone and teeth,

1) They give rigidity and strength to the skeletal structures.
2) They are also constituents of organic compounds, protein and lipids, which make up the muscles, hair, hoof hair and horns, blood and other soft cells of the body.
3) They are important in maintenance of homeostasis in the internal fluids; maintenance of cell equilibrium and there by exert characteristic effects on the irritability of muscles and nerves.
4) They also active enzyme systems; involve in direct or indirect effects on endocrine glands; effect on symbiotic micro flora of GI tract.
5) The quality and quantity of all animal products like milk; wool; eggs and meat are affected by the presence or absence of mineral in the body.

3.2 The Structural Function of Minerals: Bone and teeth: Normal adult bone may be considered to have the following approximate composition.

Composition of bone	**Percent**		
Calcium	36	Water	45
Phosphorus	17	Ash	25
Magnesium	0.8	Protein	20
Others	46.2	Fat	10
Total	100.0		

The organic matrix of bone in which the mineral salts mainly of calcium, phosphorus and carbonate, with small amounts of magnesium, sodium, strontium, lead, citrate, fluoride, hydroxide and sulphate are deposited consist of a mixture of collagen muco polysaccharides and protein carbohydrate complexes.

Minerals are also necessary for formation of hair, hoof, and horn. A small amount is present in all soft tissues, which may be quantitatively small but vital for life

processing. Blood cells contain a small amount of minerals for the normal function of blood cells. Haemoglobin of RBC contains Fe++ Without which blood will not be able to carry O_2 or CO_2.

3.3 Minerals and Homeostasis

Homeostasis is the constancy of the chemical composition and physico-chemical properties of the internal medium of the organism. These include body temperature, osmotic pressure of fluids, hydrogen ions concentration, and concentration and ratio of biologically active ions. Minerals present as soluble salt in the cell medium, interstitial fluid, blood and lymph, participate directly or indirectly in maintaining the above parameters at a constant level.

Maintenance of ionic equilibrium: Salt when dissolved in liquids, are fully or partially dissociated into electrically changed ions i.e. cat ions and anions. Cat ions are formed by metals (Na, K, Ca, Mg), while anions are formed by acid residues (Cl, HCO_3, SO_4). The ammonium ions are also a cation, while organic acids and proteins are anions.

Under normal conditions all liquids in the organisms are electrically neutral, since the sum of the positive ions (cations) is equivalent to the sum of the negative ions (anions).

The ions in the body fluids together with the other components, produce a certain level of osmotic pressure, maintain in the equilibrium of cell membranes, affect the condition of tissue colloids, help regulate the acid base equilibrium and, in addition, fulfill other functions specific to each individuals ions.

Maintenance of osmotic pressure: The osmotic pressure within the organism is an important physiological factor which promotes the migration of water and soluble substances in the tissues. The dissolved salt produces a certain osmotic pressure in the body fluids. Ionised salt, which dissociate into ions in solution, increases the osmotic pressure to a greater extent than do non electrolytes (urea, Glucose)in equal molar concentrations. The reason for this is the fact that osmotic pressure is determined by the overall number of non dissociated molecules, colloidal particles and ions.

Maintenance of acid base equilibrium: Blood and inter cellular fluids have a weakly basic reaction (PH 7.3-7.4), while the intercellular fluid is slightly higher that is 7.0-7.2 owing to intense metabolism of the cells.

The body's buffer systems namely, blood protein as a potassium salt of oxyhaemoglobin (KHbO2) phosphate as sodium phosphate (Na_2HPO_4) which dissociate with the formation of two sodium ions and a secondary phosphate ion, and the third system is of sodium bicarbonate ($NaHCO_3$), which dissociates into sodium and bicarbonate ions all involved in maintaining acid base equilibrium of the body.

3.4 Mineral and function of cell membrane

Membranes have complex chemical structure and participate in major physiological function: generation and transmission of nerve stimuli; intercellular signaling; participation in light, odours and tastes; energy conversion in cell, changes in enzyme activities etc. In the form of complex organic compounds, and mainly in the form of ions, minerals are directly relates to the structure and functions of membranes.

3.5 Minerals and Enzyme systems

Enzymes are the most effective and most specific all known catalyst. Catalyst of the enzyme system often requires the presence of not only the enzyme and substrate, but also of non protein substances the factors. Both organic compounds like vitamins which act as coenzymes and metallic ions may act as co factors.

All enzymes which require the presence of metals to achieve their maximum activity may be class into two groups: i)Metalloenzymes or metallocoenzymes and ii) metal activated enzymes.

i) *Metalloenzymes:* In metalloennzymes the metal is an integral part of molecule and cannot be removed by dialysis. Enzymes of this type usually contain transition metals (Cu, Fe, Zn), which form highly stable coordination complexes in their active centers.

ii) *Mineral activated enzymes:* The metal is not firmly bound to the enzyme, may be fully extracted by dialysis at pH 7.0.

The following 15 cations may serve as activators of one or several enzymes: Na, K, Rb, Cs, Mg, Ca, Zn, Cd, Cr, Cu, Mn, Co, Ni, Al, and Fe.

3.6 Minerals and hormones

A minimum of hormones are important as because they maintain a ionic equilibrium of some metals in various body fluids such as i) aldosterone for sodium ii) parathyroid and iii) thyrocalcitonin for calcium. Hormones of thyroid glands are found to contain iodine.

3.7 Minerals and symbiotic bacteria

A number of minerals are definitely essential for microorganisms, which produce the metabolites required by the animals. Eg. Cobalt, whose salts really serve for the microflora. The main function of cobalt is to supply the needs of certain group of bacteria producing vitamin B12 or its analogues (Cobamines, Cobalamines) require by the animals. This process takes place in (rumen, reticulum and omasum) of ruminants, in the large intestine of monogastric animals and the cecum of rabbits and hens.

Bacteria are capable of reducing feed sulphate to sulphides, and incorporate the later into sulphur containing amino acids and proteins. Thus rumen amino acids are synthesized from carbohydrates, ammonia and inorganic sulphur.

3.8 Minerals and milk

Cow's milk contains 5.8% ash or mineral matter on a dry basis. Deficiency of minerals in diet will ultimately causes poor production.

3.9 Interaction of Minerals with Each Other and with Other Nutrition

Minerals may interact each other and with other nutrition and non nutrition factors. This interaction may be synergistic (elements which mutually enhance their absorption in the digestive tract and jointly fulfils some metabolic function at the tissue or cell level) or antagonistic (elements which inhibits the absorption of each other in the digestive tract and produce effect on any biochemical function in the organism), takes place in the feed itself, in the digestive tract and during tissue and cell metabolism.

From the practical point of view knowledge of these mechanisms makes it possible to prevent undesirable form of such interaction and appearance of secondary mineral insufficiency in animals.

3.10 Mutual Interaction between Minerals

Owing to their reliability and their tendency to form bonds, minerals are much more liable to interact than are other nutrient substances.

3.10.1 Synergism : The synergism of minerals of gastrointestinal tract and at the tissue and cell metabolism renders the following interaction possible:

i) At the gastrointestinal tract: a) due to direct interaction between elements (Ca with P, Na, with Cl, Zn, with Mo), the level of absorption enhances provided the elements are at proper ratio; b) due to indirect interaction by stimulating growth and activity of the microflora in forestomachs and in the intestine by some specific such as Co causes intensification of microbial biosynthetic processes.

ii) At the tissue and cell metabolism: a) Direct interaction between elements in structural processes such as Ca and P in formation in bone hydroxyapatite, joint participation of iron and Cu in the formation of haemoglobin, interaction of Mn with Zn in the conformation in RNA molecules in the liver; b) simultaneous participation of elements in the active center of some enzymes such as Fe and Mo in xynthine and aldehyde oxidases, Cu and Fe in cytochrome oxidase are notworthy example of synergistic interaction with jointly fulfil metabolic function at the tissue or cell level.

3.10.2 Antagonism: Antagonism may one or two sided. Thus P and Mg, Zn and Cu inhibits the absorption of each other in intestine, where as K inhibits the absorption of Zn and Mn but not the other way round. Inhibition of absorption and some elements by other in the digestive tract may produced by the following mechanism.

i) Excess presence of Mg in the diet form complex magnesium phosphate complex affects the absorption in both the elements, similarly Cu and sulphate make another complex compound, formation of triple Ca-P-Zn salt in the

presence of high Ca in the diet is another complex which reduces absorption .

ii) Some elements when in excess may get absorbed in the surface of colloidal particle such as fixation of Mn and Fe on particles of insoluble Mg or Al salts affects absorption.

Antagonistic interaction mechanism may also be noted during tissue mechanism are mainly present in ions. Some of these are

i) direct interaction of simple and complex inorganic ions(eg Copper molybdenum.

ii) Competition between ions for the active centers in the enzyme system (Mg++ and Mn in metallo enzymes complex of alkaline Phosphatase, Cholinesterage, enolase)

iii) Compition for the bond with carrier substance in the blood (Fe++ competition with the Zn++ for the bond with plasma transferin a globulin that binds two atoms of iron that serves transport iron in the bond.

iv) Activation by ions of enzyme systems with opposite function such as when ascorbate oxidase is activated by Copper, it will oxidize vitamin C and will make it ineffective where as activation of Zn and Mo ions of lactonases promote the synthesis of vitamins.

v) ATPase is activated by Mg^{++} but is inhibited by Ca^{++} It is thus concluded that the antagonism of minerals is complex process of biotic interrelationship.

3.11 Mineral element in animal body

Macro element

- **Principal cat-ions:** Calcium, Magnesium, Sodium, Potassium
- **Principal anions:** Phosphorus, Chlorine, Sulfur

Micro-elements or Trace element: Manganese, Iron, Zinc, Copper, Iodine, Fluorine, Vanadium, Cobalt, Molybdenum, Selenium, Chromium, Tin, Nickel, Silicon

Possibly essential mineral elements: Arsenic, Barium, Bromine, Cadmium, Strontium

4.0 Macro Elements

Calcium (Ca)

Calcium is an important mineral for animals, both in terms of the relative requirement and the diversity of functions in the body. It is a major component of the skeleton, which also serves as a calcium storage site. In fact, about 99% of the total calcium in the body is found in the bones and teeth (Lalman, 2002).

Calcium is one of the elements occurring abundantly in mature. It is found as calcium carbonate, calcium sulphate, calcium theoride, dolomite and fluoroapatite. Eleven calcium isotopes, including six isotopes are known.

The vegetative parts of the plants contain more calcium than their productive parts. Leguminous grasses are calcium rich vegetable feeds and sunflower, cereal grasses and maize are relatively poor in calcium. The optimum level of green calcium in green plants is 40-60 mg / kg dry matter, and any excess content impairs the mineral metabolism of animals.

The amount of calcium in adult animal body is 1.2-1.5%, calculated in terms of fresh tissue, 3.5-4.0%in dry tissue, and 25-30% in calculated in terms of the total ash. The calcium and ash level of the body increases with age; variation in content may also be due to the state of the nutrition and spices. Nearly 99% of the total body calcium is found in skeletons and teeth, where the concentration of calcium is fairly constant (36-38%).

Bone is highly complex with the following composition in percentage: water 45, mineral 25, protein 20, and fat 10. Calcium and phosphorus are two most abundant mineral elements in bone. Bone ash contains approximately 36-38% calcium, 17% phosphorus and 1% magnesium. The skeleton is not a stable unit in the chemical sense: exchange of calcium and phosphorus between bone and soft tissue is always a continuous process.

The 1% of body calcium which occurs outside the bone is widely distributed throughout the organ and tissues including blood for performing vital body function. Calcium is required for normal blood clotting as it must be present for the formation of thrombin from pro thrombin, for muscle contraction, myocardial

function, normal neuromuscular excitability, activation of several enzymes and secretion of several hormones and releasing factors.

The calcium in the blood plasma of mammals is usually from 9-12mg/ 100 ml, although that of laying hen may be between 30-40 mg /100 ml. Calcium concentration in erythrocytes is negligible (0.14-0.22 mg/g in the liquid phase), but may be higher in membranous structures. The range of calcium in soft tissue of animals are given in table no.3.

Absorption

Calcium is absorbed into the organism with vegetable feeds and mineral additives. In the plants it is bound to proteins and to organic acid ions, while in the additives it appears as carbonate or phosphate. Whatever the actual chemical it takes, the bulk of the calcium compounds introduced is converted by the gastric juice to calcium chloride which is almost completely dissociated into ions. It is believed that the transfer of Ca ions across the membranes of the intestinal epithelial involves a special calcium binding protein produced by the influence of vitamin D in the mucus cell. The amount of calcium absorbed largely depends on the activity of the agents which reduce the content of ionized calcium in the intestines. If ions (negatively charged ions) which bind or precipitate of calcium (oxalates, phytates, phosphates and possibly sulphates) are present in excess, they may interfere with the absorption of calcium in the intestine. The absorption of both Ca' and P' thus favored by factors which operate to hold them in solution. The optimum calcium:phosphorus ratio is within the range of 1:1 to 2:1,although there is evidence that ruminants can tolerate rather higher ratios (McDonald et al., 1979).

Dietary Ca is absorbed from the duodenum and in upper section of large intestine (jejunum) of most animals. Absorption occurs both by active and passive transport. Depending on the age of animals and on other factors, absorption varies between 10 and 50 percent and is relatively independently nitrogen content of the diet.

It has been noted that there is always some indigenous loss of calcium through faces, irrespective of feeding a very low or optimum amount of calcium in the diet. Thus true absorption of calcium from the feed can only be established by deducting

the indigenous loss of the element. Depending on the species of animal these indigenous losses vary between 18 and 50 mg / kg of live weight per day.

Once calcium is absorbed in the intestine, it moves through the portal vein into the liver, where its complex compounds are broken down and calcium forms new compounds, possibly with proteins.

Excretion

Under the normal condition both Ca contained in the feed remains unabsorbed, and Ca of indigenous origin are eliminated from the body through the gastrointestinal tract. Unlike the monovalent ions (K, Na) which can almost entirely be absorbed in the intestine, and then eliminated without impairing the homeostatic of their regulation by the kidneys, Ca which is filtered through the kidney is almost 99% reabsorbed, so that its excretion with the urine is very limited. In principle the above applied to most laboratory and farm animals, with some variation due to age and spices. In the case of pigs, and laying hens excretion of Ca with urine is more intensive than other species. Passing in to mammary gland secreted in milk:20-30g/day.

Average Ca exchange indices in animals and Distribution of fecal and urinary Ca excretion are given in table no.4 and 5 respectively.

Regulation of Ca and P Metabolism

Metabolism of Ca and P in the body is very closely interconnected. These elements interact in the gastrointestinal tract, in intercellular fluids, in bone blood system and are essentially regulated by identical biological and physiochemical mechanisms. These mechanisms ensure:

1) Optimum absorption and endogenous excretion of Ca and P in the digestive tract
2) Maintenance of their normal concentration and proportion in blood and in the inter tissue fluid
3) Deposition of Ca and P as hydroxyapatite in bone tissue and their liberation during reasorption;

4) Realisation of the ion exchange function of the skeleton; and

5) Regulation of Ca and P excretion by variation in their reasorption or active secretion in the renal ducts.

The system which controls and co ordinates these mechanism includes: the parathyroid hormone, calcitonin, other hormones are sexual and growth hormones; and vitamin D and its derivatives.

Role of parathyroid hormone

The main endocrinological control appears to be excreted on Ca metabolism with only secondary effects of P. In fact animal seems to tolerate wide variation in concentration of inorganic phosphorus in the blood without immediate harm where as Ca is under close control.

The parathyroid hormone secreted by the parathyroid glands is a protein or polypeptide, with a molecular weight of 9500 which contain 84 amino acids regulates Ca metabolism and maintain a constant level of blood Ca at 9-12mg /100 ml in most species. In young hen Ca level in blood may be three to four times higher during egg production.

The plasma Ca occurs in two forms. One capable of diffusing through ultrafilters (65% of the total blood Ca) is in ionize form either free or complexed with bicarbonate, phosphate and citrates, the other fraction is bound with protein including albumin and globulins.

The level of blood Ca is not readily influenced by the dietary intake through there are species differences in this respect. Out of various physiological factors with tend to maintain a constant level of blood Ca in ionized form despite high intake or marked body losses, the most important is parathyroid hormone. The hormone 1) Raises by increasing the 57nsulin57tion of Ca from the bones. It is believed that the mechanism is concern with citrate ions which which function as solvent at an environment of temporary low pH, thus facilitating increasing osteoclastic (large special cell that erode bones) activity. 2) The second way in which parathyroid hormones acts is by decreasing urinary excretion of Ca but increasing urinary phosphate and lastly 3) the hormone stimulates the reabsorption of Ca in intestine

together with vitamin D.

Role of calcitonin hormone

The hormone is also known as thyrocalcitonin is produced in special parafollicular or thyroid C cells of thyroid gland (bird and fish it is formed in special organ-ultimobronchial bodies), the hormone is a polypeptide with a molecular wt. of 3500-4500, consisting to 32 amino acids and residues.

The hormone counteracts the effects of parathyroid hormone in that it decreases Ca concentration by cutting down the reasorption rate of minerals from the bones. It now seems clear that parathyroid hormone and calcitonin both act on concern to maintain blood Ca at a constant concentration. Parathyroid hormone is secreted in response to hypocalcaemia and causes Ca level to raise, this action being relatively slow lasts for several hours. In contrast calcitonin lowers the blood Ca and is secreted fast, reaching a peak in the matter of minutes after the hormone is secreted.

Other hormones affecting Ca-P metabolism (sexual n growth)

The Ca-P metabolism other hormones are also affecting. They are:

a) **Sexual hormones:** It is believed that sexual hormones, especially estrogen, enhance the content of Ca and P in the body particularly with the production of Ca reserve in the skeleton and their consumption during lactation in cow.

b) **Growth hormone:** The somatotropic (STH) hormone directly affects one of the bone growth mechanism by stimulating protein synthesis in the cartilage and bone cells either by inclusion of a large number of amino acids or by regulating of polysaccharide synthesis.

Vitamin D and Ca-P metabolism

Vitamin D is the collective name for a family of compounds with antirachitic (relating to rickets) effects. The most important compounds are ergocalciferol (Vit.D2) and cholecalciferol (Vit.D3).

Since the reserves of vitamin D in the tissues are low and are labile, uniform intake of vitamin D must be ensured. The concentration of vitamin D in the blood plasma of various species is 1.5-3 micro grams / 100 ml, and in rare cases it touches 5-6

micro grams.

The mechanisms of the principle activity of vitamin D are as follows:

1) Vit.D and its derivatives intensify the diffusion of Ca ions across the intestinal wall, by counteracting the factors which reduces the concentration of Ca or by increasing the permeability of membrane of the intestinal epithelium.
2) It is essential for the formation or initiation of the special Ca transport system in the intestinal wall. For these functions, cholecalciferol has to be hydroxylated in two stages i) in C-25 position by the liver, ii) in C-1 position by the kidney which is done under the influence of parathyroid hormone.

If the animal is tending to hypocalcaemia, parathyroid hormone will be secreted which in turn stimulates the synthesis of cholecalciferol in the kidney which is the most active metabolite of vitamin D. It stimulates the synthesis of the so-called calcium binding protein in the cytoplasmic fraction of the epithelial cells.

Deficiency symptoms of mineral elements

Some of the characteristics clinical symptoms and biochemical changes are manifested in farm animals.

1. Rickets: It is occurs in growing animals due to sub normal calcification by the lack of adequate Ca and/ or P in the diet, a decrease in the ability to absorbed these inorganic elements, or a sub optimal intake of Vit.D. The primary trouble in rickets lies in the composition of the blood or the fluid bathing the bone, which is characterized by a low level of Ca and/or P. Characteristics symptom includes stunted growth, impaired or unnatural appetite, distorted spine, ribs(arching back in calves), bowed leg in human.

1. **Osteomalacia:** The condition in which the mineral content of the bone depleted without making up for the losses found in adult animals, thus exhibit a continued mineral balance. Such a condition may be the sub optimal intake of Ca and P, a faulty absorption of these elements, an overactive parathyroid, or a special demand for mineral elements creating during pregnancy or lactation.

In osteomalacia the bones are gradually weakened. Such bones break easily, and

fractures are common in farm animals. The posterior paralysis of pregnant saw is frequently resulting of fracture of a vertebra and a consequent pinching of the spinal cord.

2. **Osteoporosis:** A reduction of total bone mass due to resorption of both mineral and organic components. The bone becomes porous and thin over the better part of a life time. This disorder may result from a) a dietary deficiency of a Ca and/ or protein, b) a lower Ca absorption c) a hormonal disturbance.

It is believed that the rate of bone formation in osteoporosis is normal but the bone resorption takes place at an increased rate from an attempt to maintain the normal level of Ca in the blood, despite an inadequate intake of Ca or an abnormally large requirement of Ca caused by faulty resorption.

The disease develops gradually, and is accompanied by decreased

productivity, impairment of digestive function, arrested moulting and shedding of wool. Hens lay eggs with poorer quality shell and with poorer incubation quality. The excreta contain a higher content of phosphorus.

3. **Parturient paresis:** It is also known as milk fever of parturient hypocalcaemia which occurs in within a few days of parturition. Species affected are cattle, sheep and occasionally goat. Its causes are low blood Ca and P with an increase in magnesium concentration. Deficiency or too much Ca in the ration can cause this condition. In milking cow Ca and P ration should not exceed 2:1.

Symptoms : commonly occurs in high producing cow soon after calving. Rarely occurs at first calving. Less appetite is the first symptom, Constipation and general depressions followed by nervousness and finally collapse. Head is usually turned back.

Treatment: Injection of a Ca salts in the form of Ca Cl2 , Ca Lactate, Ca gluconate or other Ca salts to elevate blood serum Ca above the concentration of the 5 or 6 mg/ ml that is associated with onset of tetany.

Prevention: Ca and P ration and amount approximately 2.3:1 Ca : P ratio. Feed a

ration that contains 0.5- 0.7%Ca and 0.3- 0.4% P.

Ca shock treatment: it contains 10- 14 days before calving, fed a Ca deficient ration with a Ca : P ratio 1:2. This activates the cow's Ca mobilizing mechanism for drawing Ca from the bones, with the result that it is functioning before calving and milk fever is avoided.

High vitamin D: This consist in feeding 20 million units of vitamin D/cow/day starting about 5days before calving and continuing through the first day post-partum, with a maximum dosage period of seven days.

Sources: sorces of Ca are Green leafy vegetables specially legumes. Animal by products containing bone, such as fish meals, meat and bone meal, poultry by products etc. The Ca and Ca-Phosphate supplements are Oyster shell flour 37.95%, Ground limestone 35.85%, steamed bone meal 30.92 % and defluorinated phosphate 33%.

In Poultry

(1) Reduce growth, (2) Lowering of appetite, (3) Elevated basal metabolic rate, (4) Osteoporosis in low calcium rickets, (5) Leg weakness leading to abnormal posture and gait, (6) Longer blood clotting time, (7) Increase in urine volume, (8) Thin egg shell as well as decreased production and (9) Tetany

In tetany the chemical change in body includes a rapid falls in serum calcium level and lowering of calcium and magnesium content of entire skeletal system. The bones of deficient animals are significantly dematerialized and ashes as well as calcium content of the bones are reduced to about one half level of the normal.

***Case layer fatigue*:** the condition occurs in hens under case system. In this case calcium phosphate is withdrawn medulary bone as well as cortical bone, in which long bone of the legs demineralization. The long bones become thinner and prone to fracture (Singh, 1992).

Calcium requirement of chicken at various levels of production are given in table no. 6.

MAGNESIUM (Mg)

About 70% of the total magnesium is found in the skeleton, the remainder being distributed in the soft tissue and fluids. The normal magnesium content of blood serum in cattle is within the range of 1.7-4.0 mg /100 ml blood serum, but the levels below 1.7 frequently occurs without clinical symptoms of disease.

Function

1) An essential component of bone.
2) Magnesium ions activate enzymes like phosphatase, phosphoglucokinage, creatine transphosphorylase, arginine transphosphorylase etc.concerned with the transfer of phosphate from ATP to ADP.
3) Controls the irritability of neuromuscular system.

Deficiency Symptoms

Symptoms due to a simple deficiency of magnesium in the diet have been reported for a number of animals and poultry. In rats fed of purified diets the symptoms include tetany which is exhibited by

a) Redness of exposed skin surface

b) Hyperirritability

c) Cardiac arrhythmia

d) Marked vasodilation

d) Chicks start die within a few days due to magnesium free diet.

e) Rapid decrease in egg production

f) Weight of egg, amount of shell, and magnesium content of yolk and shell decline.

g) They seem lethargic and often panting and gasping is observed.

h) Lowered blood magnesium level and mobilize the magnesium from the skeletal systemIn adult ruminants a condition known as hypomagnesaemia tetany associated with blood level of magnesium has been recognized by

   a) Convulsions

b) Hyperirritability
c) Twitching of the facial muscles
d) Staggering gait and ultimately tetany.

Tetany is usually produced by a fall in blood serum magnesium to amount 0.5mg/100 ml.

Symptoms can be reversed by injecting magnesium sulphate in early time, but in practice this is sometime difficult.

Experimental magnesium deficiency has been produced in dogs, rabbits, pigs, and chicks. In most cases the deficiency diseases are similar to those of rats and cattle. Magnesium deficient chicks grow slowly for about one weak, then growth stops and they become lethargic.

SOURCE

Green fodder, pericarps of cereal grain, bran, cotton seed cake is good sources of magnesium. When hypomagnesemic tetany is generally considered as that about 50gm of magnesium oxide should be given to cow per day as a prophylactic measure.

SODIUM (Na)

The value of salt has been recognized. The common expression 'worth his salt' and even the word 'salary' all derived from the high value placed upon salt throughout history. Unlike potassium, sodium is present in the extra cellular fluid. The sodium concentration within the cells is relatively low, the element being replaced largely by potassium and magnesium. Only one third of the total body sodium is present in skeleton, rest in all body fluid.

FUNCTION

1) It maintain body fluid pH
2) Regulates body fluid volume
3) Take active part in the nerve functions (transmission) and muscle contraction
4) Function in the permeability and carrier of the cells.

DEFICIENCY SYMPTOMS

1) Growth failure and reduces the utilization of digested protein and energy.
2) Dehydration –decreases plasma and body fluid.
3) Vascular disturbances–decrease cardiac output, decrease arterial pressure and increase hematocrit.
4) Corneal keratinization.
5) Nervous disorder.
6) In hens egg production is adversely affected as well as growth.
7) Cannabalism develops in flock.
8) Salt (NaCl) deficiency is maintained by an intense craving for salt, a lack of appetite, a generally haggard appearance, lusterless eyes and a rough hair coat. In milking cows collapse may be sudden and death may rapidly ensue.

Sodium metabolism is regulated primarily by aldosterone, a hormone of adrenal cortex which promotes the reasorption of sodium from the kidney tubules. In the absence of these hormones, sodium excretion is increased and symptoms of deficiency ensue.

SOURCE

All animal products, specially meat meals and food of marine origin are richer sources; vegetable origin have comparatively low sodium contents. The commonest sources are common salt.

POTASSIUM (K)

Potassium is the chief action of the intra cellular fluid and plays a very important part along with sodium, chloride and bicarbonate ions, in the osmotic regulation of the body fluids. Nerves and muscles cells are especially rich in potassium.

FUNCTIONS

1) Maintenance of acid base equilibrium.
2) Maintenance of osmotic Pressure
3) Nerve transmission
4) Heart beat relaxation
5) Activates certain enzymes

6) Potassium ions are necessary for carbohydrate and protein metabolism.
7) It also aids in the uptake of certain amino acids by the cell.

DEFICIENCY SYMPTOMS

Overall muscle weakness characterized by

1) Weak extremities
2) Poor intestinal tone with poor intestinal distention
3) Cardiac weakness
4) Weakness of the respiratory muscle.
5) Retarded growth and high mortality.

The potassium content of plants is generally very high. The amount present in grass dry matter, for example being frequently above 25%; so that it is normally ingested by animals in large amounts than other element the cases is not occurs in poultry. Consequently it is extremely unlike that potassium deficiency could occur in farm animals under natural conditions. Fortunately dietary excess of potassium is normally rapidly excreted from the body, chiefly in the urine. High intake interferes with the absorption and metabolism of magnesium in the animal.

PHOSPHORUS (P)

Phosphorus is found in every cell of the body, but most of it about 80% of the total is combined with calcium in the bone and teeth. About 10% is in combination with proteins, lipids and carbohydrates and other compounds in blood and muscle. The remaining 10% is widely distributed in various chemical compounds. The amount of phosphorus present in blood serum is usually within the range of 4-12 mg / 100 ml.

Function

1) Constituent in boon and teeth.
2) A constituent of high energy compound ATP and thus is necessary for energy transduction in essential for all cellular activity.
3) The oxidation of carbohydrate leading to the formation of ATP also requires P since phosphorylation is an obligatory step in the metabolism of any type of monosaccharide.

4) Phospholipids are constituent of all cellular membranes and are active determinants of cellular permeability.
5) DNA and RNA, the genetically significance compounds responsible for cell reproduction and therefore growth and for all types of protein synthesis these phosphorylated compounds are absolutely necessary.

Symptoms of Phosphorus Deficiency

1) Since phosphorus is required for bone formation, a deficiency can cause rickets or oesteomalacia.
2) Pica of deprived appetite has been noted in poultry and cattle when there is a deficiency of phosphorus in their diet; the affected birds and animal have abnormal appetite and chew wool, bones, and other foreign materials. Although pica can be developed by other causes a blood serum analysis of phosphorus may be run to know the exact cause of pica, i.e. whether pica is due to P deficiency or due to other reasons.
3) In chronic 'P' deficiency animal may have stiff joints and muscular weakness.
4) Low dietary intakes of 'P' have also been associated with low fertility and low egg production in hen and low milk yield in cows and with stunted growth in young animals.

Phosphorus deficiency is usually more common in cattle than in sheep or goat as the later group tend to have more selective grazing habits and choose the growing parts of plants which happened to be richer in phosphorus.

Absorption

In vitro studies indicate an active transport (molecules move from low concentration to area of high concentration and this process requires extra metabolic energy). Excess of magnesium, iron aluminium, by forming soluble phosphates, made phosphorus unavailable. When there is excess of calcium or excess of phosphorus the larger amount interferes with the absorption of the smaller one. Much of the phosphorus present in the cereal grains in the forms of phytates, which are salt of phytic acid, a phosphoric acid derivative. Insoluble calcium and magnesium phytates occur in cereals and other plant products. In ruminant like sheep and cattle there is no problem to hydrolyze insoluble phytase as rumen

microbes produce phytase, an enzyme which changes the insoluble form into soluble form and thus renders the phosphorus available. In pigs some of the phytate phosphorus is made available in the stomach by the action of plant phytase enzyme present in the food. Chicks can utilize only 10% as effectively as sodium phosphate.

Metabolism

The metabolism of phosphorus is in large part related to that of calcium, as heretofore. The Ca:P ration in the diet affects the absorption and excretion of these elements. If either element is given in excess, excretion of other increased. The Ca:P ratio considered most suitable for farm animals other than poultry is generally within the range 1:1 to 2:1. The proportion of calcium for laying hens is much larger, since they require great amount of this element for egg shell production.

Parathyroid hormone, when if becomes more, increase the serum calcium and lowers the serum phosphorus and vice versa.

Out of the total 4-12 mg of phosphorus per 100 ml of blood 43% are present as free HPO4 ; 20% as NAHPO4 like calcium, magnesium etc.

Sources

Grains, grain by-products, concentrate like oil cakes, barns, sterilized bone meal, milk products are the major sources of phosphorus.

CHLORINE (Cl)

Unlike sodium and potassium which are mainly found in the extra-cellular and intra- cellular fluids, respectively, chlorine is found distributed, in high concentration, both within and without animal body cells. The chloride specially in the form of sodium chloride constitute over 60% of the blood anions. It shows the great importance of chloride ions in maintaining acid base relations. The gastric secretion contains chlorine in the form of hydrochloric acid and as chloride salt.

FUNCTION

1) It maintaining the ionic strength of extra cellular fluids
2) Ionic combines with sodium which pre dominant in the fluids.
3) It is responsible for low pH of gastric secretion.

DEFICIENCY SYMPTOMS

1) Its result in poor growth in chicken.
2) Low chloride level in blood.
3) Dehydration and heavy mortality.
4) Chloride deficient diets develops characteristic nervous system.
5) They fall forward and their leg gets stretched in the rear.
6) One or two minutes later spasm cease.
7) Seizure does not occur for sometime.

SULPHUR (S)

Sulphur is present in all cells of the body, primarily in the cell protein containing amino acids, cystine, cysteine and metheonine. The hormone insulin, the two vitamins biotin and thiamin also contain sulphur. In addition to these other organic compounds such as heparin, glutathione, coenzyme-A, lipoic acid, taurocholic acid also contain sulphur. Wool is rich in cystine and contain about 4% sulphur. Keratin, a protein of hair, hoofs etc. is rich in sulphur containing amino acids. Small amount of inorganic sulphates, with sodium and potassium are present in blood and other tissues.

METABOLISM

The metabolic importance of some sulphur containing compounds reside in the sasy interconvertiblity of disulphide and sulphydril groups in oxidation reduction reactions.

FUNCTION

Deficiency of sulpuhr does not occur. Excess of sulphur may sometime occur, when birds are fed large quantity of it as anticoccidial drug sulphur replaces phosphorus and ‘sulphur rickets’ may supervene.

DEFICIENCY SYMPTOMS

Deficiency of this element in the body is not usually considered, since the intake is mainly in the form of protein and deficiency of sulphur would indicate a protein deficiency. However, in ruminant diets in which urea are used as a partial nitrogen replacement for protein nitrogen, sulphur may be limiting for a synthesis of

cysteine, cystine and metheonine. There is evidence that sodium sulphate can be used by the micro organisms more efficiently than elemental sulphur.

SOURCE

Sulphur is present in all cells of the body. The hormone 69nsulin, the two vitamins biotin and thiamin also contain sulphur. Other organic compounds such as heparin, glutathione, coenzyme-A, lipoic acid, taurocholic acid also contain sulphur.

5.0 MICRO OR TRACE ELEMENT

MANGANESE (Mn)

This is present in the soil and all forage plants contain sufficient amount. In body all tissue contains manganese, which is particularly abundant in the liver.

Manganese acts as a cofactor for many enzymes, especially those that take part in 'Kreb cycle'.

FUNCTION

1) In vitro activation of enzyme like arginase, cystine, enolase.
2) Amino acid metabolism.
3) It involves in the mucopolysaccharide synthesis and bone matrix cell maturation in the chicks.
4) Enzyme system involved in the oxidative phosphorylation in mytochondria.
5) Synthesis of fatty amino acids and incorporation of acitate into cholesterol also need manganese for their functioning.

DEFICIENCY SYMPTOMS

1) Reduced growth
2) Decrease reproductive performance in both M/females
3) 'Perosis'(Crippling leg deformities) and is characterized by gross enlargement and malformation of the tibiometatarsal joint, twitching and bending of the distal end of the tibia and proximal end of tarsometatarsus, thickening and shortening of leg bone and slippage of the gastronemiouso of achilles tendon of its condoyle. It shows skeletal and postural defect.
4) Muscular weakness, increased fatness, irregular oestrus cycle in gilt, resorption of fetuses or birth of small (neonatal ataxia).

SOURCE: Whole rice is wonderful, contains about 420ppm, all the cereal grains except for maize, most green food.

IRON (Fe)

About 65% of the total body iron is present in the form of haemoglobin (which contains about 0.34%of the element). Myoglobin accounts for another 4 percent, 1% in the form of various haemo enzymes that control intracellular oxidation, 0.1% in the form of transferrin in blood plasma. 15%stored in the form ferrtin or haemosiderin and 10-15% probably in the other forms. Broadly iron is utilized in the body for:

FUNCTION

a) Transport of oxygen in tissues.

b) For maintenance of oxidative enzyme system within the tissue cells.

c) It is also concerned in melanin formation.

Without all these important functions life would cease within a few seconds.

DEFICIENCY SYMPTOMS

A deficiency may result from inadequate intake or inadequate absorption.

1) Gastrointestinal disturbances as well as blood loss result anemia.

2) Disturbance in formation of haemoglobin compound

3) Skin colour may be reddened

4) Decrease growth rate

5) Hypochromic, microcytic anemia with poikilocytosis, achromatrichia

6) Feather may show depigmentation

7) In pig, chronic anaemia are (poor growth, rough hair coat, wrinkled skin, listlessness, paleness of snout, ear and mucus membranes.

8) Anemic pigs are more succeptible to the lethal action of bacterial endotoxin or transmissible gastroenteritis virus than their littermates that redeive Fe supplementation.

SOURCE

1) Green leafy materials
2) Leguminous Plant and seed coat
3) Bone meal
4) Liver and meat meal

ZINC (Zn)

Zinc has been found in every tissue in animal body. The elements tend to accumulates in the bone rather than liver, which is the main storage organ of many of the other trace elements. It occurs in chicken body only in trace and highest concentration in the epidermal tissue like feather and skin. It is trace amount found in bone and blood . A severe zinc deficiency causes numerous pathological changes, including skin parakeratosis, reduced or cessation of growth, general debility, lethargy, and increased susceptibility to infection (Miller, 2008).

FUNCTION

1) Zinc is an integral part of the carbonic anhydrase, which is present in RBC.
2) It is component of lactic dehydrogenase, so it is important for interconversion of pyruvic acid and lactic acid.
3) Digestion of proteins in gastrointestinal tract.
4) High concentration has been found in skin, hair, wool of animals.
5) It is used for healing of wound.
6) Carbonic anhydrase plays an important role in the lungs, in bone calcification and in the egg shell formation.
7) Metabolism of vitamin A, riboflavin, acid, biotin, pantothenic and linoleic acid.

DEFICIENCY SYMPTOMS

1) Retarded growth
2) Disorder of bone
3) Parakeratosis (Skin disease sore n itching)
4) Disorder of the feather and hair coat

5) Reduced efficiency of feed utilization
6) Delay sexual maturity, sterility and loss of fertility
7) Loss of appetite
8) Keratinization of tongue and cardia of stomach
9) Unsteady gait (abnormal leg in poultry)
10) The long bone becomes thicker, shorter and crocked
11) The joint become enlarged and thickened
12) Low intake of feed and water in young chicks
13) Chicks develop necrotic dermatitis in leg and feet.
14) Difficult in breathing
15) Reduced egg production and hatchability
16) Heavy mortality in hatched chicks.

SOURCE

1) Wheat standard middling.
2) Sunflower oil seed meal.
3) Molasses
4) Fish meal and meat meal.
5) Yeast
6) Zinc oxide.

COPPER (Cu)

The roll of copper appears to be catalyst since it is not a part of the haemoglobin molecules. Soon after demonstration of the essential roll of copper in haematopoisis, several enzymes with oxidation function were shown to contain copper. Copper is present in most of the soil inadequate quantities. It is also present in the body in most of the tissue.

FUNCTION

The functions of copper are:

1) It controls the absorption of iron from the intestine.
2) It controls the utilization of iron from the intestine.
3) It is a component of cytochrome oxydase.

4) It activates ascorbic oxydase, tyrosinage, succinate oxidase.
5) It regulates the rate of phospholipidssynthesis.
6) It is a component of mitochondria.
7) Copper plays an important role in the formation of haemoglobin as well as in the maturation of erythrocytes.

DEFICIENCY SYMPTOMS

1) Spontaneous fracture of bone.
2) Demyelination of the central nervous system.
3) Pigmentation of structure of hair, feather and wool.
4) Fibrosis of the myocardium
5) Scouring (dirrhoea) in cattle
6) Aortic rupture
7) Decrease reproductive capacity and milk production.
8) Steely wool in ship
9) Fatal syncope in cattle(falling disease)
10) A swelling of ends of the long bone
11) Stunted growth and leg weakness
12) Anemia and internal haemorrhage
13) Mortality may be very high due to internal bleeding
14) Decrease in egg production
15) Hatchability of egg is significantly reduced.
16) The embryo shows early mortality, generally 10 days of incubation.
17) In young pig microcytic hychromic anaemia.
18) Crooked leg with bone disorders, poor appetite, retard growth, cardiac hypertrophy, reduce erythrocyte life span and ataxia.

SOURCE

1) Liver and glandular meal contains about 90ppm.
2) Corn distillers dried soluble
3) Dried whey
4) Peanut meal

5) Cotton seed meal

IODINE (I)

As early as 1820, a Swiss physician, J. Francosis, Coindet, first recommended iodine as a remedy for goiter – a disease result in a swelling of thyroid gland. As far as is known the role of iodine in the animal body is related solely to its function as a constituent of thyroxin and other related compounds synthesized by the other compound. Hence a deficiency of iodine comes the structural and then physiological abnormalities of thyroid gland and there by affect entire animal body.

FUNCTION

The functions of thyroxin and thyronine are as follows.

1) It affects circulatory dynamics.
2) It influences neuromuscular functioning
3) It influences physical and mental growth and differentiation and maturation of tissues.
4) It affects other endocrine glands, especially hypophysis and gonads.
5) Calorigenic effects (exercise control of the rate of energy metabolism or level of oxidation of all cells).
6) Thyroxin has an effect on the integument and it's outer growths, hair, fur and feathers.
7) It influences the metabolism of blood nutrients, including various minerals and water.
8) In cold blooded animals thyroid hormone action is manifested by a) an effect on the differentiation and function of the nervous system,

b) an effect on the skin and its derivatives and c) a role in metamorphosis.

DEFICIENCY SYMPTOMS

1) Iodine deficiency is characterized by endemic goiter, resulting in cretinism (severe hypothyroidism and resulting in Physical n mental stunting) and myxedeima (dropsy like swelling of face and hands).
2) Greatly retards growth, including a delayed osseous development which results in dwarfinism in humans known as "cretinism".

3) Severe deprivation of iodine is accompanied by a delay in almost all development process.
4) Mental dullness in young and apathy (spritlessness) in young and old.
5) Slow pulse rate
6) Dryness and wrinkling of skin
7) Falling of hair
8) Dulling of mental activity.
9) Stoppage of egg production.
10) Birds show the classical goiter.
11) Delay hatching and low hatchability and yolk retention in hatched chicks.
12) Production of hairless pigs with thickened skin and sub cutaneous edema, die within a few hours.
13) In hypothyroidism, pigs appear stunted growth, leg bones were shorter than normal, there was labour bredthing, lethargic and reluctant to move.

SOURCE: Foods of marine origin are very rich in iodine, fish meal, meat meal, bone meal, molasses are the richest source and synthetic iodized common salt.

FLUORINE (F)

Fluorine as fluoride is present in various tissue of the body, particularly in bone and teeth. Normal bone contains 0.01-0.04/% of fluorine as an integral part of the molecule and thus is an essential mineral.

FUNCTION

1) By combining with calcium phosphate, fluorine hardens tooth enamel and so helps to guards against tooth decay.
2) It enhances growth in rats.
3) In adult osteoporosis is retarded by fluorine.

DEFICIENCY SYMPTOMS

1. Teeth become pitted and worn until the pulp cavities are Exposed
2. Drastic reduction in appetite
3. Causes fatty degeneration
4. Disturb osseous metabolism

5. Inhibit Certain enzymes concerned with carbohydrate and lipid metabolism

SOURCE: Mineral mixture.

COBALT (Co)

The cobalt is an essential mineral nutrient for ruminants. A number of disorders of c/buffalo and sheep characterized by emciation and listness typical of a mal nutrition have been recognized for many years and have given a variety of local names are bush sickness in New Zeland, coast disease in south Australia, wasting disease in western Australia, nakuruitis in Kenya, pining in U.K.etc.

FUNCTION

1) Activation of ion in certain enzyme reaction.
2) In ability of the rumen micro organism.

DEFICIENCY SYMPTOMS

1) Straggly (irregular), and rough wool in sheep
2) Severe anemia with almost complete appetite failure
3) The anima is dull and listless
4) Blanched or pale anemic look exposed skin around the eye and mouth
5) Blood volume may be reduced due to the oxygen carrying capacity or the blood is markedly reduced
6) There is total absence of body fat, on the other hand liver become fatty.

SOURCE

1) All plants and animal material
2) Legumes are richer sources
3) Liver meal

MOLIBDENUM (Mo)

It is nutritionally essential mineral. It was known as toxic in element when present in excess in animal feeds. It is essential element for formation and maintenance of normal levels of xanthine oxidase enzyme in the liver and intestine of chicks.

FUNCTION

1) Stimulate growth

2) In land it helps in better utilization cellulose
3) Molibdenum is constituent of the enzyme xanthene oxidase, which is metalloflavo protein
4) Enzyme is involved in metabolism in purines. This enzyme catalazes hydrogenaton of hypoxynthine as well as xanthene, leading to the formation of uric acid. Thus uric acid excretion decreases significantly in chicken fed molybdenum deficient diet Obviously Mo is much important in poultry than in mammals, because uric acid is the major end product of protein catabolism in birds.
5) It is apparently in haemoglobin synthesis.
6) It provides along with iron prevents the generally occurring decline in the haemoglobin levels during the first week of chicks.

DEFICIENCY SYMPTOMS

1) Molybdenosis
2) Natural condition have not been reported
3) Retarded growth in chicks.

SOURCE

Cabbage, Liver, glandular meal, Soybeans, Peas, Alfalfa and cereals.

SELENIUM (Se)

The selenium of forage causes toxicity by promoting alkali disease of blind stagger in cattle. Selenium is an essential nutrient despite its toxicity in larger intakes. Animals grazing on certain soil suffered from retarded growth and reproduction. It is essential mineral element in the diet of chickens

FUNCTION

1) It acts as non-specific antioxidant
2) It protects against peroxidation in tissue and membranes
3) Participation in the biosynthesis of ubiquinone
4) Participates in hydrogen transport along with respiratory chain
5) Prevents degeneration and fibrosis of the pancreas in chicks
6) Selenium influences the absorption and retention of vitamin E and

triglycerides in at least three ways.

7) Selenium like Vitamin E seems to function as an antioxidant and is protection of unsaturated tissue lipids against peroxidation.
8) Apparently selenium like vitamin E, is involved in the formation of ubiquinon.

DEFICIENCY SYMPTOMS

<0.05 PPM is feed producing muscular dystrophy

1) Atrophy of exocrime glandular tissue of the pancreases resulting in loss of joining of the cells
2) Decreased production of the enzymes
3) Tocopherol level of the blood is lower
4) Stunted growth, Poor feather development and degeneration of pancreas.
5) Selenium toxicity causes retarded growth, low egg production, decline in the hatchability, embryonic abnormalities is shown.

Non specific condition

1) Neonatal mortality
2) Chronic dirrhoea
3) Unthriftiness in weaner calves/ lamb
4) Infertility

SOURCE: Fish meal, kidney, pancrease, liver

CHROMIUM (Cr)

FUNCTION

1) Glucose utilization
2) It acts as a cofactor with insulin at the cellular level
3) Take part in metabolism of lipids
4) It involves in protein metabolism

DEFICIENCY SYMPTOMS

1) Impaired growth
2) Reduced lifespan

3) Corneal lesion
4) Defects in sugar metabolism

FUNCTION

1. Glucose utilization
2. It acts as a cofactor with insulin at the cellular level
3. Take part in metabolism of lipids
4. It involves in protein metabolism

Possibly essential mineral elements:

There are some mineral elements which are possibly essential. They are Arsenic, Barium, Bromine, Cadmium, and Strontium.

6.0 SUMMARY AND CONCLUSION

In animal life mineral elements are most important for maintaining their life process, physiological function, production and reproduction. There are macro and micro elements. Both of them are equally important. As their function in the animal body and their deficiency symptoms as well as concern to the metabolism of food stuff, hormones are related to the different physiological function, absorption of food stuffs, excretion of waste materials, maturation of animal body homeostasis in the animal body, circulation, vision, movement, shape and size of the body etc are plays an important role. Each chemical has its own function, so every element is equally important. In this way life is one kind of chemical composition. So in animal feed stuff should balanced mineral which make their life become easier to normal.

The animal needs feed for maintaining themselves, i.e. for basic physiological process, as well as restoring wear and tear of various body tissues. This is their maintenance requirement. The other requirements are for growth and production which include reproduction, production of milk, meat, egg, wool etc. Farmers can reduced their cost by choosing right kinds of feeds, avoid over feeding and maintain production by meeting the animal requirement of the mineral element. So, minerals are very important in animal life, without mineral elements life process will not be possible. Finally, “No mineral element, no life”.

Appendices

1. TABLES

Table No. 1: Approximate content of ash in animal body (% of live weight)

Approximate content of ash in animal body (% of live weight)		
Species	Content at birth	ash content in Mature
Swine	3.2	2.8
Chicken	1.9	4.2

Table No. 2: Approximate percentage contents of mineral elements in body ash of adult animals

S. No.	Elements	Content %
1	Calcium	28.5
2	Phosphorus	16.6
3	Potassium	4.8
4	Sulphur	3.6
5	Chorine	3.5
6	Sodium	3.7
7	Magnesium	1.1
8	Iron	0.15

* It varies in different animal species

Table No. 3: Range of calcium in soft tissue of animals (mg/100 gm fresh tissue)

Tissue	Ca content	Tissue	Ca content
Muscle	5-14	Spleen	9-15
Skin	6-20	Lungs	10-25
Kidney	6-20	Liver	10-30
Brain	8-23	Intestine	13-15
Heart	8-25	Cartilage	50-95

Table No. 4: Average Ca exchange indices in animals

Ca mg/day	Pigs	Calves	Sheep	Goat
Lived weight (kg)	35	50	43	72
Utilized	11000	5800	3000	9400
Metabolized in the body (mg)	14900	33000	20000	3200
Absorbed	4700	5300	800	1100
Endogenous faecal	1450	500	500	800
Eliminated with faeces	7800	1120	2700	9100
Eliminated with urine	110	10	50	80
Deposited in skeleton	13300	15000	5000	2300
Excreted from skeleton	10200	10300	4750	2250

Table No. 5: Distribution of fecal and urinary Ca excretion

Species	**Age yr.**	**Gram/day**		
		Ca Intake	**Faecal Ca**	**Urine Ca**
Man:(male)	11-16	1.8	1.01	0.127
	23	1.4	1.23	0.072
(female)	14-16	0.88	0.66	0.194
	55-63	0.71	0.59	0.159
Cattle	Young Adult	29.00	27.00	0.500

Table No. 6: Calcium requirement of chicken at various levels of production

Production level	**Calcium requirement (gm/day**	
	24-40 weeks age	**After 40 weeks age**
100	3.3	3.7
90	3.0	3.3
80	2.7	3.0
70	2.3	2.6

Table No. 7: Mineral requirements in the diet of breeding chickens

Mineral	ARC (1975)	NRC (1971)	ISI (1979)
Calcium %	2.7-3.2	2.75	2.75
Phosphorus %	0.5	0.5	0.5
Sodium %	0.1	0.15	-
Magnesium %	0.25	0.10	-
mg/kg			
Chloride	900	800	-
Magnesium	400	500	-
Manganese	50	33	55
Iron	-	80	20
Copper	-	4.0	2.0
Zinc	60	65	-
Iodine	0.2	65	-
Selenium	-	0.1	-

Table No. 8: Mineral requirements in the diet for grower

Mineral	**(In percentage or amount per kg of feed)**	
	NRC (1971)	
	6-14 weeks	**14-20 weeks**
Calcium (%)	0.8	0.5
Phosphorus (%)	0.4	-
Sodium (%)	0.15	-
Potassium (%)	0.16	-
Manganese (mg)	-	55
Iodine (mg)	0.35	1
Magnesium (mg)	-	-
Iron (mg)	-	20
Copper (mg)	-	2
Zinc (mg)	-	-
Selenium (mg)	-	-

Table no. 9: Toxic level of Inorganic Elements for poultry

Element	Age of bird	Compound	Toxic level (ppm)	Effect
Copper	Immature	CuSO4	324 (Practical)	Reduced Growth and Muscular dystrophy
Copper	Immature	CuSO4	1720 (Purifieddiet	Mortality
Fluorine	Immature	NaF	1000	Reduced Growth
Iodine	Laying hen	KI	625	Reduced egg Prod., size n hatchability
Magnesium	Immature	MgSO4	400	Reduced Growth
Selenium	Laying hen	---------	10	Reduced hatchability
Sodium	Laying hen	Na2SO4	1200 (winter)	Reduced egg Prod.
Sodium Chloride	Immature	NaCl	7000 (winter)	Reduced Growth n Mortality
Sodium Chloride	Laying hen	NaCl	10000 (winter)	Reduced egg Prod., Mortality
Zinc	Immature	ZnSO4	15000	Reduced Growth
Zinc	Immature	ZnO	3000	Reduced Growth

Table no 10: The common supplements and their content of Calcium and Phosphorus

Supplements	Calcium (%)	Phorus (%)
1) Dicalcium Phosphate	26.5	20.0
2) Defluorinated rocphosphates	29.36	12.18
3) Dry, steamed animal bone	29.0	13.6
4) Ground limestone	33.8	--
5) Calcium phosphate	17.0	21.0

6) Bone ash	22.0	13.1
7) Sodium phosphate	--	22.4
8) Diammonium phosphate	--	20.0
9) Oyster shell, Chalk powder, Marbal chips	35.0	--

Table No. 11: Requirement of Mineral Elements in the diet of Chicks

Minerals (0-8) weeks (%)	**Starter diets (8-20) Weeks (%)**	**Grower diet 20 Weeks onward (%)**	**Layer diet (%)**
Calcium	1.0	1.0	2.75
Phosphorus	0.5	0.5	0.5
Sodium	0.15	0.12	0.12
Potassium	0.4	0.4	0.4
Chlorine	0.15	0.1	0.1
	mg/kg	mg/kg	mg/kg
Magnesium	500	500	500
Manganese	50	50	33
Zinc	40	40	60
Iron	80	40	40
Copper	5	5	5
Molybdenum	0.2	0.1	0.1
Selenium	0.5	0.1	0.1
Iodine	0.35	0.35	0.3

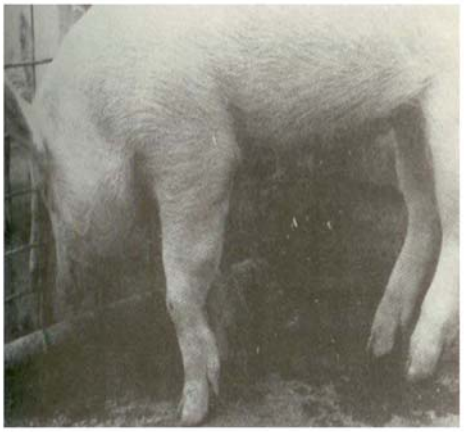
Table No. 12: Requirement of Mineral Elements of swine Allow Feed Ad Libitum (90%DM.)

	Swine liveWeight (kg)				
Mineral	1-5	5-10	10-20	20-50	50-100
Calcium (%)	0.90	0.80	0.70	0.60	0.50
Phosphorus, total (%)	0.70	0.65	0.60	0.50	0.40
Phosphorus, available (%)	0.55	0.40	0.32	0.23	0.15
Sodium (%)	0.10	0.10	0.10	0.10	0.10
Chlorine (%)	0.08	0.08	0.08	0.08	0.08
Magnesium (%)	0.04	0.04	0.04	0.04	0.04
Potassium (%)	0.03	0.28	0.26	0.23	0.17
Copper (mg)	6.0	6.0	5.0	4.0	3.0
Iodine (mg)	0.14	0.14	0.14	0.14	0.14
Iron (mg)	100	100	80	60	40
Manganese (mg)	4.0	4.0	3.0	2.0	2.0
Selenium (mg)	0.30	0.30	0.25	0.15	0.10
Zinc (mg)	100	100	80	60	50

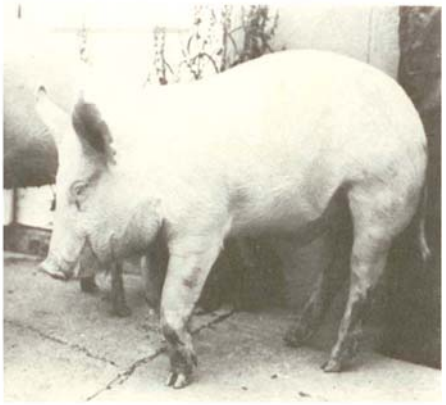
2.0 SOME PHOTO CLIPS

Manganese deficiency. Perosis - enlargement and malformation of the hock joint

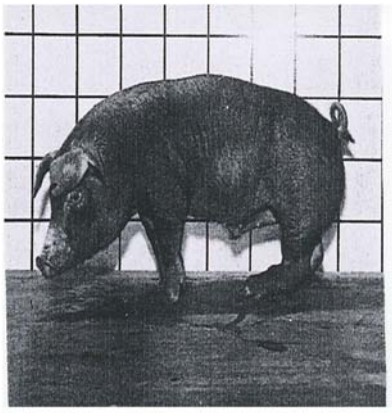
Distorted snout caused by Nutritional Secondary Hyperparathyroidism (NSH)



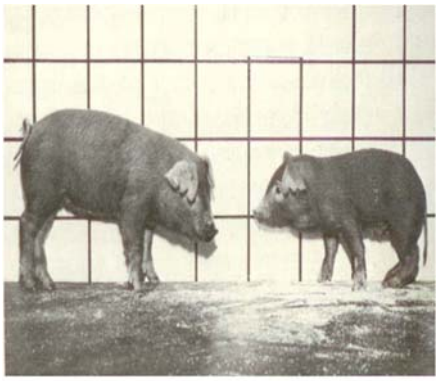
Bowed legs in pig due to calcium deficiency



Lead toxicity. Lameness and flexed carpal joints



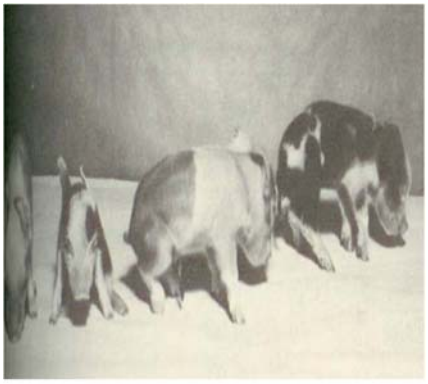
Enlarged joints and crooked hind legs due to Phosphorous deficiency



LEFT: Magnesium deficiency. Note extreme leg weakness, bowed back and the general unthriftiness

Effect of inadequate Zinc on growth rate (fed with 46, 36 and 24 ppm of zinc)

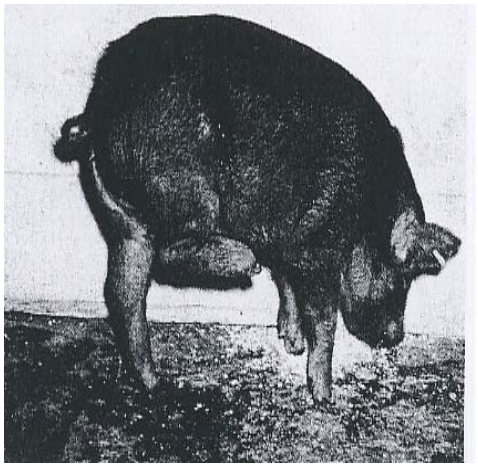
Parakeratosis
zinc deficiency in pig.



Weakness and poor sense of balance at birth. Manganese deficiency.

Increased fat deposition.
Manganese deficiency

Right: Growth limitation due to iron deficiency



Teacher's Instruction

- Classification of minerals and vitamins
- Show the picture of different deficiency symptoms.

Unit 5
Feeds

Learning Outcomes

On completion of this chapter, the students will be able to:

- Enlist different feed ingredients
- Explain the method of processing, mixing and storage of feeds

Feed (s): Edible materials(s) which are consumed by animals and contribute energy and/or nutrients to the animals diet. (Usually refers to animals rather than man (AAFCO, 2000).

We can conveniently classify feeds into three main types: (1) roughages, (2) concentrates, and (3) mixed feeds. Roughages include pasture forages, hays, silages, and byproduct feeds that contain a high percentage of fiber. Concentrates are the energy-rich grains and molasses, the protein- and energy-rich supplements and byproduct feeds, vitamin supplements, and mineral supplements. Mixed feeds may be either high or low in energy, protein, or fiber; or they may provide "complete" balanced rations.

- **Complete feed:** A nutritionally adequate feed for animals; by specific formula compounded to be fed as the sole ration and is capable of maintaining life and /or promoting production without any additional substances except water (AAFCO, 2000).
- **Concentrate:** A feed used with another to improve the nutritive balance of the total and intended to be further diluted and mixed to produce a supplement or a complete feed.
- **Supplement:** A feed used with another to improve the nutritive balance or performance of the total
- **Premix:** A uniform mixture of one or more microingredients with diluents.
- **Additive:** An ingredient or combination of ingredients added to the basic feed mix or parts to fulfil a specific need. Usually used in micro quantities and requires careful handling and mixing (AAFCO, 2000).
- **Compound feed:** A mixture of products of vegetable or animal origin in their

natural state, fresh or preserved, or products derived from the industrial processing thereof, or organic or inorganic substances, whether or not containing additives, for oral feeding in the form of a complete feed (HMSO, 1992; see also formula feed).

- Feed ingredients are broadly classified into cereal grains, protein meals, fats and oils, minerals, feed additives, and miscellaneous raw materials, such as roots and tubers.

Fig. Soya cake

maize

Mustard Cake

Processing of feeds

Objective of the processing

1. *To make more profit*: feed efficiency can be improved by 10% and occasionally by 15-20% by changing the methods of processing
2. *To alter particle size*: Increased feed intake or digestibility
3. *To change moisture content*: Make safer to store (reduced at 10% level)
4. *To change the density of feed*: Bulky feed reduce feed intake. Grains are flaked rather than ground or pelleted
5. *To change palatability*: To increase acceptability and feed intake. Molasses and fats are added to improve flavor of the feed
6. *To increase nutrient content*: When feed alone in their natural state, few feedstuffs meet the requirements of animals
7. *To increase nutrient availability*: Starch and protein appear to be less available in jowar than other grains but processing improves feeding value of jowar
8. *To detoxify or remove undesirable ingredients*: Considerable control of gossypol is possible by heating

9. *To improve keeping quality*: High moisture grains may be preserved by either drying or chemical treatment (adding an organic acid)
10. pellete feed procing method

11. To lesson moulds, salmonella and their harmful substances: Feeds are subjected to a certain process to ensure safety and avoid contamination especially from moulds and salmonella.

Mills used in the feed industry

1. *Hammer mills*: These mills use impact grinding principle to reduce particle size of feeds. Hammer mills are used for both concentrates and forages. It has been used for farm, commercial and custom grinding for many years.
2. *Roller mills*: These are used in feed processing for the crimping or crushing of grains. The roller mill consists of two rolls rotating in opposite directions at the same speed or at different speeds. If the rolls are operated at the same speed, the reduction is crushing, and if different then cutting and shearing takes place.

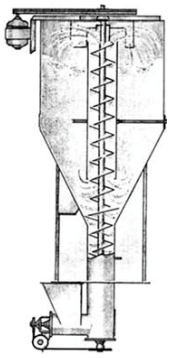
Mixing of feeds

The compounding of animal feed includes processing of raw materials of wide ranging physical, chemical and nutritional characteristics into a homogenous mixture suitable to obtain a desired nutritional response from the animals. Cereals, oil seedcakes, soybean meal, meat meal, blood meal, fishmeal undergo processing prior to their inclusion into a compounded feed.

Mixing

1. **Mixing of ground materials:** Small quantities of animal feed can be adequately mixed manually. The ground raw materials should be layered one above another, and then mixed and turned to form one heap. Mixing of the heap at least 3-4 times may produce an acceptable product. Micronutrients such as vitamins, minerals, antibiotics and others are first mixed with diluents such as wheat bran and then it is added to ensure uniform mixing.
2. Feed mixtures

- **Vertical mixer:** It is used in thousands of feed mills and farms. They may be single crew or double for elevation the material, however single crew is popular. These are relatively inexpensive and do good job of mixing most ingredients.
- Vertical mixer



- **Horizontal mixer:** Commonly used in larger feed mills. This mixture has right and left hand augers which convey the materials from one end to the other while it is tumbled within mixture.

Merit and demerits of the mixers

Attribute	Vertical	Horizontal

Cost	Inexpensive and do a good job of dry mixing	Expensive and do a good job of dry and liquid mixing
Use	Used in medium feed mills and farms	Used in small mills as well as a larger feed mills
Floor space	Requires less floor space	Requires more floor space
Time	Require 20 minutes or more time per batch mixing	Require 3-5 minutes per batch mixing
Power requirements	Consumes less power	Consumes more power
Discharge of mixed feed	Opening at one place	Opening at several places
Cleanout	Lesser extent	Generally 100% and is more efficient
Mixing efficiency	Lower mixing efficiency	Higher mixing efficiency
Liquid addition	Liquids such as molasses, fats cannot be effectively mixed	Molasses , fats etc can be mixed effectively

Liquid addition

The addition of various liquids to feeds is a normal practice. These include molasses, vegetable and animal fats, fish soluble, phosphoric acid, choline chloride, etc. These are added to enhance palatability (molasses), energy (fats) and other nutrient content of the ration. Liquids are preheated to reduce their viscosity. Molasses are heated to 95-100^{0}F while fat to 140-210^{0}F.

When liquids are added to the mixer, they should be sprayed over the entire length of the mixture.

Packaging

Compound feeds, whether in meal or pellet form are packed in bags. Bags may be filled directly from mixers, pelleted coolers or holding bins and weighed before sealing. Bags may be of jute, cotton, paper or plastic and can be hand or machine stitched or tied with string.

Storage of feed

- Feed ingredients which are dry before processing should be kept dry and cool and used on a first-in, first-out basis. As a general rule the moisture percentage should be less than 13% particularly in humid and/or tropical areas (Cruz, 1996; Parr, 1988).
- The tanks in which these ingredients are commonly stored should be cleaned monthly, or as indicated by experience, to prevent the build-up of dust and fragments of feedstuffs. Such build-up creates habitat for mould (and therefore the possible production of mycotoxins) and insects which will quickly destroy the food value of the products being stored; heat is also produced by these organisms and spontaneous combustion resulting in serious ingredient losses, and possible property losses may occur. The elevator legs, other conveying equipment and spouting should also be routinely inspected and cleaned out for the same reasons.
- While processing may dilute or kill concentrations of mould and insects, keeping equipment and storage free of dust and build-up of old feedstuffs will prevent or at least reduce the possibility of contamination of the finished feed.
- Liquid ingredients such as tallow, amino acids, and molasses should be stored in accordance with manufacturers' recommended procedures to protect freshness.
- Fats and oils may need to be heated for ease of handling and/or have antioxidants added (to prevent lipid peroxidation and control off-flavors in food animals) to maintain quality (Hardy & Roley, 2000).
- In general, aquafeeds are usually composed of some highly perishable and often very expensive ingredients and care must be taken to keep both the feed ingredients and the finished feed away from contamination including heat and light, as well as biological factors such as mildew, insects, birds and rodents (Cruz, 1996; O'Keefe, 2000).
- Propionic acid and other antifungal agents may be used during processing, but these chemicals may adversely affect palatability and efficacy of the feed. Both the feed miller and the farmer/end user of the feed need to remember that heat, light, and moisture can damage feed and that sacked feed should be stored off the ground on pallets, and out of direct sunlight due to the damaging effects of

ultraviolet rays (New, Tacon and Csavas, 1995).

- Depending upon the source and nature of bulk feedstuffs, ingredient cleaning may be necessary. Most feed mills have grain cleaning systems, designed to remove broken seed, tramp metal, and other foreign materials which contaminate inbound ingredients from time to time.
- It is wise for the buyer to specify that dust (fines) and other contaminants shall not exceed a certain level. Inbound ingredients should be subject to rejection if contamination levels exceed specification.
- Aquatic animals are particularly sensitive to low levels of, for example, fumigants, and possibly mycotoxins, and for that reason great care must be taken in the choice, sourcing and handling of feed ingredients for aquaculture (Cruz, 1996).
- Bins, silos, warehouses, and ingredient handling systems should be designed so that moisture, rodents, birds and other pests are denied access. Regular cleaning of storage facilities will go a long way toward assuring a high quality finished product.
- One of the main components of receiving and storing is proper scheduling of the arrival of ingredients so as to minimize storage time and handling of the ingredients. Quality of ingredients, be they sacked supplements and/or medications, or bulk corn, or soybean meal, for example, may lose nutrient value or efficacy from excessive handling. Handling also invites problems with shrink.
- Misformulated, damaged or returned feed must be stored such that it cannot contaminate other feeding stuffs. Confirming analysis should be made to determine if such waste feed can be reprocessed, or must be destroyed. Here again a paper trail is important, especially for medicated feeds.

Teacher's Instruction

- Show the picture and real object of different feed ingredient
- Show the vedio of feed processing , mixing and storage of feed
- Visit the different feed industry.

Unit 6
Energy

Learning Outcomes

On completion of this chapter, the students will be able to:

- Enlist different forms of energy of feedstuff in animal body.
- Define the different forms of energy

The amount of energy locked up by the bonds that hold a molecule of feed stuff together cannot be determined by direct means. However, the amount of heat energy given off or absorbed when a molecule is formed or decomposed during a chemical reaction is determined by a metal instrument, which is called a bomb calorimeter.

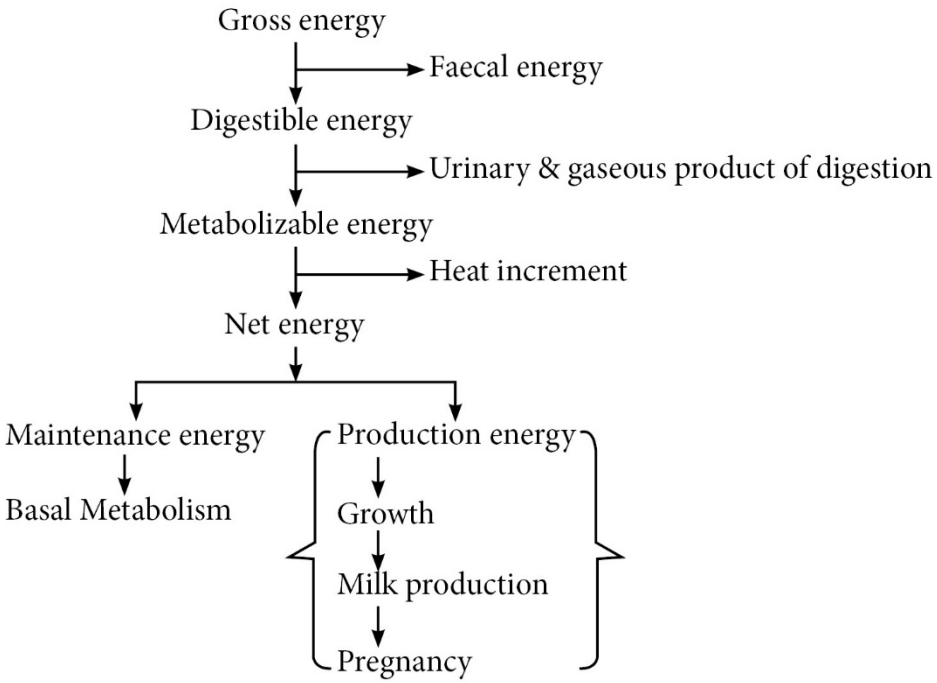


Fig. Flow Chart of Net Energy System

Net Energy System

By the use of respiration apparatus Kellner and Zuntz determined the losses of energy for mastication, digestion and assimilation. Armsby not only determined the energy required for mastication, digestion and assimilation of feed, but he also

determined the amount of heat and gases given off by the body in respiration calorimeter.

Partitioning of Energy

The energy value of feeds may be considered under the following heads:

Gross Energy

The energy given out in the form of heat when it is completely burned down to its ultimate oxidation product namely CO_2 and H_2O. The fat contains twice as much heat as the same quantity of carbohydrate.

Digestible Energy

All the heat produced by burning food in the bomb calorimeter is, however, not utilized in the animal body because food is not digested completely. The amount of energy excreted in the faeces from subtracted from gross energy gives the digestible energy of the feed.

Metabolizable Energy

In addition to the loss of energy in the faces, energy is also lost in urine and due to the rumen fermentation. When the losses in urine, feces combustible gases are subtracted from the gross energy intake, Metabolizable energy of feed is estimated.

Net Energy

Net energy is more scientifically sound for expressing energy requirements and energy value of feed. To arrive at the net energy calculation, energy spent in the work of digestion is also deducted. It is obvious that the movement of jaw in chewing a dry fibrous need energy. The secretion of digestive juices and microbial breakdown of the crude fiber also required energy. The heat thus produced is known as heat increment of the total effect namely chewing, mastication, absorption etc. The efficiency of energy use for maintenance, Pregnancy and lactation

Teacher's Instruction

- Enlist different forms of energy
- Show the flow chart of energy utilization by body & losses of energy.

Unit 7

Nutrition requirements of different stages and conditions of farm animals and birds

Learning Outcomes

On completion of this chapter, the students will be able to:

- Explain the nutrient requirements for different types of animals.
- Calculates the amount of nutrients or feed required for different types livestock.

Nutritionest defines nutrient as any food constituent or group of food constituent of the same general chemical composition that aids in the support of life. Water, protein, carbohydrates, fats, minerals and vitamins are the well recognized feed nutrients. They are to be ingested by the animal mainly for the following purposes.
Purposes :

1. Providing necessary elements for repairing wear and tear of the body.
2. Serving as a source of energy for vital process in the body, growth, work and production.
3. Providing raw material for synthesis of the body tissue in growth.
4. For generating heat necessary for maintaining body temperature, and
5. Serving as a raw material for the production of milk, meat, egg or wool

Common feed and fodder: Livestock derive their nutrients from a variety of feed stuffs. This material can be classified into different group on the basis bulkiness, moisture content and chemical composition. A generally accepted scheme of classification of livestock feeds is given as below:

Livestock feed

- Pasture
- Harvested feed
- Supplement and additive

Harvested feed

- Roughages

- Concentrated

Feed or feed stuffs

Food of animals comprising any naturally occurring ingredient or material fed to animals for the purpose of sustaining growth and development. The term is exclusively used for animals. In case of human it is food while for animals it is termed as feed.

7.1 Nutrition requirements for Dairy cattle

- Energy
- Maintenance

Energy value for maintenance of non milk producing adult cattle was determined from information received from feeding trials using indigenous animal in Africa and India. These values are 107, 98, 122, 121, 115 and 143 kcal/w kg $^{0.75}$. The average of these being 118 kcal/ w kg $^{0.75.}$ The maintenance requirement for non lactating and lactating cows is estimated to be 125 and 172 kcal ME/w kg $^{0.75}$ respectively.

Growth

Hughes et al (1997) found that Holstein calves fed a milk and concentrate diet at level sufficient to produce 0.25 and 0.75 kg daily gain required an estimated 100 kcal ME/ w kg 0.75 and 3.56 kcal ME/g body weight gain. These animals utilize the metabolizable energy in the ration at 1 to 1.13 for maintenance and gain respectively.

Pregnancy

Energy requirement for maintenance and growth has been shown in Table 3 at the end of this lecture note. The value for pregnant heifers can be determined by using the maintenance (ME) requirement given in Table 3 increasing the requirement by 30% during the seventh months, 50% during the eighth month and 80 % during the 9th month.

Lactation

The maintenance requirement cows are slightly higher than for non lactating animals. Van Es suggested that this may be 100 kcal ME/ w kg 0.758 for the non

lactating animal and 117 kcal ME/ w kg 0.75 for the lactating cow. The level of intake also greatly influences the utilization of feeds. It appears from the evidence available that the maintenance ME requirement for lactating cattle to developing cattle in developing countries is approximately 132 kcal/ w kg $^{0.75}$.

ME requirement per kg of 4 % FCM to be 1183 (Brown Swiss x Sahiwal), 1039 (Holstein Friesian x Hariana) and 1188 kcal (Temperate breeds). Sen et al (1978) recommended that 1188 kcal/ kg of 4 % FCM be used in calculating the ME requirement for Indian cattle.

Work

A value of 2.4 kcal ME/kg body weight /h has been assumed as a reasonable value for calculating the ME requirement of cattle for work.

***Example*:** Daily ME requirement of a 400 kg bullock:

ME maintenance requirement

400 $^{0.75}$ x 118 =10550 kcal

ME requirement for 4 hour work

400 kg (BW) x 2.4 x 4 = 3840 kcal

Total daily ME requirement 14390 kcal or 14.4 Mcal

ME maintenance requirement

400 $^{0.75}$ x 118 =10550 kcal

ME requirement for 8 hour work

400 kg (BW) x 2.4 x 8 = 7680 kcal

Total daily ME requirement 18230 kcal or 18.2 Mcal

These values are in agreement with Ranjhan's work reported in 1980.

Protein

The microbial activity of the ruminant tends to stabilize the biological values of protein ingested when compared to non ruminant animals. This is probably a result of the micro flora degradation of the ingested protein and ultimate utilization by the host animal of synthesized proteins of microbial origin. This type protein may have

a biological value of 80 %. A slightly lower biological value, however, is generally used in practical feeding program.

Maintenance

An average of 2.86 g DP/ w kg $^{0.75}$ has been used in estimating the DP maintenance requirement

Growth

The equation DP requirement for maintenance and gain are combined as follows:

DP requirement (g/d) = 2.86 w kg $^{0.75}$ + 0 .218 g (LWG) + 0.6631 kg (LW) – 0.001142 kg $(LW)^2$

This equation fits the requirement for N deposition and adjusts the DP requirement as influenced by the live weight.

Pregnancy

The DP requirements for the last 3 months of pregnancy have been calculated by using the same value as for comparable non – pregnant animals making comparable gain and adding 80 g DP to meet the requirements for the developing fetus and associated membranes. It is assumed that 400 g is average daily gain attributed to the products of conception during this period.

It has been suggested that the DP requirement has a direct relationship with the available energy. Suggested value ranges from about 15.6 to 28 g DOP/Mcal ME. The value given in Table 3 for mature pregnant cows (last 2 to 3 months of Pregnancy) average 21.66 g DP/ Mcal ME.

Lactation

The NRC (1971) recommends a DP requirement of 42 to 60 g/kg of milk containing 2.5 to 6% fat. A value of 55 g DP/kg 4 % FCM has been used in calculating the DP requirement as shown in Table 4.

Work

Certain percent of protein may need for work but not much literature is available in this regards for cattle. However, a protein rich feed is advisable to protect the animal from mal nutrition.

7.2 Nutrition requirement for Buffalo

Buffalo, like other ruminant, can convert poor quality forage / roughage feeds into usable sources of energy and other essential nutrient.

Energy

Maintenance

The recommended energy requirements as shown in Table 5 have been calculated using the equation;

125 kcal/ w kg $^{0.75}$ / d

Kurar and Mudgal (1981) found the ME intake of dry buffalo to vary between 100 and 147 kcal / w kg $^{0.75}$.

Growth

ME requirement per g of gain can vary from about 10 to 15.6 k cal /g gain for animal weighing from 200 to 500.

Example:

ME requirement for maintenance	400 $^{0.75}$ x 125 = 11175 kcal
Me requirement for body weight gain	13 kcal x 1000 g = 13000 kca
Total daily ME requirements	24175 kcal or 24.2 Mcal

Pregnancy

Assuming an animal of 500 kg the requirement could be;

ME requirement for maintenance:	500 $^{0.75}$ x 125 = 13212 kcal

Me requirement for growth of products of conception: 10 kcal x 400 g = 4000 kcal

Total daily ME requirements:	17212 kcal or 17.2 Mcal

Lactation

The maintenance requirement of lactating buffalo is about 38% higher than that of lactating cattle of comparable size. It is also clear that the efficiency of utilization of metabolizable energy for milk production is lower in buffalo than in cows.

The ME requirement for lactating buffalo is 137 kcal / w kg $^{0.75}$ /d. This value has been widely used in calculating the maintenance requirement of lactating buffalo.

Work

The energy requirement for work is influenced by several factors. Among these are the intensity and duration of the work, the environment and physiological condition in which the work is performed and the heath and condition of the animal.

The energy required for work is recommended as 2.4 kcal Me/kg body weight per hour.

Example: A 300 kg buffalo performing light work (4 hours) would require:

ME requirement for maintenance:	300 $^{0.75}$ x 125 = 9010 kcal
ME requirement for work:	300 kg (BW) x 2.4 x 4 = 2880 kcal
Total daily ME requirement:	11890 kcal or 11.9 Mcal.

Protein

Maintenance

Every animal, regardless of its diets or physiological function being performed will have urinary nitrogen losses. This losses is reasonably constant per unit of body size (w kg $^{0.75}$)

To maintain the protein in required level, a regular supply of protein to the animal is important. An average, 2.54 g/w kg $^{0.75}$/d gram protein is recommended and used to calculate the requirement as shown in Table 5.This value, which is 11 % below the 2.86 g/w kg $^{0.75}$ /d used to estimate the requirements of cattle, indicating the buffalo mare more efficient in utilizing protein for body maintenance.

Growth

It is much more difficult to estimate the DP requirement for growth for growth because nitrogen deposition varies with species and age of the animal.

DP for growth = 0.238 g DP/w kg $^{0.75}$ /g

The following equation has been recommended;

DP requirement (g/d) 2.54 w kg 0.75 + 0.238 g LWG + 0.6631 kg LW – 0.001142

kg LW^2

where,

LWG	= live weight gain
LW	= live weight
w kg 0.75	= metabolic body weight

The estimated values determined from the equation are given in Table 5. These value meet the dietary DP requirement of growing non – pregnant buffalo and pregnant buffalo during the first 7 month of gestation period.

Pregnancy (Last 3 months)

In addition to the maintenance requirement for DP (2.54 g DP/ w kg 0.75d), the buffalo dam must be provided sufficient nutrient to satisfy the 400 g of material being deposited in the products of conception. It is difficult to estimate this value because the body of a new born calves (or unborn fetus) contains a much higher % of water than that of growing animal. Assuming, however, that the value is comparable to the DP requirement for growth, 95 g will be needed daily.

Lactation

Protein must be provided to a lactating animal in sufficient amounts to meet its body maintenance requirements, offset amount secreted in the product (milk) and often allow for an embryo. During the early stage of lactation, especially with high producing animal, it is difficult to achieve this goal. In this situation, the animal will draw up the body reserves to meet its requirements. It is critical, therefore, that sufficient nutrients (including protein) should be provided during this stage.

The recommended value is 3.42 g/w kg $^{0.75}$ to estimate the DP requirements during the early and mid stage of lactation.

Work

There is no evidence that work increases the protein requirement above maintenance level. However, the PCARR (1978) suggest the following daily requirement;

- Light work = 90 g DP

- Medium work = 10 g and
- Heavy work = 130 g DP

Minerals

Mineral element is constantly being excreted from an animal's body. Therefore, constant supply of these essential nutrients is needed. Although the general consensus is that some of the "spent "minerals elements are recycled, some are excreted through the urine, feces and skin. Because of all these endogenous losses, animals require a relatively constant supply of minerals for maintenance. Also minerals are required for growth, production, and reproduction.

Mineral required for buffaloes includes sodium, calcium, phosphorus, sulfur, chlorine, cobalt, potassium, magnesium, iodine, iron, manganese, zinc, selenium, and copper. Other minerals such as fluorine, molybdenum, selenium, etc are required.

Calcium

An animal's net requirement for calcium is calculated from a summation of the various endogenous losses and the amount retained in the body or secreted with the milk.

The 23 to 25 g/d calcium is needed to maintain the adult buffalo. The estimated requirement used in Table 17 varies from 2.9 g/ kg for milk containing 5% fat to 4.1 g/kg for milk with 11% fat.

Phosphorus

The phosphorus requirement is between 12 and 17 g/d. Care should be taken to ensure that the Ca: P ratio does not exceed a ratio of 3:1.

Feeding concentrate and forage

A suitable ratio is needed to get maximum gain and product. A general rule is;

Roughage 90 %

- Cereal grass 70 % of 90 %
- Leguminous 20% of 90 %

Concentrate

- 10 % of 100 %.

Computation of ration for individual animals (cattle &buffalo)

In the computation of ration for cattle and buffaloes, the prime consideration is to ascertain and to meet up the total requirement in the terms of dry matter (DM), digestible protein (DCP) and energy (TDN) for 24 hours.

Requirement of dry matter (DM)

The requirement of the quantity of dry matter depends on the body weight of the animals and also with nature of its production. Cattle will generally eat daily 2 to 2.5 kg DM for every 100 kg body weight. Buffaloes and cross bred animals are slightly heavy eater and their dry matter consumption varies from 2.5 to 3 kg daily per 100 kg body weight. The matter allowance should be divided as follows:

Total dry matter (DM)

2/3 rd as roughages-

2/3 rd dry roughages or ¾th if sufficient legume is available

1/3rd green roughages (if the green fodder is legumes this proportion may be only 1/4th of the total roughages).

1/3 as concentrate

For example: For a cross bred cow weighing 400kg, the dry matter requirement will be provided as indicated below.

Total DM requirement (kg) = (4X 2.5) =10Kg.

(@2.5kgDM per 100kg body weight)

DM as concentrate (kg) = (10X1/3) = 3.33 or say3.5Kg

DM as roughages (kg) = (10X2/3) = 6.66 or say 6.5Kg

DM as dry roughages (Kg.) = (6.6X¾) = 4.95or4.9 Kg.

DM as green roughages (Kg.) = (6.6X¼) = 1.65 or 1.6 Kg.

Requirement of digestible protein & energy (DCP and TDN)

While calculating the total requirement of DCP and TDN one has to be consider the

physiological needs or say the purpose for which the animal has to be feed, i.e. whether the animal is just to maintain itself, advanced stage of pregnancy or animal under production in later case it is also necessary to consider the quantity and quality of milk.

Feeding Cattle and buffalo by thumb rule method

While considering the feeding schedule of adult dairy cattle, proper consideration should first be made for the purpose for which the animal has to be feed. These are:

1. Maintenance ration
2. Gestation ration
3. Production ration

1. Maintenance ration

This is the minimum amount of feed required to maintain the essential body process at there optimum rate without gain or loss in bodyweight or change in body composition.

Example

For Zebu cattle	for cross breed/buffalo
Straw 4kg	4-6kg
Concentrate mixture 1.0-1.25kg	2kg

2. Gestation ration

In the case of pregnancy, further allowance from the fifth month of pregnancy onwards most be made for proper growth of the foetus and to keep the mother fit for optimum milk production on calving. For this an addition to maintenance ration, further amount of 1.25 and 1.75 Kg. concentrate feed mixture is recommended for Zebu and cross bred Cows / buffaloes respectively.

3. Production ration

Production ration is the additional allowances of ration for milk production over and above the maintenance requirement. For Zebu cattle one Kg. additional concentrate is required for every 2.5 Kg. of milk over and above maintenance requirement while same amount of concentrate is required for every 2 Kg. of milk

for cross bred/Indian milch breed/ buffaloes.

7.3 Nutrition requirements for different stages Goat

The goat, being a ruminant, is able to live and be productive on fibrous vegetation of relatively poor quality. The goat is a natural browser, feeding by preference on tree leaves, flowers, and seed pods. Goats are able to eat quite woody stems of trees and bushes. They are very active when they eat, moving rapidly around a tree, picking off the best parts, and quick moving to the next tree or bush. Goats naturally prefer to eat at a height 20 -120 cm above the ground. Goats do not eat if the feed stuffs are dropped on the ground.

Colostrums Feeding

When young kids do not receive colostrums, postnatal mortality may be high. In fact colostrums not only supplies immunoglobulin, minerals and vitamins but it is also rich in lipids. The energy of milk lipid is important for thermoregulation of kids since adipose reserves are very limited at birth. If colostrums is not available (Due to early death of doe for example) following suspension can be made and fed to kids 3-4 times a day (Joshi et al , 2003).

Constituent	Quantity
Egg	1 Nos
Luke warm water	200 ml
Ordinary milk	300 ml
Liquid paraffin	10 ml.

Creep Feeding

To spare the milk for human consumption and to get a faster gain in kids, it is required to feed them a balance starter ration. After nursing the kids for 4 to 7 days on colostrums and milk, kids should be separated from their dams and kept away from on starter ration. They should be allowed restricted suckling 2 to 3 times a day or should be bottle fed a definite milk allowance. Free choice legume hay, mineral, and drinking water should be made available along with starter ration.

An example of starter/creep rations calculated to supply about 12 to 18 % DCP and

2.5 to 2.9 Mcal per kg feed is given below;

Table 1. Starter creep feeds*

Items	Feeds %						
	1	2	3	4	5	6	7
Mize	60	40	20	15	-	25	30
Barley/oats	-	23	45	40	40	40	30
GN Cake	20	20	20	20	22	10	10
Fish Meal	10	10	10	10	10	10	10
Molasses	7	7	2	3	5	12	7
Wheat bran	7	7	2	3	5	12	7
Mineral Mixture	2	2	2	2	2	2	2
Salt	1	1	1	1	1	1	1
Calculated value							
DCP	17	17	17	17	17	12	12
TDN	78	77	75	71	70	72	70
ME (Mcal/kg)	2.9	2.9	2.8	2.6	2.5	2.7	2.6

To 100 kg creep

- Add 150 g TM-5/Aurofac
- Add 25 g Vitablend Rovimix
- Linseed cake, sesame cake, , Mustard cake may be use to replace Ground cake on equivalent basis.

Feeding Schedule of Kids up to Weaning

Following feeding schedule can be used

Table 2.1. Feeding schedule for kids

Age of kids (days)	Number of feeding	Dams milk (ml)	Green fodder	Starter feed
1 to 7	With the dam	Dam'S milk	-	-
8 to 42	4	100	Ad lib	Offer creep

				feed ad lib
43 to 60 days	3	100	Ad lib	-

Simultaneously free choice hay of dubo, oat, cowpea, berseem, or lucern should be offered.

Grower's Ration

A complete ration providing 9 to 10 percent DCP and 62 to 65 percent dry matter from good quality roughage will meet the requirement. Fodders containing less protein and energy are to be balanced with the concentrate mixture as shown in below.

Table 2.2 Grower ration

Particular Ration	Percent in Feed			
	1	2	3	4
Maize	50	-	30	12
Dal chunies	-	-	30	35
Oats/Barley	-	50	30	-
Wheat bran	30	20	-	30
G.N.Cake	10	10	-	5
Molasses	7	17	7	5
Mineral mixture	2	2	2	2
Salt	1	1	1	1

Note:

- Maize can be substituted with jowar and rice polish
- Dal chunnies may be replaced with leguminous seeds like pea, gram, lobia etc.

Feeding of Pregnant Goats

High quality roughages provide the basic nutrients needed during the last 6 to 8 weeks of gestation when 70 to 80% gain in fetus mass is made. Therefore, liberal feeding of quality leguminous fodder and concentrate having 25% protein should be offered between 400 to 500 g depending upon the condition of doe should be fed.

A free choice lick of mineral mixture will take care for the calcium and phosphorus

requirement of dam and foetus. Allow good grazing if available and mahe sure that does get plenty of exercise.

Feeding of Lactating Goats

Nutrient requirements are higher during lactation. The ration for lactating does should contain high quality roughages like Lucerne, berseem, and other cereal grass that can supply mineral, vitamins, and protein and also the bulk needed for volatile fatty acid, viz., acetic acid, propionic acid, butyric acid needed for high milk production. To supplement more nutrients particularly of energy, cereal grains at the rate of 350 gram for each liter of milk must be provided.

Concentrate feed need to prepare adding 1% trace mineralized salt and 1 % calcium – phosphorus mineral mixture to concentrate mixture. Molasses of 5 to 7 % of concentrate mixture can be used to increase palatability and reduce dustiness of feed.

Keep a clean, fresh supply of water available at all time. After 2 weeks gradually increase the concentrate level to that suggested by the milk yield.

Feeding Breeding Bucks

During the non-breeding season, the buck does not require additional grain if the buck is under good pasture. During the breeding season, concentrate used to feed to the does can be fed @ 450-900 g (depending on the body weight). Care must be taken not to allow the buck to get too fat. Buck needs to have plenty of exercise.

7.4 Nutrition requirements for different stages of sheep

Bell 1978 found that sheep grazing rangelands spent 60 % of their time grazing grass, 30 % selecting herbs, and 10% eating brows. Sheep generally prefer to graze in the early morning and late in the afternoon. Generally sheep are good grazer and will adapt to many types of management system, feed resources, and environmental condition.

Feeding for Pre weaning Lambs

Up to 12 weeks of age lambs suckling the mother should be supplemented with creep mixture. Feeding of creep mixture has given a growth rate of 110 to 130 g

per \deal per day up to 90 days. Weaning age of the sheep is 120 days of birth.

Creep Mixture

Maize flour	67 percent
Groundnut cake	10 percent
Wheat bran	10 percent
Fish meal	10 percent
Common salt	1 percent
Mineral Mixture	2 percent

To 100 kg of above feed add 150 g TM – 5 and adequate vita blend to take care of Vitamin A requirements.

Growing and Finishing Lambs

Composition of Concentrate Mixture

Ingredients	Parts
Maize	25 parts
Wheat bran	40 parts
Groundnut	32 parts
Mineral Mixture	2 parts
Salt	1 part

Note: Ingredients of given concentrate can be replaced by following feedstuffs:

1. Maize, oat and Barley can be replace by Bajra, Wheat, Jowar; while using gram, groundnut cake can be reduced.
2. Groundnut cake can be replaced by Til cake, Linseed cake, Soybean meal, Cotton seed meal and Mustard cake.
3. 150 g TM – 5 and Vitablend may be added to the creep rations.

When good quality fodders such as green oats, cow pea, maize, dubo, or their hay is available that are harvested at 10% bloom stage, then following will be concentrate mixture;

Body weight (kg)	Concentrate mixture (g/d)
10 – 15	50
16-25	100
26-35	150

(b) When good quality hay is not available and animals are kept on dry roughage such as straw, stoves etc , than following quantities of concentrate may be fed;

Body weight (kg)	Concentrate mixture (g/d)
10 – 15	300
16-25	400
26-35	600

Adult Sheep

(a) Free choice maintenance quality fodders like oat hay, dub grass, maize, etc plus 100 concentrate mixtures may be fed. If leguminous roughage offered (like cow pea, lucerne, berseem etc) in sufficient amounts, the feeding of concentrate may be stopped for non – productive stock. Little straw may be provided with such roughage as to prevent digestive disorders. It is better to feed with them hays of these fodders.

(b) Absence of good quality fodders/hay, straws and stovers may fed ad lib. along with 400 g of concentrate mixture.

Breeding Rams

Generally rams are maintained on the same feeding system as ewe. In case they are over fat, they should be thinned by gradual reduction in feed. Forage feeds to be fed ad lib. During lean period 150 g of concentrate mixture can be fed with the mineral mixture. At the mating time 250 g to 500 g ofconcentrate needs to be fed.

Lactating

a) First 10 days: Legume hay ad lib. and recommended level of concentrate.

b) 10^{th} day of weaning: Feed200 g of concentrate mixture in addition to ad lib legume hay up to two and half month after maintenance allowances is

adequate.

Flushing

About weeks before the rams are let loose with sheep, 200 g of concentrate mixture plus good quality roughage can be given.

7.5 Nutrition requirement for Poultry

Principle of Poultry Feeding

- Poultry feeding is one of the important components of poultry rearing because the feed alone accounts for 60 to 65 % of the total farm expenses.
- High cost involved in poultry feed force to formulate the ration using the low cost ingredient without compromising its nutrient quality. While computing ration for poultry birds, following facts should be considered.

1. Birds needs more concentrate as they do not have lips and teeth.
2. Birds are having simple and short digestive tract so the digestion is quite rapid. It takes about two and half hour for feed to go from mouth to cloaca in the laying hen, and 10 hours in the non laying hen. Therefore the nutrient requirement of poultry are more precious.
3. Unlike ruminants, where micro organisms synthesize a sizable portion of amino acid, Vitamin B complex, Vitamin K in the stomach. The poultry completely dependent upon the dietary source for all such nutrients.
4. Poultry birds are fed collectively rather than individually.
5. Due to higher rate of metabolism, poultry require a more exact ration.
6. Care should be taken to select optimum C/P ratio for the purpose for which feeds are compounded.

Table 1: Need of C: P ratio

C:P ratio = Metabolizable energy in Kcal/kg diet % Protein in the diet	
The recommended C:P ratio for the diet of various classes of chickens are as under: ● Starter ration (0 to 8 weeks) ● Grower chicken (8 to 20 weeks)	 135:1 140: 1

• Layer chicken (20 Weeks onward) • Starter broiler chicken (0 to 6 weeks) • Finisher broiler chicken (6 week onward)	175: 1 135: 1 155: 1

Note: C: P = Calorie: Protein (C/P)

Methods of Feeding

1.0 Whole grain feeding system

2.0 Grain and Mass Method

3.0 All Mash Methods

4.0 Pellet Method

5.0 Restricted or controlled feeding

- The method involves restriction of feeding pullets during 6 – 20 weeks of age instead of *ad libitum* feeding.
- This method is practiced in recent years in most poultry farm. This method reduced in feed cost, delayed sexual maturity but improved egg production curve, with a reduction in the number of small eggs laid are some of the advantages of this system.

Method of feed restriction

- Skip a- day programme
- Alternate day feeding
- Restriction of feeding time

Types of Poultry Feeds

Poultry feeds are of the following three types:

1. **Starting Poultry Feed**: An all mash ration to be fed to chicks up to the age of 8 weeks.
2. **Growing Poultry Feed**: A ration to be fed to growing chickens after 8 to 20 weeks or until lying commence.
3. **Laying Poultry Feed:** A ration top be fed to laying birds after 20 weeks onwards or after laying commences.

Feeding Broilers

- A broiler which grow very fast and can be marketed during the ages between 8 to 12 weeks old.
- Broiler rations are especially formulated in such a way that they promote an early rapid growth.
- Usually broiler rations are prepared in such a way that so that the feed contains relatively high energy and high protein when compared with the feed of chickens other than broilers.
- A protein per cent between 22 to 24 are fed to broilers for the first 5 to 6 weeks to obtain rapid early growth.
- These rations are called broiler starter rations. After this period, broilers are fed with a different type of ration having relatively less protein and more energy for fattening. Such a feed is known as broiler finisher ration.

7.6 Nutrient requirement for Swine

Proper feeding is an extremely important item of management since feed represents a very high percentage of the total cost of production of pig, some time as high as 80 %. Pig grows at a very faster rate and thus the demand for feed very high. At birth the birth weight of piglets is about 1.4 kg and at an age of 18 months the body weight is 163 kg. Thus in 18 months, the weight is 120 times higher. Pigs are 12 times faster growing than calves.

Pig is omnivorous, i.e. it can eat all types of feed. Although it likes to graze or chew forage but due to the singe stomach they can not live entirely on roughages.

Characteristic of Swine and Their Production

1. **Superior feed conversion power**: The capacity of swine to convert vegetable concentrated feeds into animal protein such as in to pork, bacon etc has brought them an especial importance in the human diet. The can produce more live weight gain from a given weight of feed than any other class of meat animals. On average pigs can produce a kilogram of pork from 3.0 to 3.5 kg of feed.
2. **Swine store fat Rapidly**: No other animal produces per unit of live weight, so much fat in so short a time or at the expense of so little feed. The waste fat

problem in swine is very important. Feed efficiency will not be improved until excess fat is eliminated.

3. **Swine are prolific and bring quick return**. Swine grow rapidly, mature quickly and are prolific. A unit of 10 sows and 1 bore will produce about 160 piglets during the first year.
4. Enterprises Requires moderate investment: The initial investment is small.
5. **Swine excel in dressing percent**: A 65 to 80 % meat of their live weight.
6. **Pork is most nutritious**: Due to higher content of fat, the energy value of pork is higher.
7. Swine are sensitive to unfavorable ration and careless management:
8. Because of their rooting and close grazing habit, hogs are hard on pasture:

Nutritionally, the feeding pigs is a complicated affairs, which may be realized from the fact that about 30-40 % of all pigs farrowed die before they reach market. This losses is generally due to bad feeding mostly because of nutritional deficiencies. Producer can reduce these losses only by practicing an improved feeding

Practical Feeding of Pigs

1. Feeding of Weaning Pigs (Creep and Starter Ration)

Usually swine are weaned at 6 weeks of age. But experiences show that pigs should be weaned considering by weight rather than age. They are fed with special ration known as “creep ration” when they attain the weight of 2 kg. The creep ration should be fortified with protein, mineral, vitamins, antibiotic, and highly palatable energy feed. A good creep feed should contain 20 % CP, low in fiber, and palatable.

The composition of creep feeds and the mineral composition are shown in Table 1 and 2.

Table 1. Composition of Creep Mixture (for Asian Region)

Ingredients	Percent/gram
Ground yellow maize	40 %
Skimmed milk	10 %

Ground nut cake	10 %
Sesame cake	10 %
Molasses	10 %
Wheat bran	10 %
Fish Meal	6 %
Brewer's yeast	2 %
Mineral mixture	2 %
Add vitamin ($A+B_2+D_3$)	10 gram

Table 2.The composition of mineral mixture

Ingredients	**Quantity**
Sterilized bone meal (finely powdered)	45.0 kg
Ground chalk	10.0 kg
Dicalcium phosphate	12.0 kg
Common salt	30.0 kg
Yellow oxide of iron (Ferrous sulphate)	0.5 kg
Potassium iodide	0.25 kg
Starch	0.75 kg
Sodium carbonate	0.75 kg
Sodium thiosulphate	0.75 kg
Add for 100 kg	
Cobalt chloride	55.0 gram
Copper sulphate	265.0 gram
Manganese sulphate	330.0 gram
Zinc chloride	750.0 gram

Piglets are more prone to the pig let anaemia. Generally a dose of copper and iron should be injected at the age of two weeks to these piglets to prevent from anaemia. Creep meal should be offered at 10 days of age and continue to feed up to the

weaning of 56 days of age as formulate using ingredient in Table 1 and 2.

2. Grower Ration

When the pigs are 10 to 12 kg, they are fed with grower ration. The following are some of the formulated composition of grower's ration as suggested by S. K. Ranjhan 1994.

(a) Cereal Ration

Maize	30.0 part
G. nut cake	20.0 part
Wheat bran	40.0 part
Fish meal	7.5 part
Mineral & vit mix.	2.5 part

(b) Non cereal ration

Wheat bran	30.0 part
Rice [polishing	30.0 part
Yellow maize	10.0 part
G. nut cake	10.0 part
Til cale	10.0 part
Fish meal	2.0 part
Common salt	0.5 part
Rovimix (A+B2+D3)	10 gram

3. Finisher Ration

Pigs are fed with finisher ration when they attain the weight of 50 kg and continue to feed finisher ration till they attain 80 to 90 kg weight. The experiment in India has shown that the slaughter weight of 70 kg is more economical compared to 90 kg body weight. Following is the composition of the finisher ration.

(a) Cereal Ration

Maize	40.0 parts

Wheat bran	30.0 part
G. nut cake	12.0 part
Til cake	10.0 part
Fish meal	5.5 parts
Mineral mixture	2.5 parts
Rovimix (A + B2 + D3)	10 gram

(b) Non–cereal

Wheat bran	75 parts
G. nut cake	17 parts
Fish meal	5.5 parts
Mineral mixture	2.0
Common salt	0.5 parts
Rovimix (A +B2 + D3)	10g

The above formula can be modified according to local conditions. All these rations supply adequate amount of essential amino acids as per the requirement shown as below,

Table 3. Essential amino acid requirements of swine*

Amino acids	Growing pigs weighing (kg)			Finishing Pig	Bred sows and gilt
	5 – 10	10 - 20	20 - 30		
Agrinine	0.28	0.23	0.20	-	-
Histidine	0.25	0.20	0.18	-	0.20
Isoleucine	0.69	0.56	0.50	0.35	0.37
Leucne	0.83	0.68	0.60	-	0.66
Methionine	0.69	0.56	0.50	-	0.28
Phenylalanine	3.69	0.51	0.50	-	0.52
Threonine	0.62	0.51	0.45	-	0.34
Tryptophana	0.18	0.15	0.13	0.90	0.07
Valine	0.69	0.56	0.50	-	0.46
Lysine	0.96	0.79	0.70	0.50	0.42

* Each requirement is expressed as percent of the diet.

4. Feeding of Pregnant and Lactating Sows

A 2 to 2.5 kg of meal can be sufficient for pregnant sows. Higher amounts of meal may cause embryonic mortality.

In lactating sows 3.5 kg of meal with 0.2 kg of meal per piglet in the litters can be incorporated.

Teacher's Instruction:

- Enlist different nutrient with their amount requirement for different stage of animal
- Show the result of feeding different stages of animal

Unit 8
Introduction to the fodder production

Learning Outcomes

On completion of this chapter, the students will be able to:

- Explain Importance of fodder for livestock rearing
- Classified the forage crops and differentiated it.
- Identify fodder and forage tree.

Forage is the edible herbage eaten by the animals. The term forage is used for roughages. The forage is bulky feed either due to lightweights of dry forage or due to high moisture and loose structure of green herbage. Nutrient density varies from very low feeding value of straw to very high nutritional value comparable with many concentrates such as berseem, lucerne and well cobbed green maize, harvested at milk stage.

Total pasture area of Nepal: 17, 57,345 ha.

Approximate animal feed sources:

Agricultural bi-products:	31.5%
Forest:	50 %
Pasture:	18.5 %

Feed stuff: Material fed to animals for the purpose of sustaining growth & development.

Dry matter: The part of feed that is not water, sometimes referred to as total solid.

Nutrient: Any chemical compound having specific function is the nutritive support of animal life.

Dry matter requirement: -

Zebu cattle:	2-2.5 kg. DM. /100 kg. body weight.
Buffalo & cross bred:	2.5-3 kg. /100 kg. body weight.

Importance of forage crops

1. These are highly digestible when harvested at proper time.
2. Grass proteins are particularly rich in ariginine and also contain glutamic acid and lysine.
3. Green fodder contains higher amount of carotene.
4. Green fodder reduces the cost of production of milk, meat and wool.
5. Green fodder is the cheap source of animal feed, which provide proteins, vitamins, minerals, carbohydrates, fat etc.

Grasses varieties and production

a) High mountains

Grasses / Legumes	Time of cultivation	Seed rate (kg/ha)
Perennial ryegrass	Sept-Oct	10
Italian ryegrass	"	"
Tall fescue	"	6-10
Timothy	"	10
Red clover	Oct.-April	4-8
White clover	"	3-5
Kote (Lucerne)	Autumn & Spring	12-30

b) Mid-hills

Maize	March-April	40-50
Teosente	"	30-40
Oats	Oct.-Nov.	100-125
Napier	July	111111 sets
Setaria	"	20
Perennial ryegrass	Sept.-Oct.	10-20
Joint vetch	March	1-3

Common vetch	October	30-35
Silverleaf desmodium	March-April	1-3
Stylo	July	3-5

c) Terai

Jowar	March-July	40-50
Bajra	March-Sept.	10-12
Maize	March-April	40-50
Oats	Oct.-Nov.	100-125
Napier	July	111111 sets
Berseem	October	25
Lucerne	"	15-20
Paspalum	June-July	4-6
Joint vetch	March	1-3
Common vetch	October	30-35
Siratro	July	3-4
Stylo	"	3-5
Greenleaf desmodium	March	2-3
Teosente	"	20-40
Setaria	July	20

8.2 Importantance & scope of fodder trees:

- Fodder tree provide green during dry and winter season.
- The left over by the animals can be used as a fuel wood.
- It can also be used for timber purpose.
- It can also be used as bedding material for animals.
- Fodder tree minimizes the soil erosion.
- It is used as a wind- breaker in cropland.

- It is used for live fencing.
- It is also planted for beautification.
- It can also provide fruits, pollen, tannin and gum, which are used for various purposes.

Important fodder trees found in different climatic region of country are given below.

Fodder trees propagated by seed:

Common name	*Botanical name*
Ipil-Ipil	*Leucaena lecocephala*
Koiralo	*Bauhinia variegate*
Kutmero	*Litsea monopetala*
Khaniu	*Ficus semicordata*
Khari	*Celtis australis*
Githi	*Boehmeria regulosa*
Gogan	*Saurauria napaulensis*
Chiuri	*Aesendra butyracea*
Tanki	*Bauhina purpurea*
Painu	*Prunus cerasoides*
Badahar	*Artocarpus lakoocha*
Bakaino	*Melia azedarach*
Baanj	*Quercus leucotricophora*
Berulo	*Ficus clavata*
Bhimal (Fosro)	*Grewia optiva*
Saaj	*Terminalia tomentosa*

Fodder trees propagated by vegetative parts:

Kabro	*Ficus lacor*
Mallbery	*Morus alba*

Chuletro	*Brassaiopsis hainla*
Jingat	*Lanea coromandelica*
Timilo/Nimaro	*Ficus roxburghii*
Dudhilo	*Ficus neriifolia*
Pakhuri	*Ficus glaberrima*
Bans	*Bambusa spp.*
Bains	*Salix babylonica*
Amriso	*Thysanolaena maxima*

Fodder tree and their habitat:

Terai and inner terai	Mid hill	Mountain/hill
Ipil-ipil	Ipil-ipil	Ipil-ipil
Kabro	Kabro	Kabro
Mulberry	Mulberry	Rai khainu
Koiralo	Koiralo	Khari
Kutmero	Kutmero	Githi
Jingat	Khari	Timilo
Kane khanue	Rai khanue	Chuletro
Tanki	Githi	Painu
Timilo	Gogan	Baanj
Pakhuri	Chiuri	Berulo
Badahar	Jingat	Bhojpatra
Bakaino	Chuletro	Bains
Bans	Tanki	Bhimal
Saaj	Timilo	Khasru
Amriso	Pakhuri	

Painu

Badhar

Bakaino

Bans

Berulo

Bains

Bhimal

Saal

Fodder tree and their availability:

Name of the fodder tree	lopping time
Ipil-ipil	Round the year
Kabro	Baishakh-Ashar
Koiralo	Mangsir toChaitra
Kutmero	Kartic to Falgun
Mulbery	Asoj to Poush
Khari	Falgun to Ashar
Khannau	Kartic to Chaitra
Gogan	Poush to Chaitra
Githi	Mangsir to Falgun
Chiuri	Kartic to Chaitra
Chuletro	Kartic to Baishakh
Jingat	Poush to Magh
Tanki	Kartic to Falgun
Timilo	Kartic to Chaitra
Dudhilo	Poush /Magh and Jeth/Ashar

Pakhuri	Ashoj
Painu	Ashar to shrawan
Badahar	Kartic to Chaitra
Berulo	Mangsir to Poush
	Baishakh to Jeth
Bans	Chaitra to Baishakh
Bains	Hills and mountain:
	Baishakh to Kartik
	Lower belt:
	Kartik to poush
Bakaino	Baishakh to Bhadra
Baanj	Poush to Ashar
Bhimal	Ashoj to Falgun
Saj	Ashoj to Mangsir
Amrisho	Mangsir to poush

Seed collection schedule of different fodder species:

Seed collection month	Fodder species
Baishakh	koiralo,Gogan,Tankiand painu
Jeth	Koiralo,Kutmero,Tanki
Ashar	Koiralo,Kutmero,Khanyu,Chiuri, Badahar and Berulo
Shrawan	Kutmiro,Khanyu,Chiuri,Badahar and Berulo
Bhadra	Khanyu,Chiuri and Berulo
Ashoj	Khanyu,Khari,Githi andGogan

Kartik	Ipil-Ipil,Khanyu,Githi
Mangsir	Ipil-Ipil,Khari,Githi,Gogan, Bakino,Baanj and Bhimal
Poush	Ipil-Ipil,Bakino,Baanj Bhimal
Magh	Ipil-Ipil,Bakino,Baanj,Bhimal and saj
Falgun	Tanki,Bakino,Baanj
Chaitra	Koiralo,Gogan,Tanki,Painu, Bakino and baanj

8.3 Classification of Forage crpos

Forage is grown for feeding domestic animals reared on a farm. Domestic animals are either allowed to graze for themselves or simultaneously are also feed to supplement grazing with cut grass in stalls. Although forage and fodder crops are synonymous terms, yet the latter is referred to cultivated forage crops, which may be either cereals or legumes.

At present almost 90% of the herbivores subsist on naturally growing grasses, which are of low nutritive value. Moreover the amount available to the herbivores is less than the requirement. For better health and high production, the animals especially the ruminant must be provided either with additional forage crops (fodder) or concentrate feed. Unfortunately, farmers cannot afford to feed the bulk of the ration as concentrate feeds.

Animals yielding as high as 10 liters of milk can easily be maintained solely on green fodder without any complaint. This reduces the feed cost by 20-25% compared to normal dry roughages (straw) and concentrate ration. It is well known fact that for any livestock farm, feeding alone involves 60-75% of the total expenditure.

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

b) Concentrates

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).

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.

Roughages are further categorized as follows:

-Dry roughages e.g.straw, hay

-Green roughages e.g. legume and non legumes

-Legume e.g. berseem, Lucerne, cow pea etc.

-Non-legume e.g. maize sorghum, bajra, oat etc.

-Fodder tree e.g. Legume & non-legume

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 can not 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.
- Additives:
- Vitamin and mineral supplements, antibiotics, probiotics, anabolic agents etc.

Major Drawbacks

- Poor participation of people
- Imported seeds / insufficient planting materials
- Over stocking /over population of livestock
- Degraded natural rangelands
- Livestock feed deficit situation
- Little consideration for bio-diversity conservation
- Scarcity of technology and manpower
- Geographical and climatic extremes
- Uncontrolled grazing system
- Lack of coherent policy on rangeland management
- Responsibility split among different agencies related to agriculture, forestry and environment; lack of responsibilities among such agencies
- Negligence in using indigenous knowledge of rangelands while formulating plans
- Poor state of knowledge on scientific rangeland management from environmental perspectives
- Capacity, capability and role of GOs, NGOs and community organizations and those of private sector is not clearly identified
- Lack of promotion of fast propagation techniques such as, through sexual (seed) and asexual (vegetative) means especially for indigenous and naturalized species of high altitude region.
- Continuous encroachment of pasturelands and forest in Terai
- Higher dependence on crop residues, terrace risers and roadsides, which have poor nutritional values for livestock feeds especially in Terai

- Lack of understanding about the technological, ecological and socio-economic requirements for sustainable rangeland development

Teacher's Instruction:

- Enlist importance of fodder for livestock rearing and Nepalese condition
- Show locally available fodder and forage

Unit 9
Cultivation practices

Learning Outcomes

On completion of this chapter, the students will be able to:

- Cultivates the different fodder and forage.
- Produce and increase fodder production in their area.

9.1 Agronomical practices for production of Non Legume forage crops

1. Perennial Rye Grass *(Lolium perenne)*

This is a perennial grass Suitable to temperate regions. Unless covered with snow, it remains green round the year. Since perennial rye grass tolerates heavy grazing pressure, it is suitable to range lands. It has extensive tillering ability and is bright green in colour. Under good management systems, it grows to a height of about one metre.

Fig. Rye grass

Climatic requirements: The grass is suitable in alpine region or it requires temperate climate. In Nepal, for example, the altitudes ranging between 1200 and 4000 msl is ideal for the growth of rye grass. Type of soil is not a constraint for its growth, but adequate soil moisture and occasional showers of rain accelerates its growth.Temperate perennial grass grows vigorously during spring. Temperature and day length affect spikelet and floral population in a plant.

A long day plant - seed head emerges in long days.

Vernalization is required for flowering. Some cultivars/ genotypes require low vernalisation period. Vernalisation is the wintering period required for a plant.

Sowing: Seeds can be sown at various places such as pasture land, rangeland, fruit gardens, croplands, wastelands, forest area with scarcely scattered trees.

Time: Sowing time is dependent upon the local climate. In the alpine belt, suitable sowing time is after melting up of the snow in the month of March or April. In the lower mountainous regions, on the other hand, seed can be sown during September-October or May -June. Instead, seedlings can be transplanted after one or two monsoon rain.

Seed rate: About 10 kg of seed is sufficient to one hectare of land. In case of transplantation, 100,000 seedlings are required

Method of sowing: If the grass seed is to be sown in the form of single fodder crop, 3-4 ploughings are necessary. The seed is sown by broadcasting. Line sowing is also common. In such method of sowing or transplantation, the distance between two rows should be about 30 centimeters.

In rangelands and pasturelands, ploughing is not practicable. In such situation line sowing by making parallel contour lines becomes necessary. The contour line should be 15 cms deep and 15 cms wide. In heavily grazed land surface, the seeds can be sown without digging or ploughing. Broadcasting of seeds should be done uniformly and seeds should be buried about 1 cm. deep. Similarly during transplantation, the roots should reach properly into the soil.

Manuring: 10-20 tones of farmyard manure is recommended during seed-bed

preparation. At sowing, chemical fertilizers-nitrogen, phosphorus and potash at the rate of 100:60 and 40 kilograms may be drilled into the soil.

Crop mixtures: Rye grass makes excellent combination with white clover.

Yields: Under scientific method of cultivation, animals can be left for grazing after 3-4 months. Irrigation could be necessary during dry periods. Under scientific method 10-12 tones of dry matter can be obtained. In general, 8-10 cuttings can be taken per year.

Seed production: In normal condition, 100-150 kilograms of seed can be obtained per hectare. Under scientific method of cultivation, seed production is about 400 kilograms.

Available nutrients in rye grass:

Crude protein	12 %
NDF	61.8%
ADF	38.1 %
Lignin	8.1 %
Cell wall content	38.2 %
Cellulose	30 %
Hemi cellulose	23.8 %
Minerals	13.7 %

In Nepal more than 26 varieties of rye grass seed were imported from different countries for trial. However, only the following varieties have shown good results.

Varieties	Production (DM/ha)	Sources
Bastion	14.0	Netherlands
Lamora	13.3	"
Prumo	13.2	Germany
Ranui	12.5	New Zealand
Limes	10.9	Germany

Belida	9.1	Denmark
All Star	8.5	USA
Sammora	8.5	Netherlands
Meltra	7.6	Belgium
Kangaroo Valley	9.5	Australia

1. Oats (Avena sativa)

Oats is the most important cereal fodder crop grown in the winter from Terai to high mountain regions. It is quick growing, palatable, succulent and nutritious crop and forms an excellent combination when fed along with other cold season legumes like berseem, Lucerne, white clover, pea or vetch. On a dairy farm, oats fodder is a must as it can be fed green and surplus converted into silage or hay for use during the scarcity period. Oats grain is very much relished by horses, sheep and poultry.

Fig. Oat

Climatic requirements: Cold and moist conditions, as prevail in temperate regions, are congenial for its growth. A well- distributed rainfall of 400 mm during the four months duration is sufficient to meet its requirements as a fodder crop. Frost & severe cold conditions retard its growth where as hot and dry conditions hasten its maturity resulting in poor yield and inferior quality of fodder.

Plant Characteristics: Usually an erect annual with a fairly good tillering habit, attains a height of 1-2 meters. The leaves may reach a length of 25cm. and breadth of about 1½ cm. Roots are fibrous and may penetrate to a depth of 1½ meters.

Panicles are lax and effuse. Inflorescence is equilateral or unilateral. Main axis and lateral branches end in a single apical spikelet. The grain is long and slender or spindle-shaped.

Toxicities: If the hay prepared from heavily fertilized Oats with nitrogenous fertilizers is fed to the animals, nitrite poisoning might take place. Nitrates (particularly in hay) are accumulated in heavily fertilized oats with nitrogenous fertilizers. If hay is moistened 8-10 days and exposed to air, nitrates are reduced to nitrites. It converts haemoglobin to methaemoglobin that cannot act as oxygen carrier.

Soil conditions: Fertile and well-drained loam to clay loam soils suitable to wheat cultivation are the best for oats as well. It can tolerate slight acid or saline conditions but not pH above 8.5. Crop lodges badly if heavily fertilized with large doses of nitrogenous fertilizers on ill-drained clay soils.

Seedbed preparation: The land should be opened with a bullock -drawn soil inversion plough followed by two operations by desi ploughs.

Sowing:

a) **Time:** Sowing should continue from the first week of October up to the end of November to supply green fodder from mid December to the end of April. The early sown crop will provide two cuttings and help to tide over the scarcity period from middle of December to middle of January.

b) **Method:** Seeds should preferably be drilled. Broadcasting or transplanting of 4 weeks old seedlings can also be done successfully.

c) **Spacing:** In case of low tillering varieties, the spacing between rows may be kept between 20 and 25 cm but increased to 30 cm in heavily tillering types.

d) **Seed rate:** 100-125 / ha.

Crop mixtures: The seed rates (kg/ha) for different mixtures may be as follows: (Oats-Kent variety):

Oats + Berseem (40+25), Oats + Shaftal (40+15), Oats + Lucerne (40+15), Oats + Pea (70+40), Oats + Chinese cabbage (100+3.5), Oats + Japanese rape

(100+3.5), Oats + Turnip (100+2.5)

Oats variety suitable for Nepal: Kent and Swan; farmers prefer Kent.

Recommended varieties:

Terai: Swan, Amuri, Carville

Mid-hills: Taiko, 83 I.N.C., 19 G-3, Canadian, Kent, Karishma

High-mountains: Omihi, Kent

Manuring: The crop may be manured with 25 tones of farmyard manure 10 to 15 days before sowing. At sowing 65 kg urea, 200 kg superphosphate and 50 kg potash.

Irrigation: Irrigated 5-7 days before drilling. First irrigation- after 30-40 days of sowing. Subsequent irrigations at 25-30 days' interval

Harvesting: Harvested immediately after the initiation of flowering up to 50 percent bloom after 60-70 days, then harvested every month.

Yields: Average : 350-400 quintals; with top management, yields of 550-600 quintals can be obtained.

3.Napier Grass (Pennisetum purpureum)

Napier grass is also called Elephant grass due to its tallness and vigorous vegetative growth. It responds to high fertility and frequent irrigation. The plants tiller freely and a single clump may produce more than fifty tillers under favourable climatic and soil conditions. The grass is perennial and clump increases in number of tillers and size every year. Once established, the grass grows very aggressively and suppresses weed growth. Unfortunately, the grass is coarse-textured, the leaf blades and sheaths hairy, leaf margins sharply toothed and stems less juicy and fibrous. Hybrid N.B.21 has a universal acceptance due to its excellent performance.

Fig. Napier

Geographical distribution: The grass is native of tropical Africa. It is grown under warm and humid in Transwal and Uganda. Its cultivation is now extended to Florida and Hawaii in U.S.A., tropical Australia, South America, Sri Lanka, Malaysia, Indonesia, Philippines, Burma, Bangladesh, Pakistan and Middle-East countries.

Climatic requirements: Warm and humid weather, as prevails in the monsoon season, is most congenial for the vigorous growth of the grass. Intermittent showers followed by bright sunshine result in lush growth. The grass remains dormant during the winter season. At higher altitudes, severe frost kills it. Its minimum rainfall requirements vary from 800 to 1000 mm. The mean optimal temperature varies from 24°C to 28°C.

Plant characteristics: It is a tall robust perennial growing from creeping rhizomes in clumps of 20-25 tillers, each about 2.0 to 2.5 cm. in diameter. The leaves are light green, flat and about 70 to 90 cm long and 2.0 to 3.0 cm broad. The inflorescence is spike like long panicle. The spikelets may be single or in groups of 2 to 3. The

spike is yellow to golden yellow in colour from 15 to 25 cm long and 2.0 to 3.0 cm thick. The grass reaches a height of 3 meters. The leaves are generally hairy with rough and sharp margins. Hybrid Napier is comparatively more soft, less hairy, faster growing and produces more number of tillers.

Toxicities: The oxalate content in Napier grass varies from 3 to 6 percent. It depletes body calcium and damages the kidneys of the animals. They should be fed with small quantities of di-calcium phosphate along with the mineral mixtures to make up the loss of calcium, or the deficiency make up by feeding Lucerne hay or concentrate mixtures containing groundnut cake and leguminous grains which are rich in calcium.

Soil conditions: Deep retentive fertile loam to clay loam soils are the best. Free drainage is essential, as the grass cannot withstand prolonged water logging. It tolerates a soil pH range from 6.5 to 8.0 and can grow better than Guinea grass in saline sodic soils. Although it performs better in alluvial and black soils, it grows quite satisfactorily in red and laterite soils. Phenomenal yields are on very fertile soils rich in organic matter and major and minor elements.

Seed-bed Preparation: A thorough and clean cultivation to produce a weed-free, deep and compact seed-bed is required. The field should be opened with a deep mould board or disc plough and followed by two to three operations by disc harrow or cultivator. When bullock-drawn implements are used, the initial operation should be given by deep soil inversion plough followed by three ploughings by desi ploughs.

Sowing:

a) *Time*: On irrigated soils, planting can be done immediately after the end of the cold season in the last week of February to early March. The plantings can be continued up to end of August. As a dry crop, however, it should be planted with pre-monsoon showers by end of June or early July.

b) *Method*: Napier grass can be propagated by seeds, stem cuttings and rooted slips. The seeds of Hybrid Napier, on the other hand, are sterile and therefore it can be planted only by stem cuttings or rooted slips as follows:

i) Three budded sets may be inserted into the soil in a slanting manner at an angle of 45º to the ground.

ii) Planting stem cuttings like sugarcane. Furrows are opened with a small rider or a sesi plough and three budded sets placed end to end in these furrows. Planking is done to cover the sets and irrigation is applied, if the moisture in the soil is insufficient for the sprouting of the buds.

iii) Planting rooted slips. Break up the old clumps and separate the tillers along with their roots. Each slip may consist of one to two tillers about 10 to 12 cm in height along with the roots and inserted into the soil by digging a hole with a *khurpi.* This is the best method particularly in the summer season when the stems in the first two methods are likely to dry up in the hot desiccating wind.

c) *Spacing and seed rate*: Spacing is dependent upon various factors such as soil fertility, climate and irrigation facilities. In general, the spacing between the plants within the rows may be kept at 30 to 40 cm but increased t 2 metres between the rows to permit sufficient space for the associated crops to grow satisfactorily. Also, the spacing can be increased to 60 cm X 60 cm where the soil fertility is low and irrigation facilities are inadequate.

Seed rate is dependent upon the spacing and the weight of the stem cuttings or rooted slips used for planting. The number of rooted slips and the seed rates per hectare for the various spacing are indicated below:

Spacing in meters	Number of stem cuttings or rooted slips/ha	Seed rate (kg/ha)
0.30 X 0.30	1,11,111	8,000
0.30 X 0.50	66,666	4,800
0.60 X 0.60	27,777	2,000
0.30 X 2.00	16,666	1,200
0.40 X 2.00	12,500	900
1.00 X 1.00	10,000	720

Crop Mixtures: In the winter, it can be intersown with *berseem, shaftal, senji*, pea, oats, barley, Chinese cabbage or Japanese rape. In the summer season, it may be grown in association with cowpea or guara. In areas subject to severe drought in the summer season, it may be intercropped with a mixture of Sweet Sudan, M.P. Chari and bajra that are also multicut crops. In Lucerne fields, Hybrid Napier may be interplanted in February or March after taking a cut. The spacing between the rows may be 2 meters and between plants within the rows 30 to 40 cm. In the rainy season, when Lucerne remains very much suppressed due to high atmospheric humidity and waterlogged conditions, Hybrid Napier makes a vigorous growth and compensates for the loss of Lucerne yields. Hybrid Napier can also be grown in association with Centro and Glycine legumes.

Manuring: A minimum of 40 tones of farmyard manure may be applied 2 to 3 weeks before planting the sets or rooted slips. In pure stands, cattle yard washings or sewage irrigation can substitute farmyard manure. At planting, 250 kg super phosphate and 65 to 70 kg muriate of potash may be drilled into the soil. This dose may be repeated every year in the month of June or July with the first monsoon showers. After taking each cut, urea may be applied at the rate of 110 kg per hectare. In a mixed stand with legumes, where Hybrid Napier is widely placed, the dose of urea may be reduced to half. Hybrid Napier should be liberally fertilized to exploit its high-yielding potentiality and improve its protein content.

Irrigation: After planting in February or March, the first two irrigations should be given every 7 to 10 days. Fortnightly irrigations should be given after establishment of he crop in the summer season and 15 to 20 days after the end of monsoon season. The field should be kept well drained during the rainy season, as the crop cannot withstand wet conditions for more than a few days.

Weed Control: The crop gets badly infested with weeds particularly *Sorghum halepense, Trianthema monogyana, Echinochloa colonum* and *Cyperus rotundus* immediately after planting. Interculturing should be done twice or thrice till the crop is fully established and stats growing vigorously. In subsequent years, interculturing should be done as and when found necessary. The chemical control for broad-leaved weeds consists of post-emergence spray pf one kg acid equivalent

per hectare of 2, 4-D, about 5 to 6 weeks after planting.

Harvesting: The first cut after planting can be taken after 9 to 10 weeks. Subsequent cuts can be taken after 4 to 6 weeks. At this stage, the crop is nutritious, succulent and palatable and attains a height of about one and half meter. If left to grow taller, it becomes coarser and unpalatable. Younger crop contains high amounts of oxalates which deplete calcium from the body of the animals. While harvesting, a stubble height of 10-15 cm from the ground level should be left out to encourage quicker regeneration from the basal buds. The first cutting after the end of the winter season should be taken close to the ground to remove the dead tillers. Sometimes, the old stands are burnt to produce fresh growth.

Yields: Average yields from each cutting vary from 250 to 350 quintals per hectare, being lower in the summer and post monsoon seasons than during the rainy season. High average yields of 450 to 500 quintals per cutting per hectare can be obtained with liberal application of fertilizers and irrigation. On an average, annual yields of 1500 to 2500 quintals per hectare are common.

Seed Production: The seeds of Hybrid Napier are sterile. The crop is multiplied by vegetative propagation by using either stem cuttings or rooted slips. As far as possible, only mature plants, which have attained heights of about two meters, should be used for this purpose. Old clumps that have grown in girth should be thinned by one-third to one-fourth from one side, and from remaining sides every year, and the rooted slips and stem cuttings utilized for fresh plantings.

Rotations: Hybrid Napier generally remains on the same land for three years. As it is a very exhaustive crop it should preferably be rotated with legume fodders like berseem, shaftal, pea, senji, Lucerne, cowpea, velvet bean, rice bean or guara, or cereal -legume mixtures as indicated under jowar, maize, bajra, teosinte and oats.

Conservations: The surplus fodder available in the months of July, August and September should be chaffed and conserved in the form of silage. One part of legume fodders such as Lucerne, cowpea, soybean, rice bean or *guara* and two parts of the grass will produce a more nutritious and better-balanced silage, rich in protein, energy and minerals. The oxalate content in the grass is appreciably

reduced on conservation in the form of silage. It can be converted into hay in the months of April, May and June when drier conditions prevail. The chaffed material should be exposed to the sun only for a day and further drying done under the shade of trees or any structure with a covered roof but open from the sides.

Varieties: Previously, Hybrid NB 21 was most popular with a wide adaptability. It was not only high yielding variety but also possessed the quality of faster rate of growth. It, therefore, replaced earlier hybrids like Pusa Giant and E.B. 4. However, Moth Napier has become most popular in Nepal in recent years.

9.2 Agronomical practices for production of leguminous/non-leguminous fodders in different seasons

Leucaena leucocephala

Family: Leguminosae

Common name: *Ipil ipil*

It is either a tall tree or many- branched shrub. Of all the tropical legumes, *Leucaena* probably offers the widest assortment of uses.

Flowering is dense with white flowers and roots are deeply seated. There are more than 800 known varieties, but universal common name is *'Leucaena*' although many countries may use local names.

Fig. Ipil

Variety of *Leucaena*

1. Common type- bushy and propagated very fast, aggressive weed.
2. Giant type: Tall up to 20 meters.
3. Peru type: medium sized reaching a height of about 10 meters. They have extensive branching even low on the trunk. Therefore, this is considered to be promising variety for forage production so far.

Leucaena is found in most tropical countries and is a perennial summer growing browse plant.

Climatic requirements: For optimum growth, a temperature range between 22 to 30°C is required although survival at higher temperatures (45°C) is not uncommon. The plant can withstand a temperature of 10°C, but heavy and prolonged frost will kill it. But if the frost is light and occasional, it will just be defoliated and after the commencement of warm temperatures, the plant will burst with greenery again. Surprisingly, the tall plants are found to persist in temperatures down to -10°C in winter and up to 42.5°C in summer probably because the greater heights enables them to escape frosts.

In natural conditions, *Leucaena* is not found to thrive well above 500 masl, but when planted it can withstand up to an altitude of 1600 metres. At higher elevations, however, *Leucaena* growth becomes slower and the plant tends to remain a shrub.

It requires considerable rainfall (600-1700 mm annual) but with irrigation it has been successfully grown in low rainfall areas receiving 300 mm of annual rainfall. The plant can withstand drought, but may defoliate giving a low production. However, the plant has a poor tolerance to flooding and requires drainage. In spite of adequate moisture, temperature and nutrients, higher yields cannot be expected in low solar radiation. Partial shade may not affect the plant's growth, but there is stunted growth in heavy and prolonged shade.The plant can grow in a range of soil pH from 5.0 to 8.0, but the growth in acidic pH is poor and an outstanding growth is displayed at a pH range of 6.0-7.7.

Weed Control: One of the major causes of failure or slow establishment of *Leucaena* is weed. Until a height of 1-2 metres is attained, regular weeding is

advised. Larger areas, however, may require the application of herbicide.

Insects: Insect pests like mound-building ants attack young seedlings and cause severe damage in some regions by eating the leaves and bark.

Toxicities: Researchers have found that *Leucaena* contains a toxic amino acid called mimosine. This chemical causes hair loss and also affects foetal development in non-ruminants. 3-5% of the total dry matter is occupied by mimosine.

Method of cultivation: Seed or coppice can propagate *Ipil ipil*. Coppice growth is faster than that of seedlings. Its seeds are broadcasted in raised beds or in containers. Seedlings are planted during spring or summer rains. In a fuel-wood plantation, a 2-3 year rotation is maintained.

Harvesting: Shrubby plants are cut back to a height of 1 meter for fodder production. By cutting close to the ground every five years, it has remained in vigorous conditions for 55 years in the Philippines. At a spacing of 3 meter it can contribute about 100 kg N/ha/year to the soil. Dry matter yield of 25-30 mt/ha/year can be obtained by planting at 1 meter spacing. Leaves and pods are very nutritious.

9.3 Agronomical practices for production of leguminous fodders in different seasons

Inoculation of Legumes

Key concepts:

- There are many soil conditions, which make it necessary to inoculate legume crops to get maximum yields.
- The choice of methods for seed and soil inoculation depends on materials available and climate and soil conditions.
- The proper inoculants must be used with each legume.
- Inoculants contain living organisms that must be protected from heat & sun.
- If inoculant is not stored properly, the number of rhizobia in the inoculants will decline.
- Poor inoculants quality is an important reason that farmers do not get yield increases from inoculation.

- Inoculants production is a process, which requires specialized equipment knowledge & skill.
- Various types of inoculants are produced for various seeds & needs.

What is Inoculation?

Rhizobia are soil bacteria, which can infect the roots of legumes to form effective nitrogen fixing nodules. Legume inoculants are a liquid or solid substance that contains live rhizobia. Inoculation is simply bringing rhizobia in contact with the seed or legume root. Modern inoculants have millions of rhizobia per gram.

There are several types of modern inoculants:

1.Liquid cultures 2. Freeze-dried preparations 3. Oil -dried preparations on talc, &4.Liquid broth cultures mixed with carrier material such as peat, charcoal or lignite.

A commonly used method in Nepal:

Usually inoculant carrier used in Nepal is peat soil, either in the form of powder or slurry. In case of slurry, 30-35 gm. of inoculant and required amount of water are to be mixed with 1kg of seed. A 100 gm. of sugar or molasses solution can be separately prepared to be mixed with the formerly prepared solution. Sugar/molasses solution has two functions: firstly, it helps in sticking the inoculants to the seed & secondly, it provides instant food energy to the rhizobia for initial growth until they (host & organism) establish the symbiotic relationships.

After the seeds are evenly mixed with the solutions it should be spread over a plastic sheet under shade for drying. This will be ready for use after half an hour. Inoculated seed should be preferably be used within 24 hours.

1. Berseem (Trifolium alexandrinum)

This is also called Egyptian clover. This is also said to be the king of fodder crops due to high yields of succulent, palatable and nutritious fodder that it provides over a long season from November to May in five to six cuts.

Fig. Berseem

Climatic requirements: Cool to moderately cold conditions is required. Temperatures, 4 to 5º C below freezing kill the plants. It is for this reason that in Himalayan regions, Lucerne, red clover and white clover replace berseem.

Plant characteristics: It is a succulent annual growing to a height of 80 to 90 cm. The leaves are slightly hairy. oblong. thin and trifoliate. The flower heads are white to yellowish white. The seed colour is bright yellow and turns from brown to chocolate on storage under humid conditions.

Toxicities: Oestrogens are sex hormones which produce oestrus or heat in females of mammalian species. Excess of oestrogens, however, may affect the fertility of the animals. Berseem shows fairly high oestrogenic activity but continuous feeding all through the winter and spring does not seem to bring about any significant disorders or changes.

Excessive feeding of berseem in the young stage or when it is wet with dew in the morning causes bloat called tympinitis. If the animals are allowed to graze, the crop should first be sprayed with emulsion of linseed or mustard oil to prevent bloat.

Soil conditions: Well drained loam to clay loam soil rich in phosphorus, potash and calcium with neutral to slightly alkaline reaction is ideally suited to cultivation of berseem. Acid and water logged soils should be avoided. The land should be very well leveled as the young plants die in stagnant water.

Land preparation: One ploughing with soil inversion plough or spade to a depth of about 15 cm followed by two ploughings and plankings are recommended.

Sowing :

a) **Time :** Immediately after the end of monsoon season.

b) **Method:** The easiest and quickest method is by letting in water to a depth of 4 to 5 cm in a well leveled field and broadcasting soaked seeds of berseem uniformly in a crosswise direction. Seeds should be inoculated with the inoculum before sowing.

Soak 25-30 kg of berseem seed for one hectare in a gunny bag for 10-12 hours.

Use 10% solution of sugar or gur as initial energy material for the growth of Rhizobia.

Spread out the seeds on the clean and firm ground or in a bucket, in small lots and mix the gur solution in proportionate quantities and rub the seeds with hand thoroughly so that each seed is smeared with the bacterial culture uniformly. If the gur solution is sticky, small quantities of soil may be added to the mixture.

Allow the seed-gur-bacterial mixture to dry in shade for about an hour. If exposed to sun, the bacteria will die.

Evening sowing is preferred

After broadcasting, the seed must be mixed with the soil.

Bacterial culture can also be taken from the soil where berseem was sown earlier.

c) **Spacing:** Since the seeds are generally broadcast, they lie very close to one another. When drilled, the rows may be kept about 20 cm apart.

d) Seed rate: 25 kg/ha.

Manuring: 25 tones of farmyard manure may be applied and thoroughly mixed

with the soil before sowing. At sowing, 375 to 400 kg super phosphate, 50 kg muriate of potash and 55 kg urea should be added.

Irrigation: Initial irrigation - after 5-7 days, afterwards at 10-15 days' interval.

Harvesting: First - after 60-70 days

Second - after 35-40 days

Third and fourth - after 30 days

Fifth and sixth - after 20 days

Yields (per hectare): First cut - 175 quintals, second and third cuts - 225 quintals each, fourth cut- 175 quintals, fifth cut - 125 quintals, sixth cut - 75 quintals.

Common varieties: Mescavy, Baradan, BL 22, UPB 103, Gija, Tetraploid, INFRI-S-99-1 etc.

2. Stylo (Stylosanthes spp.)

Stylosanthes is genus of summer growing perennial pasture / fodder legumes. Most of its species are natives of South and Central America and the Caribbean Islands. Important Stylo species are as follows:

a) Stylosanthes hamata

b) " *guianensis* or Palpa Stylo

c) " *scabra*

d) " *seabrana*

Morpho-physiological and edaphic adaptation:

Stylosanthes consists entirely of herbs and small shrubs. Usually they have a 'crown' of growing points near the soil surface. This enables the plants to overcome the excessive damages caused by fire and frost, and the grazing animals. They have indehiscent seeds, regulating dormancy. The seeds have hooks for dispersal through animals. The seeds can also pass through digestive system of animals. The plant thrives well in light soils due to its deep rooting system.

In humid tropical environments, *S. guianensis* thrives very well and can withstand flood and drought lasting short periods. Germination and growth are favoured at

high temperatures. Flower initiation is favoured at lower temperatures, prevailing at the end of growing season of falling day lengths. These are short-day plants. Perennation at a particular locality takes place through regeneration of seeds.

Stylosanthes is adapted to infertile and acid soils. As tropical legumes, they tolerate low Ca better than temperate legumes. High Ca levels may adversely affect the growth. In some soils of the tropics, Mn toxicity limits the growth of pasture legumes. Nodulation is also affected by Mn toxicity.

It has recently been introduced in the pastures in India for reseeding old pastures or is being grown in between rows of planted / sown fodder crops. In the tea gardens, it is also being used as a cover crop.

Varieties are usually erect to semi-erect. They are generally not profusely branched at the base; layering of some branches is observed. It can grow up to 1.5 m in height, particularly when it gets support from the associate grasses. The trifoliate leaves are long, rather narrow and pointed. The stems are coarse and hairy. In some of the varieties, the leaves are sticky. The flowers are small and yellow producing single seeded pods. It does not tolerate frost and shade and can grow very well in areas receiving 900-4000 mm of annual rainfall. Stylo responds well to phosphate and is sensitive to copper deficiency. Stylo is less resistant to heavy grazing than Centro and Siratro. Stylo seed should not be sown below 7-13 mm. A seeding rate of 2-4 kg / ha is usually satisfactory. Stylo will usually nodulate from naturally occurring Rhizobia strains; these, however, will not be as effective as the commercial strains.

The main variety commercially grown is known as 'Schofield'. This is an erect variety and very late in flowering. The variety 'Cook' is more resistant to Botrytis disease.

Fig. Stylo

3. White Clover (Trifolium repens)

White clover is a perennial legume fodder. Once established, it lasts for about 10-12 years. It is probable that white clover seed was brought from England in Nepal and propagated during Rana regime. It is a winter fodder crop, which is highly nutritious and relished by cattle. It can also be converted into hay or turned into the soil as green manure. It forms an excellent pasture particularly when grown mixed with grasses like ryegrass, cocksfoot or local grasses. In mixed cultivation, 40 percent of white clover and 60 percent of other grasses would be recommendable.

Fig. White clover

Climatic requirements: Alpine regions of Nepal with altitudes ranging between 1200 and 4000 msl are suitable. Cool and dry conditions with occasional light showers of rain during the colder months of December and January are ideal for its growth. It can tolerate colder temperatures and humid conditions much better than berseem. In the spring season in the months of February and March, it grows faster and shows its best performance.

Toxicities: Bloat is caused when the animals graze or eat fodder in highly succulent state or when the plants are covered with raindrops or dew.

Soil conditions: Fertile loam to clay loam soils is the best. The soil should be rich in phosphorus, calcium and potassium as well as trace elements like molybdenum, zinc and copper. Free drainage is essential, as the crop cannot stand waterlogged conditions for more than a few days.

Sowing: Time: After one or two showers in the month of March or April. If the small branches of the plants are to be transplanted, the months of June or July would be appropriate. Before sowing or transplanting, the land should be properly ploughed to a depth of about 15 cm.

Seed rate: The seed rate of white clover is generally lower than that of berseem due to smaller size of seeds. Generally 3-5 kg of seeds is sufficient per hectare of land. The usual method of sowing is by broadcasting. The mixing of seeds with soil or *Rhizobia* culture may be done in the same manner as in case of berseem.

Manuring: Farmyard manure may be applied at the rate of 10 tones per hectare before seed bed preparation. In addition, fertilizer mixture consisting of 20-25 kg urea, 250 kg super phosphate and 35 kg of potash may be drilled in the soil at sowing

Irrigation: After sowing, first two irrigations may be given at an interval of 10 days. Subsequently, irrigation may be given every one-month in the winter season, 20-25 days in the spring months of February and March, and 15 days in April.

Harvesting: Although white clover is considered to be pasture forage, first harvesting can be done after about 60 days of sowing. Thereafter cuttings can be taken at monthly intervals.

Yields: Under scientific methods of cultivation, 3-4 tones of dry matter per hectare can be obtained. If sown on rangelands, seed production is only about 20-30 kg per hectare. From scientific methods, seed yields of about 400-500 kg are not uncommon.

Nutrients in white clover

Crude protein	22.4 %
NDF	50.7%
ADF	39.4 %
Lignin	6.3%
Minerals	11.4 %

Varieties of white clover suitable for Nepal.

S.N.	Cultivars	Country of Origin
1.	Ladino	New Zealand
2.	Huia	" "
3.	Regal	USA
4.	Tilman	Australia
5.	Arkadia	Denmark

4. Lucerne (Medicago sativa)

Lucerne is fondly called Alfalfa (an Arabic name meaning 'the best', 'Queen of fodder crops', or 'Green Gold'. Its key nutrient is protein, followed by calcium, potassium and phosphorus. It is very valuable leguminous forage and hay crop for the dry and irrigated areas of the world. In fact, no other fodder legume so cosmopolitan in adaptability and so widely distributed as Lucerne. It is perennial, persistent, productive, heat and drought-tolerant and provides better seasonal distribution. In the summer season when it grows very fast, it can be fed along with green maize, jowar, bajra, teosinte, Hybrid Napier, Guinea grass, Rhodes grass, Blue panic, Anjan, etc., and sunflower and fodder beets. In India and other Asian countries, paddy straw, wheat bhusa and dry stems of jowar, bajra and maize that

are practically devoid of digestible crude protein, are the mainstay of milk animals. Supplementation with Lucerne either in the green or hay form will make up the protein, calcium and other mineral deficiencies. In U.S.A., it is fed along with maize grain to provide a nearly balanced ration for high producing dairy cows. By pelleting urea with Lucerne meal, the quantity of urea in high producing cows can be extended to 40 percent of the total dietary nitrogen to supply a good substitute for costlier forms of protein-rich diets. Top grazing of Lucerne is also a common practice.

Hybrid Napier, which contains large quantities of oxalates in the young stage, causes calcium deficiency in the cattle leading to kidney disorders. When fed along with Lucerne, it counteracts such deleterious effects.Lucerne is also an excellent source of protein for the poultry and a constituent of mixed cattle feeds.

Fig. Lucern

Geographical Distribution: Lucerne is native of the Mediterranean region. It is believed to have originated in South West Asia. It was grown in Persia as early as 700 B.C. and was introduced into Greece by about 500 B.C. The other countries in which Lucerne is grown are the temperate regions of Europe, U.S.A., South America, New Zealand, Australia, Algeria, Republic of South Africa, North West Asian countries, India and Pakistan. In the humid tropical regions, it is preferred as a seasonal crop from October- November to June or at best retained for 12-15 months in the garden lands.

Climatic Conditions: Lucerne persists in a wide range of climatic conditions from extreme heat as prevails in Rajasthan to cold temperatures in Ladakh and Canada.

It prefers high light intensity and cool temperatures. Lucerne performs better during the cooler, drier years than cloudy, humid and wet seasons. It can tolerate short spells pf drought and remain dormant. Fresh growth starts as soon as moisture becomes available. Moist but not wet conditions are conductive for vigorous growth. It does not tolerate waterlogging and high atmospheric humidity and gets overrun with grassy weeds in the rainy season.

Plant Characteristics: The inflorescence is a close raceme borne on auxiliary stalks. The flowers are purple, violet to blue. Small bracts at base subtend the short stalks. Each flower has 5 sepals, 5 petals and 10 stamens. The pods are dehiscent, twist spirally with several seeds. The seeds are kidney-shaped to oval. The plant is erect but becomes tufted after the first year. Leaves are trifoliate. Leaflets are generally hairy with serrated upper margins. Stipules are broad and serrated. The plant is tap rooted and goes very deep. Sometimes it branches and produces aerial roots.

Toxicities: Animals grazing on Lucerne pastures may develop bloat. Silicones and turpentine oil relieves and prevents bloat.

Like most of the legumes, Lucerne fodder contains oestrogens that may create reproductive disorders if fed in large quantities. It may also cause photosensitization, in which case cattle, sheep, horses and pigs become hypersensitive to light. White-skinned animals or those with white patches when exposed to bright sunlight develop a syndrome consisting of dermatitis sometimes associated with conjunctivitis. The affected animals may be kept in dark and fed chlorophyll-free diet. Saponins are glycosides, which are bitter in taste, foam forming and hemolyze red blood cells. They are toxic to animals and are present in Lucerne. Low saponin containing strains should be developed as there is a large variability in the different cultivars of Lucerne.

Soil Conditions: Well-drained loam soils are the best although Lucerne can grow even on sandy loam to clay types of soils. Drainage is very necessary as the crop is intolerant to waterlogging. It tolerates slight salinity but not sodic conditions. Very fertile soils, rich in calcium, phosphorus and potash produce extremely high yields as Lucerne is a heavy user of these three nutrients. The pH of the soil should be

between 6.5 and 7.5. Acid soils should be dressed with lime to improve the availability of calcium and phosphorus and neutralize the toxic effects of aluminum and manganese.

11.4 Agronomical Practices of fodder tree plantation

1. Koiralo (Bauhinia variegata)

Small to medium size fodder tree. It is popular in mid hills. Fodder is available during winter. Animals prefer it very much. Buds and flowers can be used for vegetables. The fodder can be cut or lopped during the months of Mangsir to Chaitra.

Fig. Koiralo

Climate: It can be planted to sub tropical type of climate from terai to high hills. This is also found in forest in natural condition.

Method of planting: The fodder is mainly propagated by seed. For this a nursery bed is prepared for seed sowing. Appropriate time for seedbed preparation in various regions is:

Terai: Baishakh

Mid-hills: First week of Chaitra

High hill: Bhadra

Method of seeding:

The seed should be shown directly in the seedbed or in the poly pot. Seed should

be soaked in cold water for 24 hours before sowing in the nursery. If seeding is done in poly pot, 2 seeds per poly pot is required. Single plant should be maintained in poly pots after four weeks of germination by removing the weaker ones. The seedling is ready for transplanting after 6 months in terai and after one year in mid-hill and high hills.

Seed collection: Seed is ripened during the months of Baishakh to Ashad. Lopping should not practice if seed has to be collected from that particular tree. The ripe pod is brown in colour. The ripe pod should be dried in sunshine. After complete drying it should be threshed, cleaned, dried and stored in the tin box. The viability of seed can be maintained if it is stored in proper place.

The fodder can be planted in well-drained, dry soil. It performs well in terai and mid-hills up to a height of 1500m from sea level. The fodder can be propagated both from seed as well as plant parts. The fodder contains 19% crude protein.

Yield: Fodder production is dependent upon the age and height of fodder tree. Generally an adult tree can produce 30 to 40kg dry matter per year. However, according to farmer's perception, excessive feeding of this fodder reduces milk production.

2. **Tanki** *(Bauhinia purpurea*): Tanki is medium to small sized leguminous fodder tree found in mid-hills up to an altitude of 600 to 1400m from the sea level. Fodder is also found in forest in natural form but propagation by seed is also common. It can be grown in dry and sloppy land but performs well in moist and fertile soils. Fodder tree is not grown well in shady place.

Fig. Tanki

Seed collection: Do not lop fodder if seed has to be collected from the particular tree. The seed is ripened during the months of Falgun to Jestha. The ripe pods should be dried in sunshine and dried pods threshed manually; cleaned, dried and stored in a tin box. The viability of seed remains up to one year.

Time of planting: The seedling should be transplanted in well-drained land. Generally seedling is prepared in nursery bed or in poly pot. The seed should be soaked in cold water for 24 hours. Two seeds should be seeded per poly pot. The seedling is ready for transplantation after six months in terai while in mid-hills it will take one year. Rainy season is the best time for transplanting. The seedling should be transplanted 2m apart. The fodder can be lopped after 4 to 5 years after planting. An adult fodder tree produces about 15 to 20 kg dry matter.

Time of fodder lopping: Mangsir/Poush. Single cut can be taken in a year. Fodder is nutritious and contains 17 to 20% crude protein.

3. Badahar (Artocarpus lakoocha):

It is one of the popular fodder trees, considered as the best among the fodder. It is highly nutritious and good for milking animals. The fruit is edible and consumed by human being. Timber is used for furniture. Badahar seed can also be used as a medicinal purpose particularly in diarrhoea case. The bark of this tree is used for wound relief by making pastes. Green fodder is available during the months of Kartik to Chaitra. The fodder can be lopped once in a year.

Fig Badahar

Climate and soils: This fodder can perform well in terai to mid-hills. Moist, fertile and loamy soil is the best, cannot tolerate shady place. Upland bounds, ridges and

uncultivated lands are suitable for fodder plantation.

Seed collection: The fruits are ripened at the end of the Ashar to first week of Bhadra. Fully ripe fruits are orange-red in color. Immature and over ripe fruit seed is not good for seed purpose. Seed should be separated from fruits and dried in shady place. The seed may be germinated 2 to 4 days after separation. Do not cut fodder if seeds are to be collected.

Time of planting: Immediately after fruit collection or two to four days after seed separation. Two seeds should be shown per poly pot; germination will take place within three weeks. Single seedling should be maintained by thinning weaker ones. The seedling is ready for transplantation after one year.

4. Bhimal (Grewia optiva):

This is one of the important medium- sized multipurpose fodder tree. The fodder contains 20.7% crude protein. This is mostly found in mid-hills of far and mid-western development regions up to an altitude of 2100masl.This is generally found in terrace bounds, ridges, near by dwelling places. The height of tree ranges from 8-10m and girth is about 2m. The leaves are rough and oval shaped and the taste of ripe fruit is sweet and sour and can consumed by humans. The fodder is lopped during winter and an adult fodder tree can yield 15-20kg fodders on DM basis.

Being a multipurpose fodder tree it is useful for various purposes. For example the branches left over by the animals are useful for fiber production after decomposition process (submerged in water for 15-20 days). The stem after fiber extraction is utilized for fencing as well as fuel wood purposes. This fodder is considered as best fodder in western part of Nepal. This is nutritious and fed to milch animals.

Fig Bhimal

Climate: This fodder is successfully grown from terai to mountain up to an altitude of 2000m. South facing, sunny and fertile soil is important, dry and infertile land is not suitable for plant growing.

Seed collection: Seed ripening is started from Mangsir to Magh; ripe fruits are black in color. For the separation of seed from fruits, fruit is put in bucket and some sand and water is added and rubbed by two palms. Thereafter the seed is separated from pulp cleaned, dried and stored in a tin box.

Time of plantation: The seedlings are transplanted during monsoon. Nursery bed is prepared for seedling. Seed should be shown directly in the bed and mulching and watering is required. The seed will germinate after 2-14 weeks after sowing. When seedling bears 3-4 leaves, it should be transplanted in poly pot. These poly pot plants are ready for transplantation in the main field after one year.

5. Khari (Celtis australis):

Khari is a tall type of fodder tree. The fodder is lopped during Baishakh and Jestha and considered a best fodder. In western Nepal its ranks second to Bhimal. The left over is used for fuel wood and timber can be utilized for construction purposes.

Climate: It can be grown from sub-tropical to temperate type of climate up to an altitude of 900-3000masl. South facing land with loamy soil is considered better for higher production of green biomass. The fodder trees are planted in terrace bounds, ridges, roadside, and small stream banks etc.

Seed collection and storing: Seed ripening is started in the months of Ashoj to Mangsir. The ripe fruits are black in color. Seed extraction methods are similar to

Bhimal.The well dried seed is stored in plastic or tin box in dry and shady place. The seed viability remains up to four years.

Planting time: The seed is shown in nursery bed in the months of Mangsir/Poush. The seed is soaked in water for 24 hours before showing in the nursery bed. Seed is also seeded in poly pot@2 seed/pot. It will germinate within 3 weeks of showing and seedling is ready for transplantation after 6-7 months.

6. Pakhuri (Ficus glaberrima):

This is one of the biggest trees among the tree fodder. It is popular in western development region especially in Lamgung and Kaski districts. Fodder is nutritious and fed to milch animals as well as growing animals. Fiber can also be produced from its branches or stems.

Climate:

It can be grown in tropical to sub tropical type of climate up to an altitude of 1200m from sea level. It prefers sunny places, loamy fertile soil. This fodder does not perform well in water- logged condition, but it can be planted in river-side and banks for higher production. The size of the tree is very big so it is not advisable to plant nearby cultivated land.

Plantation

It can be propagated by seed though stem and branch cuttings are considered better for plantation.

Propagation by stem / branches

Pencil size stem is cut in the month of Falgun with three nodes. The cutting is planted in poly pot leaving one node below the soil, one at the soil level and the third one above the soil surface. Thereafter poly pots should be kept in shady place making temporary thatch and irrigation provided regularly. The plant is ready for transplantation in the main field after 4-5 month or Ashad/ Shrawan.

Whole branches can also plant directly at the month of Ashad/ Shrawan.

7. Bains (Salix babylonica):

This is a small to medium size fodder tree. The fodder can be lopped during the months of Baishakh to Kartik in mountains and hills and Kartik to Poush in mid-hills. In the Himalayan region, the fodder is cut in Kartik, stored in dry form for later use (i.e. in the hay form).

Climate: This fodder is found in the range of 1000-3600m from sea level. It is famous in temperate region; fodder performs best in moist area especially riverbanks. South facing fertile land is considered better.

Propagation: It can be propagated by branch or stem cutting. The farmers of this

fodder growing area generally practice plantation of big branches during the month of Falgun.

8. Kimbu (*Morus alba*):

This is a small-sized fodder tree, but it can also be found in big form in mountain region. It regenerates soon and can be lopped frequently. Fodder is nutritious. It can be cut any time in between Ashoj to Poush. Fodder tree is deciduous in nature, fruits are edible. This tree is also used for silkworm farming.

Fig. Kimbu

Climate: It can be grown in tropical to temperate type of climate up to an altitude of 2400masl. It prefers moist and fertile soil. Sandy loam soil is the best.

Plantation: This fodder is generally propagated by stem cutting. It requires three nodes for planting. One-year-old stem is cut and planted in the poly pot. The poly pot should be kept in shady place and irrigated regularly. The poly pot plants are ready for transplantation after 6-7 months.

9. Amrisho (*Thysanolaena Maxima*) or Broom grass:

It is not a fodder tree; it is a shrub with profuse tillering ability. The fodder is cut in the month of Poush. Flowers are famous for broom making. Stems are used for fencing, making Mooda etc. In some places this fodder is used for retention of placenta. Thus, this is a multipurpose fodder.

Fig. Amrisho

Climate: It can be planted from terai to mountain up to an altitude of 2000masl. It requires moist and fertile soil. It does not thrive/grow well in dry area. Sandy loam soil is the best. For better production it can be planted in channel ridge, stream bank, bounds etc.

Plantation: It can be propagated by both seeds and stem cuttings. The stem should be separated from tiller and should have at least one node. The cutting should be planted in the nursery and irrigation should be followed as required. The plant is ready for transplantation in the month of Ashar/Shrawan.Whole tiller can also be transplanted in the main field.

Teacher's Instruction

- Classify annual , perennial legumes and non-legumes fodder and forage
- Cultivate different fodder in the field (all perennial, annual and seasonal

Unit 10
Pasture/rangeland management

Learning Outcomes

On completion of this chapter, the students will be able to:

- Explain the importance of pastureland management in Nepal.
- Explain animal feeding and grazing system in Nepal.
- Identify problems in pasture improvement in Nepal.

10.1 Importance and scope of pasture/rangeland management in Nepal

Pasture

Pastures aid the oldest form of livestock feed. The word pasture refers to land on which different types of edible grasses and other plants grow or are grown for grazing livestock.

Permanent pastures are those covered with perennial or self- seeding annual species of plants. Temporary pastures are those planted with quick growing crops like Sudan grass and can be divided into two types:

1. Natural grassland
2. Cultivated grassland
    a. Permanent pasture
    b. Temporary pasture

Fig. Pasture of Nepal

Rangeland and pastureland

Literally, rangeland is defined as an open region of natural grassland over which animals (livestock) roam and feed. In constraints, pastureland is a peace of land where plants or grasses are grown. In Nepal almost all the existing pasturelands are natural and thus the terms rangelands and pastureland have been used as synonymous.

1. ADB (1993) noted that about half of the country's forested area is estimated to be grazed by livestock and 50%of livestock fodder comes from forest sources.
2. Forage produce on range land, together with forest, shrubs lands and crop land are important resources in Nepal to produce green bio-mass in the form of grasses, hedge, herbaceous tree foliage, crop and crop residue.

Rangeland resources:

Rang/pasture land area by type:

Type of rang land	area km square	percent
Sub tropical and temperate	6293	34.4
Alpine	10141	55.4
Steppe	1875	10.2
Total	18309	100.00

Source: Miller (1989) quoted in ADB (1993)

Types of pastureland

Tropical Rangelands

This type of rangeland covers a vast area in the southern part of Nepal. It is found up to an elevation of 1000metreand mostly tall savannah (tree less grassy plain in tropical and sub tropical area) types of grassland are predominant. Most of the grasslands have been converted to cultivated land and the remaining grassland have heavy grazing pressure.

Sub-Tropical Rangelands

It is located approximately 1000-2000 meter in the hilly region of siwaliks, Mahabharata valleys and mountain slopes in the mid hills of Nepal. Large portion of the grazing lands have been brought under cultivation.

Temperate Rangelands

They are situated between 2000-3000meter from the sea level. The temperate grass species dominate. In addition to grazing crops residue and tree fodder are also used.

Sub-Alpine Rangelands

They are located in between 3000 to 4000m.These pasturelands provide feeds for the migratory herd of cattle and buffaloes during summer and large herds of Yak, Chauries, goat and sheep most part of the year.

Alpine rangelands

They are situated between 4000 and 5000m and have short growing period of 4 to 5 months. They provide summer grazing for Yaks, hybrids, sheep and goats.

Steppe Rang Lands

It is situated at an altitude ranging 2450 to 5000 in Mustang, Dolpa, Manang and Mugu which fall under the rain shadow area, with vegetation comprising of spiny, dwarf, cushion-type and prostrate shrub like plants. The steppe rangelands consist of grass and legume in the irrigated fringe area, which are used for hay making. However, rangelands have also been categorized by physiographic region and altitude, such demarcation is summarized in following table:

Rangeland categorized based on Physiographic region and altitude

Physiographic region	Range lands type	Altitude
1. Terai	Tropical range lands	1000m
2. Siwalik	Sub-tropical rangelands	1000-2000m
3. Middle mountain	Temperate rangelands	2000-3000m
4. High mountain	Sub-alpine rangeland	3000-4000m
5. High Himalaya	Alpine	4000-5000m
6. Trans Himalayan	Steppe zones	2400-5000m

Characteristics of good quality pasture

- Herbage should be palatable digestible and succulent.
- Herbage should be good dense of growth.
- Have ability to good stand trampling of the animals.
- The pasture should have nutritive grasses with high protein and minerals.
- The grasses should be adaptable to soil and climatic condition.
- Should be maintaining with sufficient height of grass.
- Animals get more feed with minimum walk.
- Needs less cost of cultivation and maintenance.
- Pasture should be keeps with young and abundant growth of grasses for even supply of the grasses and fodder throughout the year and season.
- Pasture should provide sufficient herbage for more animals on a limited area.
- Free from unwanted and poisonous plants.
- There should be sufficient water facilities for maintaining tender growth of herbage.
- It should be free from worms and other parasite of the animals.
- Pasture grasses should be well adjusted in crop rotation.
- Pasture should be near to cattle shed which can avoid long walk by the animals and wastage energy in the movement.

Advantage of good pasture

- Less labor is required for pasture development
- It requires less care
- Cost of production of herbage is less
- It requires less fertilizers
- Prevent soil erosion
- It is most economical and natural way of feeding animals.

Pasture Cover

World	-	25%
Mongolia	-	80%

Australia	-	54%
New Zealand	-	52%
China	-	43%
Iran	-	23%
Nepal	-	11.9%

Current Livestock Population of Nepal

Cattle:- 69,66,436

Buffaloes:-39,52,654

Sheep:-8,24,187

Goats:-69,79,875

Pigs:-9,35,076

Poultry:-2,30,23,979

Ducks:-4,05,217

Milking cows:-8,88,190

Milking buffaloes:-10,15,727

Laying poultry:-66,79,954

Laying ducks:-2,11,838

Importance

1. During dry season, to fulfill seasonal forage shortages and when the forage is of low quality
2. Cheapest and easiest source of feed
3. If good quality fodder leaves / grasses are supplied, concentrate feeds are not essential.
4. Abundant fodder can be obtained from limited area of land or limited number of trees.
5. Small and marginal farmers (with small land holdings) are particularly benefited from fodder trees.

6. Green forages can be conserved in the form of hay and silages and utilized during scarcity period.
7. With the full utilization of fodder and pasture, livestock products can compete the market price.
8. Animal production can be maximized in lean season.
9. Fodder trees and grasses will conserve the topsoil, which will minimize the problem of soil erosion. They become permanent feed resources for livestock.
10. There will be increased permeability of water into the soil leading to retention of moisture for longer periods.
11. During the summer, excessive oxidation of organic matter will not take place because of the shade provided by fodder trees, shrubs and grasses.
12. Excessive amount of rainfall can be expected in forest and grassland areas.
13. Maintain pleasant and healthy environment both for animals and human beings.
14. Morphological and physiological flexibilities allow trees and shrubs to survive in the harsh environment. They become major feed resources in extreme conditions, e.g. in Himalayan region.
15. Trees provide shade and shelter for various living beings including wildlife.
16. Various herbal medicines are prepared from trees, shrubs and grasses.
17. Fibrous plants required (requirement of fibers) for the growth and activities of microbes.
18. Balanced feed from the combination of legumes and non-legumes.
19. Steep and degraded land can be utilized for livestock productivity.
20. Nitrogen fixation (atmospheric) by legumes, increasing the soil fertility.

10.2 Animal feeding systems and grazing systems in Nepal

Systems of Grazing

Grazing has been defined as the partial defoliation of pasture plants by the animals. Animal production from pasture depends on the quality and quantity of herbage available to grazing animals, type and physiological stage of animal, climatic

conditions and management practices. Under grazing condition soil, vegetation, climate and animal form an integrated ecosystem and each factor effect the level of animal production. Management skill is another important factor, which affects the overall productivity of pasture and livestock.

Grazing Management

Grazing management consists of the wise and skillful manipulation of two basic biological systems; the pasture sward i.e. the herbage available for grazing and the grazing animals. Factors affecting either system will ultimately influence output per animal (milk, meat, wool, hides and skin, reproduction) and pasture yield per hectare. The principal factors under direct control of the manager include:

a. The choice of grass and legumes for the pasture;
b. Manipulation of agronomical practices in pasture maintenance, i.e. fertilizer, weed control;
c. Selection of livestock, type of animals as well as individual;
d. Choice of grazing system; and
e. Use of supplementary feeding etc.

Grazing Systems

Grazing of the grass at the early stage of growth is beneficial from animal production point of view but harmful for pasture because early and frequent defoliation decreases the photosynthetic activities resulting into low level of carbohydrate reserve in root system, which is essential for subsequent re-growth. Lack of leaf fall leads to poor organic matter accumulation, humus formation and increased soil compaction etc. resulting into degradation of pasture due to soil water losses. Contrary to this, grazing at late stage of maturity is beneficial from pasture point of view but not desirable for animals because of poor quality of herbage. Therefore, any grazing system should aim at:

a. To maintain a high production of good quality forage for the longest possible period;
b. To maintain a favorable balance between herbage species;
c. To achieve efficient utilization of the forage produced; and

d. High animal production

The system that meets these objectives should be employed under a particular condition.

1. Continuous Grazing

This is an extensive system of grazing in which the stock remains on the same grazing areas for prolonged period. This system of grazing is the normal practice in our country. After a long period of uncontrolled continuous grazing under high stocking rate, pasture will get deteriorated leading to degraded land.

2. Rotational Grazing

Rotational grazing is an intensive system of grassland management. The system involves the use of dividing the grazing area, for instance, in four paddocks and the animals are moved systematically from one to another in rotation. Each paddock is grazed for a period of about seven days after which the stock is moved on the next paddock while the first is rested. By the time the last paddock in sequence has been grazed, the first paddock becomes ready for grazing to the second time.

The aim of this system of grazing is to use the grassland when it is young and highly nutritious and then to allow an adequate recovery period. This system has the following advantages:

a. The vegetation gets chance to make better growth.

b. Young and nutritious grass becomes continuously available during the grazing period. Persistency and productivity of legumes are better maintained.

c. The grazing period with better quality herbage is prolonged.

d. Cattle and buffaloes maintain better condition.

e. Soil erosion is reduced; and

f. Stocking rate is increased.

3. Deferred grazing

Deferred grazing means delayed grazing. Deferred grazing implies delayed grazing until after the most important forage plants have set seed. In other words, the

practice of conserving standing hay in part of grazing area with maturity, the feeding value and palatability of grass fall off but even this will be of great value at the peak of dry season when pastures are grazed almost bare.

The practice is beneficial for improving degraded pastures by allowing the plants to mature before grazing, their vigour is built up, root systems are allowed to develop and self sown seedlings to become established.

4. Deferred-Rotational Grazing

Deferred-rotational grazing consists of dividing the grazing land into three compartments and grazing the animals alternately into two while protecting the third compartment during the growing season so as to permit the palatable species to recoup their vigour. The animals are then allowed to graze the third protected compartment after grass has seeded. Protection of one compartment once in three years maintains the grasslands in high state of production. This system is mainly recommended for pastures in which perennial species are dominant.

5. Strip Grazing

Strip grazing is a more intensive method of rotational grazing based on the use of electric fence. A movable electric fence is replaced across a grazing paddock and is moved forward once or twice each day. The strip grazing is of value only when pasture is highly nutritious and productive. Any restriction on intake on poor quality pasture will lead to a fall in animal production. The system is mainly applied to high producing dairy pastures.

10.3 Plant poisoning in pasture and their management

Sources of poisoning are diverse. These may enter the body by way of contact, inhalation. Ingestion etc. may be accidentally, unintentionally or intentionally . Depending on the sources such as Natural (Plant), and manmade sources . Most of the intoxicant of natural origin enters the body through food chain (food or water). Some of the rocks and soils are very rich in some of the toxic minerals e.g Fluorine , arsenic , selenium lead etc, Thus, the plants, crops or grasses grown in these area are rich sources of theses intoxicant e.g high quantity of nitrates in well water , copper in non legumes plant , nitrate in spinach and selenium in seleniferous plants..

Various plant s are among the important causes of economic loss to the livestock industry. Usually animals are poisoned because hunger or others conditions causes them to graze abnormally, due to wrong management or agricultural practices. Certain area s are rich in poisonous plants depending on the climatic condition, geographical location etc. Generally, the toxic plants have a repulsive odours and are usually refused by the animals, however, during the peak summer or winter month when there is scarcity of green fodder, some of the toxic / poisonous plant are consumed by the animals especially when they are hungry e.g *Lantana camera, Quercus incana Acacia leucophloes*, Sudan grass etc are very rich in toxic principles such a cyanogenetis glycosides, nitrates, nitrites oxalates selenium etc

Cyanogenetis plants

- Acacia leucophloea
- Lotus sp.
- Nerium oleander
- Sorghum vulgare
- Sorghm halepense
- Zea mays
- Phaseolus lunatus
- Kalanchoe integra
- Eucalyptus sp.

Other poisonous plant

Poisonous plant	Common name	Family	Toxic constituents	Lethal dose
Abrus precatorius	Rosary pea, Jequirity bean Prayer bean plant	Leguminosae	Abrin(Present in seed)	0.1µg abrin /kg
Sorghum vulgare	Jower, Joar, Millet, Jonlu	Cyanogenetic glycosides		
Lantana camara	Lantana, Wild saga, Bunch berry	Verbenaceae	Polycyclictriterpnes	5gm(dry leaf powder/kg body wt

Ipomoea carnea	Jalap, Jangaliake, Besharmi booti	Convolvulaceae	Saponin	
Thevetia nerifolia	Yellow oleander	Apocynaceae	Cardio-active glycosides	0.005% in horse
Daturastramonium	Thorn apple, Jimson weed, Mad apple Stink weed	Solanaceae	Hyocyamine, Atropine	2.7mg /kg body wt of pig
Strychnos nuxvomica	Nuxvomeca	Loganiaceae		0.5mg/kg body wt in dog
Ricinus communis	Castor bean	Euphorbiaceae	Ricin	2gm seed/kg bwt in cattle
Lyonia ovalifolia	Aagayri			
Oryopteries fillix	Ooneu			
Aconitum heterophyllum	Atiisa			

Control of poisonous plant in pasture

- Feed plenty of fodder/grass to animals
- Cut/ remove poisonous plant from pasture time to time
- Store plenty of fodder/ grass in available season to scarcity in dry period.
- Usually an animal doesn't eat poisonous plant until scarcity of fodder in dry period.
- Effective herbicides used to remove plant.
- Biological control
- Seed head fly larvae feed on poisonous plant
- Root gall bettle larvae feed and weaken plants.

10.4 Factors affecting the Natural Grasslands

The factors affecting the local eco-system are i) the environments like soil and climate, and ii) biotic influences such as the natural fauna of the area, grazing by

animals, firing and other changes brought about by the man like clearing, cutting of jungles etc.

1. Soil

The effect of soil type on the natural grassland is mostly the result of the moisture available to the different grass species growing in that area. For instance, Mustang district is deficient in rainfall i.e. moisture, that is why growth of local legume, Kote is adversely affected. However, irrigated soil is found to be highly fertile. On the other hand, growth of Furcha (local grass) is excellent due to adequate rainfall in Solukhumbu district. Since Mustang lies in the trans-Himalayan region, growth of pastures is extremely slow due to inadequate rainfall. Ilam is probably the leading district for the growth and availability of better quality natural pasture

2. Climate

Climate is one of the most important factors which determine the type of grassland and its botanical composition. Generally, wetter the climate, the denser is the tree cover. Therefore, in humid tropics, tree cover is dense and treeless grasslands are rarely found except in alpine pastures of the Himalayas.

In the tropical countries of Asia, South East Asia grasses like *Heteropogan, Dicanthium, Imperata, Andropogon, Bothriochloa, Cymbopogon,Saccharum, Sechima. Sorghum, Eululia* etc. are distributed in the areas which have warm monsoon climate. These types are found in India, Bangladesh, Pakistan, Philippines etc.

In the high rainfall area grasses like *Panicum, Paspalum, Digitaria, Pennisetum, Urochola* etc. are distributed.

3. Biotic Influence

Fires in grasslands which have become a frequent feature in the tropics affect the dominance of some of the grass species. Frequent firing has led to the dominance of *Imperata cylindrica* in the humid and sub-humid tropics of Africa and South East Asia. Similarly clearing of forests by removing the trees also affect the composition of grasslands.

The botanical composition of grassland is affected by grazing. For instance, when

Dicanthium/Cenchrum/Lasiurus grassland type in India subjected to grazing on loose textured soils, the more palatable *Dicanthium annulatum* is lost from the sward and the *Cenchrus ciliaris* and *Lasiurus sindicus* become dominant. As the grazing pressure is further increased, the sward is dominated by the low grazing stoloniferous *Cynodon dactylon* and by *Elensine compressa.* This in turn gives place to *Aristida spp*. and to annual *Cenchrus biflorus.* Finally, only unpalatable annual weeds and bare soil remains.

4. Day length

The day length or photo period controls the daily energy inputs and consequently controls flowering in plants. It is therefore an important factor in selecting pasture variety in a particular place.

5. Temperature

Temperature plays an important role in the growth pattern of plants. Flowering of some legumes like Siratro is affected by temperature. At low temperature below 13°C, flowering process is retarded.

The fires which are regular features of the tropical grasslands affect the regeneration of some leguminous species. Siratro regenerates rapidly after fire but Stylo is completely killed.

6. Rainfall

Rainfall in the tropics is extremely variable from zero in deserts to as much as 10,000 mm annual as in Cherapunji of India and some parts of Hawaii. The rainfall is erratic and is not uniform throughout the year.

Following types of rainfall have been reported by Kendrew (1961)

1. Equatorial where two seasons of heavy rain occurs in the course of the year with very little dry season. This occurs only a few degrees of latitude on each side of equator, e.g. Cameroon.
2. Tropical- between the equatorial area and neighbourhood of the tropics of Cancer and Capricorn most rain in the hottest months when the sun is the highest; winter a pronounced dry season. It is subdivided into:

a) Inner tropical with two maximum of monthly rainfall found between 10° N and S of equator, e.g. Juba, the Sudan. It is like equatorial.

b) Outer tropical with a single maximum in summer and long dry season, e.g. India, Bangladesh, Pakistan.

A uniform medium rainfall (50-70") gives the best performance of tropical legumes and grasses (India, Kenya, Uganda). Similar trend may be observed in temperate pastures (New Zealand) although winter shortage is high. However, numerous leguminous species have adopted in arid and semi arid conditions (Stylo, Alysicarous). High rainfall with poor drainage may result in water logging which may affect the propagation of Kudzu and Calopo.

10.5 Problems in pasture/ rangeland improvement in Nepal

- Poor land allocation
- Lack of pasture management technology
- Over grazing / continuous grazing
- Lack of community organization
- Lack of co-ordination / help between governmental organization
- Terrace land empty
- Lack of fund and motivation

Teacher's Instruction:

- Show different data of pasture
- Enlist the poisoning plants.

Unit 11

Conservation of fodder/forages: hay and silage making

Learning Outcomes

On completion of this chapter, the students will be able to

- Student can prepare hay, silage.

Feeding of green and succulent fodder is of utmost importance to farm animals. In our country Nepal, the availability green fodder is limited to a particular season only. During the lean month green fodder is not available for feeding to the livestock. In Nepal, during rainy season plenty of green are available but the farmers do not properly utilize them due to lack of sufficient knowledge of fodder conservation.

In order to feed green during lean month they are conserved in the form of hay and silage. In fact none of these methods are being used by the farmers of Nepal for fodder conservation. Hay and silage making practices are limited only to government livestock farm. The farmers of temperate region of the country are being practiced to hay making.

1. Hay Making

Forage plant when preserved through reducing the moisture content to the level at which plant tissue are dead or dormant, is termed hay. In other words hay refers to grasses or legumes that are harvested, dried and stored as 85 to 90 per cent dry matter. High quality hay is green in color, leafy and pliable and free from weeds. When harvested in the proper physiological stage of growth and well cured to 20 per cent or less moisture at the time of storing, hay can be utilized as an excellent feed for dairy cattle particularly when fodder is scarce or pasturage is insufficient.

Fig. Hay

Advantage of haymaking

1. The hay provides the nutritious food to the livestock during the lean season when there is scarcity of fodder.
2. The good quality legume hay, May replce certain amount of concentrate in the ration, thus reducing the cost of production.
3. The fodder can be harvested at the stage when there is maximum accumulation of nutrient in the plant.
4. The ration of the animals can be balanced with the help of good quality hay.

Principles of haymaking

The principles involved in hay making is to reduce the water content of the herbage so that it can be safely stored in mass without under going fermentation or becoming mouldy.

Important points for haymaking

1. The forage for haymaking should be leafy with tender and thin stem.
2. It should contain about 7-to10 percent proteins and 0.5 per cent calcium.
3. The harvested crop should be dried in field till its dry matter content reached 60 per cent. Now it should be dried-up to 85 to 90 per cent dry matter on a special type of frame made for this purpose. Care should be taken that there is no loss of its green coloring matter during this process of drying.

4. Occasional tilting of grasses over the frame is necessary for proper curing.
5. The hay to be stored should not contain more then 15% moisture.
6. The hay should be dried as early as possible it helps in preservation of nutrient present in the crops.
7. There should be no loss of leaves during the act of harvesting, transportation and drying.
8. The suitable crops for haymaking should be harvested at flowering stage. At this stage they are rich in carotene, protein digestible carbohydrates and minerals.

Suitable crops for haymaking

Berseem, Lucerne, oat, cowpea, soybean, anjan and Sudan grasses are suitable crops for haymaking. Some self-grown natural grasses drying monsoon are also good for this purpose.

Requisites of good quality hay

1. Good hay should be leafy; it has been found that leaves are richer in food value compared to other parts of the plants. The leaves are generally rich in protein carotene, vitamins and minerals.
2. It should be prepared out of herbage, cut at a stage nearing to maturity, preferably at the flowering stage when it has the maximum of nutrient. Delay in cutting would mean losses of a part of nutrient which would be used up by the plant in seed formation
3. It should be green in colour. The green colour of the leaves indicates the amount of carotene, which is a precursor of vitamin A.
4. It should be soft and pliable.
5. It should be free from dust and moulds.
6. It should be free from weeds and stubbles.
7. It should have the smell and aroma characteristics of the crops from which it is made.
8. The moisture percentage in hay should not exceed 15 per cent.
9. Hay of average quality will usually run from 25 to 30 per cent crude fiber and 45 to 60 per cent TDN.

10. Hay is primarily a cattle, buffalo, horse, sheep and goat feed. Very little of hay of any kind is ever feed to swine.

Kinds of hay

Generally there are three types of hay:

a) Legume hay

Good legume hay has many characteristics that make it of special value to the dairy cattle. It has a higher percentage of digestible nutrients. It has more of digestible protein because of higher protein content. The proteins of legumes are of superior quality as compared protein from other plants. The legume hay is rich in vitamins, carotene, vitamin-D, E and calcium. Among various leguminous fodder crops Lucerne berseem cowpea and soybean hays are considered first.

b) Non-legume hay

Non-legume hays made from grasses are inferior to legume hay. They are, as a rule less palatable and contain less proteins, minerals and vitamins than the legume hays. Non-legume hays have the advantage over legumes hays because there out turn per hectare is more than that of legume hays and former can be grown easily. Hays made from green crops like oat and barley compare very favorably with the other grass hays. For good quality hay making these crops should be harvested in the milk stage. They are low in protein and minerals, but rich in carbohydrates.

c) Mixed hay

Hay prepared from mixed crops of legumes and non-legume is known as mixed hay. The composition of such a kind of hay will depend on the proportion of the different species grown as a mixed crop. Such a crop is generally cut earlier because of the variation in the seeding time of the mixed crops

Harvesting of the crop for hay making

The crops should be harvested during the daytime after the dew has dried off so that plants when spread over the ground may dry evenly. Another, which needs attention, is that the field should not be wet; otherwise uniform drying will not take place. The crop cut early is higher in protein lower in crude fiber, contains more of protein, is more palatable and will shatter less. The best time for cutting a crop for

haymaking is when it is one third to half in blossom.

Curing of hay

In curing, it is necessary that the herbage should be saved from bleaching by the sun and as for as possible, leaves preserved from shattering. The maximum quantity of moisture should be evaporated, so that it can be stored without generation of heat and consequent loss of nutrient.

Losses of nutrient in haymaking

The main aim of the process of haymaking is to reduce the moisture content of the herbage to a safe level (about 15%) and to retain its nutritional characteristics during the process. Some nutrients are always lost in field curing hay, but under favorable condition this loss is not too much. If the plants dried without fermentation or bleaching, they contain a higher percentage of nutrients.

The losses in nutrient value in haymaking are:

- Losses due to late cutting.
- Losses of leaves by shattering.
- Losses of vitamins due to leaching and fermentation.
- Losses of soluble nutrients by leaching in heavy rain.

Losses due to late cutting

Late cutting means greater lignifications and lower carbohydrates and protein digestibility, while cutting early suffer from low yield and high moisture content of the forage meant for hay making

Losses of leaves by shattering

The loss due to shattering of leaves and finer part in haymaking is of importance especially in the case of legumes. The leaves are much richer in digestible nutrients then the stem hence losses by shattering materially decrease the nutritive value of hay.

Losses of vitamins

In the process of drying much of the green coloring matter containing carotene, a

precursor of vitamins-A is lost with bleaching. In general the carotene content of freshly cured hay is proportional to the greenness.

Losses in fermentation

In fermentation of hay some of the organic nutrients like starch and sugar are oxidized into carbon dioxide and water. If during is prolonged due to unfavorable weather condition the activity of bacteria and fungi occur, resulting mouldy hay. Such type of hay is harmful both for the livestock as well as the person handling hay due to the presence of mycotoxins.

Losses of leaching

When exposed to heavy and prolonged rains, especially when it is in the field, severe losses may occur through leaching.

Storage of hay

Hay is usually stored in stacks or in the trees. Care should take that the hay is in a good and dry condition before it is stored. It should be stacked in a shady place where there is no danger of fire.

Brown hay

Sometime because of very unfavorable weather condition, good hay cannot be obtained by the ordinary method of curing. Under such circumstances, hay is allowed to dry until about 50% moisture has been removed and then it is packed in stack or piles. Fermentation take place and the hay may become very hot; the temperature should not be allowed to exceed 80 c. There are great losses in the nutritive value on account of fermentation. These losses range from 30-40%. Such hay are often palatable.

Fig. Brown hay

Haylage Making

Haylage is low moister silage (40 to 45%moisture) and is made from grass/or legume that is wilted to 40-45% moisture content before ensiling. It is similar to silage except it is lower in moisture haylage some time called low moisture silage is a form of preserved forage with characteristics between those of hay and silage. It is made from grass/or legume to a moisture level of 40-45 per cent when harvested or wilted to this level if the harvested forage is having higher moisture percentage before ensiling. It must be preserved by process some what different from those for wilted or unwilted silage. The silo should be well constructed and as air tight as possible so that the oxygen present soon used up, the CO that is produced is trapped and held within the silo. These conditions prevent the forage from spoiling by molding, oxidizing; heating etc. Air exclusion is the key to the success or failure of making low moisture silage.

Advantage of Haylage making

Properly made haylage has a pleasant aroma and is a palatable high quality feed. Animals usually receive more dry matter and net feed value then silage made from the same cut. If forage is mowed with the intention of making hay and weather becomes unfavorable for drying the partially dried forage can be made into haylage.

Disadvantage of haylage making:

With haylage, fine chopping, good packing and complete sealing against air entrance in the silo is a must and more critical than with silage.The danger of excessive heating which lowers protein digestibility is more acute in haylage than silage.

2. Silage preparation

Silage: Silage is a form of conserved grass, silage make during summer month when the grass supply is plentiful and is feed to animals during winter month when the grass supply is less.


Fig. Silage

Crop suitable for ensilage are: Clovers, afla-afla, vetch, oats, rye grass , maize, various weed etc which are tore in silo. To make silage, plant should be 50-60% moisture.

Principles: Silage undergoes anaerobic fermentation (without oxygen) which convert sugar to acid fermentation is essentially complete after about two weeks.

Phase of silage preparation:-

Anaerobic phase: oxygen inside is utilized first.

Acid fermentation phase: Various lactic acid bacteria decomposed carbohydrate into acetic acid , butyric acid and lactic acid

Stable phase: The phase produced certain Ph and sours in taste (also called sour silage).

Ph and temperature of silage

	Day 1	Day 2	Day3	Day4-7	Day8-21	After 21 days
Ph	6	5	4	--	4	4
Temperature ºF	70	95	---	80-85	-	Stable

Method

Grass/fodder/crop

↓

Mowing(cutting) in pieces about 0.5 inch (1.3 cm) long

↓

Crop / grass are spread in uniform layers overfloor of silo

↓

Then silo is packed tightly so that air, water can't get in.

Losses during silage preparation

Anaerobic loss 10%

Effluent 3%

Fermentation5%

Filling 5%

Field 4%

Teacher's Instruction

- Prepare hay and silage by involving students.

Unit 12
Economy in Livestock Feeding

Learning Outcomes

On completion of this chapter, the students will be able to:

- Know how to minimized the cost of livestock feeding & increase production.

Feeding of animals is based on certain standard that takes into account the physiological needs for specific functions such as maintenance, milk production, egg production, growth, pregnancy and for which energy, protein, minerals and vitamins must be provided in adequate amounts to encourage maximum production .In normal practice only the energy and protein needs of animals are mostly considered. Various feeding standard have been adopted in different countries. Due to this the same feed is valued in a different manner (specially roughages) , which complicated the consumption of ration. There are basic principles involved in livestock feeding some of these can be reduced to rules and guide that will be useful to feeder .Like all commercial practice the profit from animals depend on the difference between inputs and outputs. Under high cost structure of concentrate feeds extensive application of intensive livestock farming practices involved in production of nutritive forage to replace concentrate is essential to effect economy in livestock production. Before approaching the nutritional needs of any particular types of livestock the importance of appetite or dry matter consumption is very important. There are various factors which have got bearing on the dry matter intake like addition of molasses, processing of feed like grinding, pelleting,, warfaring etc. Physiological effect of climate namely, hot and humid has also a depressing effect on feed intake thereby decreasing growth and production of livestock.

About 60-70% cost of operational cost of livestock rearing expenses on feeding of animals. So, minimizing the feeding cost on livestock rearing increase the profit amount. In developing country likes ours, livestock are mostly fed on the crop residues, some of grazing and supplementation of diets with small amount of agro-industrial by product. Though the cereal production increased due to improved technology still it is not enough to feed the increasing human population as well as

animals. Therefore, to minimize the cost of feed we can fed animal agro-industrial by product, agricultural waste and unconventional feeds which are locally available in our country.

Agro-industrial by product can be grouped according to the content of nutrient namely:

- Energy rich supplement: e.g. molasses from cane and beet, citrus, reject banana, pineapple waste
- Protein rich supplement like oilseed cake, fish and meat meals animal organic waste
- By product which supply minerals like bone meal, seaweeds

Unconventional feeds

Unconventional feeding materials are those which are not traditionally used as animals feed but which inherit potential for use. The materials either due to lack of production , processing technology, presence of toxic principles or lack of appropriate feeding technology are by and large considered to be waste materials.

- Concentrate feed resources are castor bean meal, mangoseed kernel, neemseed cake watermelon seed cake etc
- Roughages from leaves of fodder trees
- Tree leaves and fallen tree leaves e.g. papal ,mango, bamboo, banana etc
- Marine and aquatic waste : fish waste
- Starch industry waste: maize germ, maize barn, maize oil meal
- Slaughter house by product: blood meal , bone meal, rumen content etc
- High moisture agro-industrial by-product are tomato pomace, pineapple waste, dairy whey, pulp and paper mill residue.
- Poultry industrial by products are feather meal, offal meal, poultry waste, hatchery waste etc

Teacher's Instruction:

- Show the comparative study of economy of livestock rearing as surveyor in village via questennionarmethod.

Index -1

Minerals	Function	Deficiency symptoms
Calcium	● Formation of skeleton and bone. ● Normal cardiac function ● Activity of various enzyme ● Formation of blood clot ● Production of more eggs and thick shell ● Transmission of nerves impulse ● Acid base balance	● Rickets in young & osteomalacia in adult ● Poor growth rate ● Poor hatchability ● Osteoporosis ● Decreases egg production with thin egg ● Longer blood clotting time ● Leg weakness ● Low appetite
Phosphorous	● Constituent of bones & teeth ● Better nutrient& calcium absorption ● Energy metabolism ● Composition of nucleic acid ● Component of co-enzymes ● Determine cellular activity	● Pica(abnormal eating habit) ● Loss of appetite ● Rickets & osteoporosis ● Poor growth ● Muscular weakness
Potassium	● Activates intracellular enzymes ● Maintain acid base balance ● Need for normal heart beat ● Maintain osmotic pressure ● Roles in nerves and muscular activity ● Need for carbohydrate and protein metabolism	● High mortality of chick ● Retard growth ● Muscular weakness
Sodium	● Maintain osmotic pressure ● Regulate acid base balance	● Cannibalism in poultry ● Kidney damage

	• Role in nerves and muscles contraction • Preserve permeability of cell	• Decrease feed efficiency • Delay sex maturity • Low body weight & egg formation • Soft bone formation
Chlorine	• Water balance & osmotic pressure maintain • Acid base balance • As gastric juice	• Diarrhea • Heavy mortality • Nervous symptoms • Poor growth •
Iodine	• Constituent of thyroxin • Work as energy metabolism	• Goiter • birth hairless pig • hypertrophy of thyroid • retard growth • subnormal metabolism • decrease & delay hatchability
Zinc	• Component of enzymes • Essential for normal growth, reproduction & life expectancy • Digestion of protein in gastrointestinal tract • For wound healing & tissue repairing	• Abnormal leg • Parakeratosis • Retard growth & dehydration • Frizzled feathers of poultry • Leg disable & ataxia • Reduced feed & water • Difficult breathing • Low egg production
Copper	• Catalyst for haemoglobin formation • Activate various enzymes	• Gingin rickets/ enzootic neonatal ataxia/ sway back • Decrease iron absorption

	● Necessary for maturation of erythrocytes	● Stunted growth ● Leg weakness ● Internal haemorrhage ● Depigmentation of feathers ● Reduced hatchability
Selenium	● Component of glutathione peroxidase ● Acts as antioxidant ● Increase function of vitamins E	● White muscles diseases in cattle ● Poor feathering ● Stunted growth ● Retard egg production & hatchability
Iron	● Constituent of hemoglobin ● For normal functioning of organ & tissues ● Present in muscles pigment in myoglobin ● Help in cellular respiration	● Depigmentation of feather ● Hypochromic & microcytic anemia ● Stunted growth ● Impair haemoglobin formation
Manganese	● Oxidative phosphorylation ● Fatty acid synthesis ● Activation of enzymes ● Synthesis of organic matrix ● Egg production & hatchability	● Retention of yolk in hatch chick ● Decrease hatchability ● Poor growth ● Crippled diseases of poultry(slipped tendon) ● Deformed embryo ● Low egg production ●
Magnesium	● Component of bone ● Activate enzymes like phosphates	● Grass tetany ● Lethargic ● Decrease growth rate, egg

	● Phosphorylation reaction ● As cations in soft tissue ● Control irritability of neuromuscular system ● Essential in energy exchange mechanism	production, & weight gain ● Gasping & panting ● Neuromuscular dysfunction

Index -2

Vitamins

Vitamin	Chemical names	Deficiency symptoms
A	Retinol in animals Carotene in plants	Xerophthalma & nightblindness Nutritional roup in poultry
D	Ergocalciferol (D2) Cholecalciferol(D3)	Rickets in young, osteomalacia in adult Bowlege condition in dog
E	Tocopherol	Young cattle- white muscles diseases Poultry – cyazy chick diseases
K	Phylloquinone (k1) Menoquinone(k2)	Delayed blood clotting
C	Ascorbic acid	Scurvy in man & guinea pig Delayed wound healing
B1	Thiamin	Man- beriberi Poultry – star grazing Polioencephalomalacia
B2	Riboflavin	Curled toe paralysis in poultry
B3	Nicin	Dog- black tongue Man-pellagra
B4	Choline	Fatty liver haemorrhagic syndrome in poultry
B5	Pantothenic acid	Goose stepping gait in pig
B6	Pyridoxine	Convulsion
B9	Folic acid	Anemia
B12	Cyanacobalamine	Megaloblastic anemia
H	Biotin	Dermatitis,perosis

PRACTICAL

PRACTICAL NO -1

Identify common grasses, forage legumes and fodder trees

Objective

- To be familiar with forage and fodder plants
- To identify the name of forage and fodder commonly found in local area.

comments

Annual Graminaceous summar Growing :

sorghum Sorghum bicolar

Sudan Grass : Sughum bicolar (L) moenchi

Maize : Zea mays

Teosinte: Euchloena maxicana

pearl millet : Pennisetum americanum

Denanath grass : Pennisetum pedicellatum

Annual Graminaceous winter growing

Oat cv Canadial

Oat cv Bandel 85

Oat cv JHO 882

Oat cv 323 / 025

Oat cv 346/62

Oat cv Taiko

Oat cv Kent

Oat cv Swan (Pak)

Oat cv swan (Nep)

Oat cv Charaville

Oat cv Omihi

Oat cv CDA/DD

Oat cv Awapani

Oat cv 83INC 1863

Oat cv Nare (Pak)

Oat cv PDL x GS

Oat cv CARISMA

Annual Leguminous Summer growing

Cow pea : *Vigna vinguicalate*

Rice bean : *Vigna Ambellate*

Moth : *Phasealus aconitifliues*

Soybean: *Glycin max*

Valvate bean: *Mucuna Pruriens*

Cluster Bean Cyrnopsis tetragoloba (i)

Turnip: *Brassila Compestries*

Annual Winter Growing leguminous:

Berseem : *Trifolium alexandrium*

Softal clover : *Mulilonos Paruiflora*

Vetch : *Vicia species*

Perrinial Graminaceous summer growing:

Hybride Napier: *Pennisteum purporeum P. americanum*

Hybrid Pennisetum : *P. Purpureum P. tybheides*

Guinea grass: *Penicum maximum*

Para grass : *Brachiara mutica*

Pangola grass : *Digitaria decumbens*

Doob grass : *Cynodum dactyions*

Anjan Grass : *Cenchrus ciliaris linn.*

Black Anjan grass: *Cenhrus setigerus*

Rhodes grass: *Chloris gayana kunth*

Setoria grass: *Setaria anceps*

Thin Napier *Pennisetum Polystnehyon*

Elephant grass or Napier grass : *Pennistum Purporeum*

Marvel grass : *Dichantium annulatus*

Mollassies grass : *Melinis minutiflora*

Rya Grass CV. : *Lolium perenne*

Marvel grass: *Dichantium annullatum*

Paspalum : *Paspalum dilatum*

Dinanath : *Pennisetum pedicellatum*

Sain : *Sehima nervosum*

cooks foot: *Dactglus glomerate*

Trimothy: *Phleum paratense*

Perrinial graminaceous winter growing

Granary grass: *Phalaris turosa*

Perrinial leguminous summer growing

style: *Stylosanthes SP*

Centrosema : *Centoosema pubescens*

Clitoria: *Clitoria ternated*

Desmodium green leaf: *Desonodium intortum*

Desmodium silver leaf: *Desonodium uncination*

Lablab: *Lab purpureus*

Tropical kudza: *Puerarip phaseoloides*

joint vetch: *Aeschynomone felecate*

Lucern : *Medicago sativa*

White clover : *Trifolium repens*

Redclover: *Trifolium pretense*

Perennial leguminous winter growing

White clover cv : *Trifolium repens*

Lucern (alfa alfa) : *Medicago sativa*

Amriso : *Thanolaena maxima.*

Conclusion: Thus, we were able to identify common grasses, forage egumes and fodder trees.

PRACTICAL NO. 2

Identify common feed ingredients for farm animals and poultry birds

Objectives

- To be able to know the common feed ingredients
- To be able to use common feed ingredient which are locally available.

Theory

Feed (s): Edible materials(s) which are consumed by animals and contribute energy and/or nutrients to the animal's diet. (Usually refers to animals rather than man (AAFCO, 2000).

We can conveniently classify feeds into three main types: (1) roughages, (2) concentrates, and (3) mixed feeds. Roughages include pasture forages, hays, silages, and byproduct feeds that contain a high percentage of fiber. Concentrates are the energy-rich grains and molasses, the protein- and energy-rich supplements and byproduct feeds, vitamin supplements, and mineral supplements. Mixed feeds may be either high or low in energy, protein, or fiber; or they may provide "complete" balanced rations.

- **Complete feed:** A nutritionally adequate feed for animals; by specific formula compounded to be fed as the sole ration and is capable of maintaining life and / or promoting production without any additional substances except water(AAFCO, 2000).
- **Concentrate:** A feed used with another to improve the nutritive balance of the total and intended to be further diluted and mixed to produce a supplement or a complete feed.
- **Supplement*:*** A feed used with another to improve the nutritive balance or performance of the total and intended
- **Premix*:*** A uniform mixture of one or more microingredients with diluents.
- **Additive:** An ingredient or combination of ingredients added to the basic feed mix or parts thereof to fulfil a specific need. Usually used in micro quantities and requires careful handling and mixing (AAFCO, 2000).
- **Compound feed:** A mixture of products of vegetable or animal origin in their

natural state, fresh or preserved, or products derived from the industrial processing thereof, or organic or inorganic substances, whether or not containing additives, for oral feeding in the form of a complete feed (HMSO, 1992; see also formula feed).

- Feed ingredients are broadly classified into cereal grains, protein meals, fats and oils, minerals, feed additives, and miscellaneous raw materials, such as roots and tubers.

Fig. Soya cake

fig. maize

Mustard Cake

Conclusion:

Practical No. – 3

Cultivation practices of common annual and perennial grasses and legumes.

Objective

- To know about different forage and fodder cropping and season.
- To know various cultural practices used during forage and fodder production.

Materials Required

i. Measuring Tape
ii. Field
iii. Seed
iv. Fertilizers

Comments

i. Crop oats *Avena Sativa*

Sowing time : Kartik – Mangsir

seed rate : 100 – 120 kg/ha

Fertilizer Frm : 5 ton, NPK : 80 : 60 : 40 kg/na

Production: 23 – 73 tonlha

Irrigation : 2 – 4 times.

Kent swan Kathmandu netra.

2. Crop Berseem *Trifolium alexgondrinum*

Sowing tim : Kartik – Mangsir.

Seed rate : 20-25 kg/ha

Fertilizer : FyM 5 ton, N:P:k: 40: 60:40 kg/ha

Production: 60-85Ton/ha

Irrigation : 3-5 times

Baradane, Maxsive

Crop comman Vetch Vasia sativa

Sowing time Kartik Mangsir

Seed Rate 40 kg/ha

Fertilizer Fym 5 ton, N : P : K 40 : 60 : 40 kg/ha

Production : 40 – 60 ton/ha

Irrigation : 2- 4 times.

Crop Pea : (summer)

Souling time : Kartik – Mangsir

Seed Rate : 25 kg/ha

Fertilizer Fym 5 ton, N : P : K 40 : 60 : 40 kg/ha

Production : 405 – 60 ton/ha

Irrigation : 2 – 4 times.

Summer

Bajra, Teosenty, surgumi

Seed rate – 25 – 40 kg/ha

NPK = 80 : 60 : 40

FyM = 5 – 10 ton/ha

Perrinial:

Stylo – 4 – 5 kg/ha

White clover – 4-5 kg/ha

Rye gras – 25- 40 kg/ha

setaria – 5 – 7 kg/ha

Cultivation of seed rate and fertilizer for 250 m^2 land

Seed Amount	Oat	Berseem	Vetch
For 1 hector (10000M^2) -		120 kg	25 kg40kg
for 250 m^2 -	3 kg	5/8kg	1kg.

Fertilizer

IN DAP – P = 48%, N = 18%

Urea – N = 46%

Potash – K_2o_5 = 60%

Requirement of fertilizer for oat (250m^2)

FyM : - 0.25 ton

N : P : K - 1 kg : 1.5 : 1 kg (Atsonilny)

Put we also get N from P 50;

Yield (oat) : 1.075 – 1.825 ton.

Procedure : If land is barren, then first it was filed and fertilizers applied sown and irrigated and again tiled & seed are sown in constant water.

If the land has proper moisture then once land is tiled then fertilizers are applied & tiled and seed can be sown by broad casting or making row (for seed purpose) transplanting.

Conclusion : From above practical we were able to know how to cultivate winter crop (oat)

Practical No. – 04

Prepare seasonal calendar of different cereal fodder and legumes considering sowing and harvesting time to supply green fodder all the year round

Objectives

1. To make the availability of fodder erop all the year round .
2. To know the ecological zone sowing time amount of seed fertilizers and harvesting period of particular plant .

Calendar for your round forage/ fodder crop cultivation

Winter Fodder crop

S.no	Fodder crops	Ecological zone	sowing Time	Amt. clsed	Amt of fertilizers	Harvesting period	Production hec
1.	Oat	Terai high hill mid	Kartik -Magh Kartik –Magh	100-120kg 100-120kg	80 120:60:30 60:30:0	Poush Chaitra Falgun-Ashar-Poush	25-50ton
2.	Berseem	Terai Mid hill	Kartik -Magh Kartik –Magh	20-25Kg 20-25Kg	25:60:30 25:60:30	Chaitra Poush-Baishak	70-80 70-80
3.	Vetch	Terai-MId hill	Kartik-Magh	25-40kg	25:60:25	Poush	60-70
4.	Lucern	High hill Terai/Mid hills	Ashoj-Mangsir Chaitra-Baishakh	20-25Kg 20-25Kg	25:60:30 25:60:30	Asar-Asoj Poush-Jeastha	70-80 65-75
Summer Season fodder crop							
1.	Tiosente	Terai Midhill	Baishak-Asar	35-40	80:40:30	Asar-Asoj	60-80
2.	Sudan	Terai Midhill	Baishakh-Asar	10-12	60:30:30	Asar-Asoj	80-100
3.	Magic	Terai Midhills	Baishakh—Asar	30-350	80:60:40	Baishakh-Bhadra	50-80
4.	Dinanath	Terai	Baishak-Asar	10-12	60:30:30	Asar-Asoj	80-100

		Midhills					
Perrenial folder crops							
1.	Napier	Terai Midhill	Jestha-Asar Asoj-Kartik		80:50:40	Jestha-Margh	120-130
2.	Para grass	TErai – Inner Terai	Asar – Shrawan	10-15Kg 10,000 seed	60:10000:40:30	Baishakh-Magh	30-60
3.	Setaria	Terai Midhill	Baishakh – Ashar	8-10	60:40:30	Jestha – Kartik	30-80
4.	Rholes	Terai, Midhill	Baisakh	10-15	80M60M40	Shrawan-Magh	30-65
5.	Clover	Mid hill High hill	Jesth-Asoj	3-5kg	25M60M25	Baisakh-Kartik	120-180
6.	Rye grass	Mid hil high hill	Jestha-Asoj	10-20	60:40:25	Asar, Kartik, Baisak, Kartik	10-14 120-180
7.	Cocks foot	Midhill High hills	Jestha-Asoj	10-12	60:40:25	Baishakh-Kartik	10-14
8.	Stylo	Terai, Midhill	Jestha-Asoj	5-6	25:60:30	Bhadra-Poush	4-5kg.

Conclusion

Thus, by above we studied the year round fodder/forage production.

PRACTICAL NO.5

Prepare a Herbarium of common forage

1. To be familiar with common forage/fodder
2. To know how to prepare the herbarium of forage.

Introduction

A Herbarium is defined as a collection of plants that usually have been dried, pressed, preserved on sheets and arranged according to any accepted system of classification for future reference and study. In fact, it is a great fileting system for information about plants, both primary in the form of actual specimens of the plants, and secondary in the form of published information, pictures and recorded notes.

Methods of preparation of herbarium specimens

The preparation of a herbarium involves:

(i) Field visits,

(ii) Collection of specimens

(iii) Drying,

(iv) Mounting on a herbarium sheet,

(v) Preservation,

(vi) Labelling and

(vii) Proper storage.

(a) Field visits and specimen collection

A complete specimen possesses all parts including root system, flowers and fruits. Therefore, regular field visits are necessary to obtain information at every stage of growth and reproduction of a plant species. In the fields, the tools required are mainly trowel (digger) for digging roots, scissors and knife for cutting twigs, a stick with a hook for collection of parts of tall trees, a field note book, polythene bag, old newspaper and magazines.

To avoid damage during transportation and preservation at least 5-G specimens of a plant should by collected. The collected specimens are transported in a vasculum

(specimen box) to prevent willing, livery collected specimen must be tagged with a field number and necessary information should be recorded in a field note book.

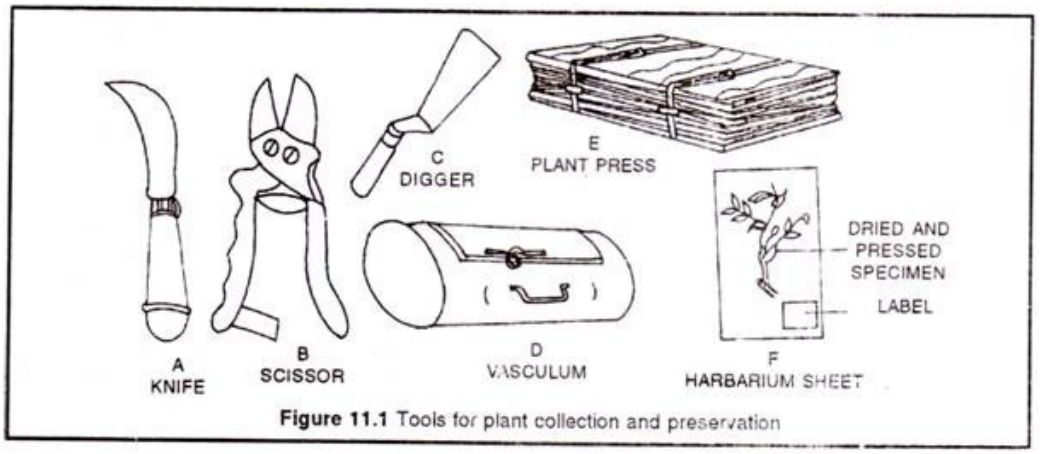


Figure 11.1 Tools for plant collection and preservation

(b) Pressing and drying

The specimens are spread out between the folds of old newspapers or blotting sheets avoiding overlapping of parts. The larger specimen may' folded in 'N' or' W' shapes. The blotting sheets with plant specimen should be placed in the plant press for drying. After 24 to 48 hrs the press is opened.

(c) Mounting

The dried specimens are mounted on herbarium sheets of standard size (41 x 29 cm). Mounting is done with die help of glue, adhesive or cello-tape. The bulky plant parts like dry fruits seeds, cones etc. are dried without pressing and are put in small envelops called fragment packets. Succulent plants are not mounted on herbarium sheets but are collected in 4% formalin or FAA (Formalin Acetic Alcohol).

(f) Preservation

The mounted specimens are sprayed with fungicides like 2% solution of mercuric chloride.

(e) Labelling

A label is pasted or printed on the lower right hand corner. The label should indicate the information about the locality, altitude, habit, date and lime of collection, name of collector, common name, complete scientific name etc.

(f) Storage

Properly dried, pressed and identified plant specimens are placed in thin paper folds (specimen covers) which are kept together in thicker paper folders genus overs), and finally they are incorporated into the herbarium cupboards in their proper position according to a well known system of classification. In India Bentham and Hooker's system of classification is used for' his purpose. Type specimens are generally stored in separate and safe places.

Conclusion

Thus, by above we know the technique of preparation of herbarium of forage.

Practical No – 06

Develop a fodder tree nursery

Objectives

a. To get concept about nursery.
b. For management of nursery.

Introduction

Shortly, it is also known as baby plant production as new plants are produced either from seed or steam cutting. so, it is the place for production of new plants.

It can of be done in 3 types:

a. In tray: It can be done for those plants, whose seeds are very minor. When the seed germinates and 2 – 3 kaves arises, plant is shifted to poly bag. eg. It can be done for Berseem, Nemaro etc.
b. In poly bag: It can be done for those plants, whose seeds are larger in size. It doesn't need to shift to other medium. The mixture of soil in poly bag most be made as follow:

   forest soil - 2 parts

   sand - 1 parts

   FyM - 1 parts

c. Nursery bed: In nursery bed medium size of seed are rounded. In general, vegetable propagated plants are also cultivated. Construction of nursery bed depends on the season because during the summer season the nursery bed is raised up white during the winter season or dry season, nursery is not raised from the ground surface. The width of bed should be 1 m thile length of beds depends on availability of land and production of sampling. Nursery bed should be well leveled. In nursery bed recommended amount of organic and in organic fertilizer should be applied.

Required materials:

i. Plastic
ii. Sickture

Procedure for nursery bed preparation:

- At first remove the waste material from nursery.
- Dig about 2 time 30cm from the surface than spread farmyard manure.
- Mixe well the farmyard manure in soil and remove all the weeds and make soil fine.
- The nursery should be well labeled.
- Then Plastic should be kept over the nursery are in order to maintain moisture and restrict the growth of weeds
- Then the nursery width is measured up to 1m, then the stem of mulberry which is cut in stinting manner is deep on nursery in about 60 angle between stem and soil surface with gap of 10cm between two stem.The bud should be always upper or in natural direction.
- The cutting surface of stem most be towards the opposable side of sunrise in order to prevent maximum transpiration or gestation.

Conclusion

Hence, from the above practical we are able to prepare nursery bed.

Practical No. 7

Preparation of urea molasses blocks (UMB)

Objectives

- To prepare the UMB

Introduction

Poor quality roughages, e.g. cereal straws, poor quality hay, or dry-season forage that contains a lot of stem but not much leaf, can be deficient in crude protein (N). Insufficient N in the diet means that rumen microorganisms cannot make enough microbial protein for the maintenance or growth of ruminants. This can become critical, resulting in loss of condition and increased disease risk.

Urea and ruminant digestion

When fed as a part of the diet to ruminants, urea is converted to ammonia by the microflora in the rumen. Microorganisms in the rumen use ammonia to make microbial proteins as long as energy is available at the same time. Bacteria and protozoa are then digested by the animal. Urea therefore has a value that is partly equivalent to protein for ruminants. Molasses is a major by-product of the sugarcane industry. It is a source of energy and a widely available concentrated form of fermentable carbohydrate. Molasses, urea and other ingredients can be used in the manufacture of molasses/urea feeds prepared as blocks. UMB are an excellent way of providing readily degradable protein and readily fermentable energy to ruminant animals, and they help increase the protein supply to the animal in situations where this may be limiting.

Urea toxicity

All the ruminants are nevertheless sensitive to a large quantity of urea which becomes toxic and intoxication can occur if a large amount of urea is ingested. Especially, goats are very fond of concentrates with urea and are therefore particularly sensitive to urea toxicity. So it is essential that the blocks are accurately made so that goats are not fed too much urea at one time. Also, an adaptation period of at least three weeks is required for the animal to utilize urea efficiently.

Ingredients for UMB

UMB can be made from a variety of components depending on their local availability, nutritive value, price, existing facilities for their use, and their desired influence on the quality of blocks. They can also include specific components:

Molasses

Molasses provides fermentable substrate and various minerals and trace elements (but low amounts of phosphorous). Because of its pleasant taste and smell, it makes the block very attractive and palatable to animals. The degree Brix of the molasses should be as high as possible, and preferably higher than 85, to ensure solidification. (Degrees Brix is a hydrometer scale for sugar solutions graduated so that readings at a specified temperature represent percentages by weight of sugar in the solution, so 85° Brix is equivalent to 85 percent sugar).

Urea

Urea provides fermentable nitrogen, is the most important component of the block. With the increase of the microflora in the rumen, urea may increase the intake of straw and other low quality forages as well as their digestibility. The intake of urea must be limited to avoid toxicity problems but sufficient to maintain ammonia levels in the rumen consistently above 200 mg N/l for growth of microorganisms in the rumen and high rates of degradation of fibre.

It is important that urea and molasses are provided together to provide ammonia and energy at the same time ? hence their combination in UMB.

The urea used in this formula is fertilizer grade, normally used as a nitrogen fertilizer in sugarcane plantations and rice fields. Since the urea is hygroscopic it is possible that during storage lumps may form in the sacks. In order to prevent excessive consumption of urea in too short a period, which may cause intoxication of the animals, it is necessary that all the lumps are crushed before introducing the urea into the mixture. This will guarantee a homogenous mixture of urea in the mass.

Wheat or rice bran

These serve a multiple purpose in the blocks. They provide some key nutrients

including fat, protein and phosphorus. It also acts as an absorbent for the moisture contained in molasses and gives structure to the block. It may be replaced by other fibrous materials such as dry and fine bagasse (the residue from sugar cane processing) or groundnut hulls which are finely ground.

Other crop residues

Other crop residues can also be included in UMB. This depends on availability, and some crop residues and by-products will provide more nutrients than others.

Minerals

These may be added where appropriate. Common salt is generally added because this is often deficient in the diet and it is cheap. Calcium is supplied by molasses and by the gelling agent, calcium oxide or cement (see below). Although phosphorus is deficient, there is no evidence that its addition is beneficial where animals are at below maintenance requirements when grazing on dry mature pastures or fed low-quality forage.Mineral requirements are reduced at maintenance or survival levels. Deficiencies will generally become a problem only when production isincreased, particularly when a bypass protein supplement is given (proteins that are not degraded by rumen microorganisms and are digested inthe intestines). In these cases phosphorus should be included in that supplement.

Binder

A gelling agent or binder is necessary in order to solidify the blocks. Various products have been tried successfully: magnesium oxide, bentonite, calcium oxide, calcium hydroxide and cement. The use of cement has raised questions about possible negative effects on animals. Research on the use of cement or its by-product, cement kiln dust, as a mineral supplement have not shown adverse effects at levels of 1 to 3 percent of the total diet dry matter. The USDA has restricted the use of cement kiln dust since it could cause a deposit of heavy metals in animal tissue.

Various chemicals or drugs for the control of parasites or for manipulation of rumen fermentation can be added to the molasses blocks which can be an excellent carrier for these products.

A leaflet produced by (KHAN and SIDDIKI[6] 2004) includes the ingredients and instructions for a 10 kg block, as well as the following

procedure for making 10 kg UMB in rural areas at least cost

1. At first 3.9 kg. molasses is weighed and put in a large bowl.
2. 500g. common salt and 1 kg of urea is added and admixture well manually.
3. This mixture is kept for one night or at least 12 hours.
4. After 12 hours, the mixture in the bowl is again mixed well by hand.
5. Then wheat bran, rice polish, and lime, which were previously kept into separate bowls, are added with this mixture and also mixed well.
6. Now, this mixture is placed in a 9 inch long, 5 inch wide and 5 inch height wooden mould, and then pressure is applied by wooden cover

to give it block shape, block so prepared usually weighs 2.5 kg.

The block is now displaced from the mould and kept for 15 hours for hardening before ready for animal consumption. The mixture can be pressed in a bowl that results bowl-shaped blocks.

Distribution to the animals

For adult cattle or buffalo, about 0.5 kg of UMB can be given daily. For small ruminants, about 70-80 g can be provided per animal per day (pers. comm. CIRAD).

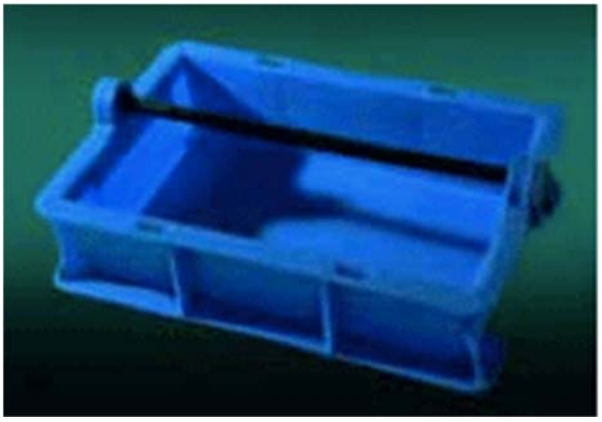
Economic data

Costs of UMB will be variable, depending on location and supply of the required ingredients.

Conclusion

Thus, we able to prepare the urea molasses minerals block.

Figure 1. Urea-molasses multinutrient blocks



Practical No. 8

Preparatioin of Hay

Objectives

- To prepare hay.

Theory

Principles of haymaking

The principles involved in hay making is to reduce the water content of the herbage so that it can be safely be stored in mass without under going fermentation or becoming mouldy.

Kinds of hay

Generally there are three types of hay:

a) Legume hay

Good legume hay has many characteristics that make it of special value to the dairy cattle. It has a higher percentage of digestible nutrients. It has more of digestible protein because of higher protein content. The proteins of legumes are of superior quality as compared protein from other plants. The legume hay is rich in vitamins, carotene, vitamin-D, E and calcium. Among various leguminous fodder crops Lucerne berseem cowpea and soybean hays are considered first.

b) Non-legume hay

Non-legume hays made from grasses are inferior to legume hay. They are, as a rule less palatable and contain less proteins, minerals and vitamins than the legume hays. Non-legume hays have the advantage over legumes hays because there out turn per hectare is more than that of legume hays and former can be grown easily. Hays made from green crops like oat and barley compare very favorably with the other grass hays. For good quality hay making these crops should be harvested in the milk stage. They are low in protein and minerals, but rich in carbohydrates.

c) Mixed hay

Hay prepared from mixed crops of legumes and non-legume is known as mixed

hay. The composition of such a kind of hay will depend on the proportion of the different species grown as a mixed crop. Such a crop is generally cut earlier because of the variation in the seeding time of the mixed crops

Harvesting of the crop for hay making

The crops should be harvested during the daytime after the dew has dried off so that plants when spread over the ground may dry evenly. Another, which needs attention, is that the field should not be wet; otherwise uniform drying will not take place. The crop cut early is higher in protein lower in crude fiber, contains more of protein, is more palatable and will shatter less. The best time for cutting a crop for haymaking is when it is one third to half in blossom.

Curing of hay

In curing, it is necessary that the herbage should be saved from bleaching by the sun and as for as possible, leaves preserved from shattering. The maximum quantity of moisture should be evaporated, so that it can be stored without generation of heat and consequent loss of nutrient.

Method of making hay

- Forage is cut before it is fully mature (long before it has seeded) to maximize its nutritive value. Although cutting hay early will result in lower total volume, the increase in nutritive value will more than compensate for reduced yields.
- Leaves are more nutritious than the stems, and so when cutting forage, it is important that it is cut with as much leaf and as little stem as possible.
- Do not leave cut forage to dry in a moist environment, as this will encourage the growth of moulds. These can be extremely harmful to livestock and to people handling it.
- The cut forage is laid out in the sun in as thin a layer as possible, and raked a few times and turned regularly to hasten drying.
- Chopping forage into small pieces after drying will hasten the dying process.
- The drying process may take between 2 to 3 days.
- Hay should not be over dried as it may start to ferment and also become a fire hazard.

- The dried hay should ideally be stored in form of bales when the moisture content is low, ideally less than 15%. This helps storage and requires less space.

Leaves are more nutritious than the stems, and so when cutting forage, it is important that it is cut with as much leaf and as little stem as possible. However, during drying, the leaf (being more brittle) will tend to shatter. Hay should therefore be handled with care, to try and minimize the amount of leaf that is lost in this way.

Crops with thick and juicy stems can be dried after chaffing to speed up the drying process and to prevent loss of nutrients. Field curing is conducted during bright sunny weather but may result in bleaching of the forage and loss of leaves due to shattering. To avoid this, drying can be done in barns by passing hot air through the forage. Although artificial drying produces hay of good quality, it is expensive and beyond the reach of small and marginal farmer but can be attempted on a community basis in areas where there is a need, and the necessary facilities.

Storage of hay

Hay is usually stored in stacks or in the trees. Care should take that the hay is in a good and dry condition before it is stored. It should be stacked in a shady place where there is no danger of fire.

Conclusion

Thus , we are able to prepare the hay of different forage and fodder.

Practical No. 9

Preparation of Silage

Objectives

- To prepare silage

Silage preparation

Silage: Silage is a form of conserved grass, silage make during summer month when the grass supply is plentiful and is feed to animals during winter month when the grass supply is less.

Crop suitable for ensilage are: Clovers, afla-afla, vetch, oats, rye grass , maize, various weed etc which are tore in silo. To make silage, plant should be 50-60% moisture.

Principles: Silage undergoes anaerobic fermentation (without oxygen) which convert sugar to acid fermentation is essentially complete after about two weeks.

Phase of silage preparation

Anaerobic phase: oxygen inside is utilized first.

Acid fermentation phase: Various lactic acid bacteria decomposed carbohydrate into acetic acid , butyric acid and lactic acid

Stable phase: The phase produced certain Ph and sours in taste (also called sour silage).

Ph and temperature of silage

	Day 1	Day 2	Day3	Day4-7	Day8-21	After 21 days
Ph	6	5	4	--	4	4
Temperature ºF	70	95	---	80-85	-	Stable

Method

Grass/fodder/crop

↓

Mowing(cutting) in pieces about 0.5 inch (1.3 cm) long

↓

Crop / grass are spread in uniform layers overfloor of silo

↓

Then silo is packed tightly so that air, water can't get in.

Losses during silage preparation

Anaerobic loss 10%

Effluent 3%

Fermentation5%

Filling 5%

Field 4%

Conclusion

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Reference

- Benergee, G. C. 2003. A text book of animal husbandry. 8th edition. Oxford and IBH Publishing Co. Ltd. New Delhi.
- Bredon, R. M. and T. J. Dugmore. 2009. Mineral and vitamin nutrition of dairy cattle. Cedera Agriculture development Institute. Available: http://agriculture.kzntl.gov. (Retrieved: March 31, 2010).
- Chakrabarti, A. 2006. A text book of clinical veterinary medicine. 3rd edition. Kalyani Publishers. New Delhi
- Church, D. C. and W.G. Pond.1978. Basic Animal Nutrition and Feeding. O& B Book USA.
- D.B. Subba(1998): Chemical Composition and Nutritive Value of Feeds of East Nepal. Pakhribas Agriculture Center, Dhankuta, Nepal.
- F. MESCHY INRA-INAPG UMR Physiology de la Nutrition et Alimentation, 16 rue Claude Bernard, 75231 Paris cedex 05Home > 2002 > Volume 15, Issue 4 October, 2002 > Mineral nutrition (macro-elements) recent (...)India.
- Indrajeet Jauha. Livestock Production and management
- I.J . Mc Cracken and M.L Shrestha (1992) : Common Tree species Field manual for community and Private Foresty in Nepal , HMG/UNDP, FAO Community Foresty Project (Phase II).
- *Joshi . D.* – Trainers Manual Livestock Extension.
- Jagadish Prasad –Animal Husbandry and Dairy Science
- Khanal B (2013). Effect of Feeding system on growth performance of high hill goat. Proceeding of National Workshop on Research and Development Strategies for Goat Enterprisesin Nepal 27-28 Sep 2012, Kathmandu, Nepal.
- Lalman, D. and C. McMurphy. 2008. Vitamin and mineral nutrition of grazing cattle. Oklahama State University. Available: http://pods.dasnr.okstate.edu. (Retrieved: February 31, 2011).
- McDonald, P., R. A. Edwards and J. F. D. Greenhalgh. 1979. Animal Nutrition. 2nd edition. ELBS and Longman, Singapore.
- McDowell, C. R., J. K. Conrad, G. L. Ellis and, J. K. Loosli. 1983. Minerals for grazing ruminants in Tropical Regions. University of Gainesville: Florida.

- Miller, E.R. 1991. Iron, copper, zinc, Manganese and Iodine in swine nutrition. *In* E.R. Miller, D.E. Ullrey, A. J. Lewis is (eds.) Swine Nutrition. Butterworth-Heinemann, Boston. pp. 267-284.
- Miller, W. J. 2008. Zinc nutrition of cattle: A review. University of Georgia. Available: http://jds.fass.org. (Retrieved: February 31, 2011).
- Morrison, F.B. Feeds and Feeding, CBS Publishers and distributors, Shahdara, Delhi,
- Owen OD (1987). The response of migratory sheep and goats to Strategic minerals supplementation. *Technical Paper N. 87/10 Lumle Agricultural Center,Lumle Kaski , Nepal.*
- Pandey RS (1995) Status and scope of forage seed production in Nepal.
- Radostits, O. M, C. C. Gay, D. C. Blood, and K. W. Hinchcliff. 2006. Veterinary Medicine. A Textbook of the Disease of Cattle, Sheep, Pigs, Goats and horses. 9th edition. W. B. Saunders Company Ltd. London, UK.
- Reddy D.V.-Advanced Animal Nutrition
- Ranjhan S.K-Animals Nutrition and Feeding Practices.
- Romanoff, A. L. 1967. Biochemistry of the Avian Embryo. A Quantative Analysis of Prenatal Development. John Wiley and Sons, New York, NY.
- Singh, K.S. and B. Panda. 1992 Mineral Nutrition, in Poultry Nutrition Second Edition. Kalyani Publisher, Ludhiana, pp.104-133.
- Shrestha S.R, P Sapkota and RC Mahato(1994) Study of oat production at farm condition.
- Shrestha SP, Kunwar, M Prajapati and DR Khanal (2013) Enhancement of productivity on goat with economic supplementation. Proceedings of the National Workshop on Research Development Strategies for Goat Enterprise in Nepal27-28 Sep 2012, Kathmandu Nepal.
- Statistical Information on Nepalese Agriculture (2013). Statistical Information on Nepalese Agriculture, 2012/13. The Government of Nepal, Ministry of Agriculture, Agricultural Statistics Division, Kathmandu, Nepal.
- Shing Surya Bd. Nepalkaa Parmukha DalayGhasharu CALDP Hariharbhawan , Kathmandu
- Tiwari MR, NL Tamrakar and HR Shrestha (2006). Effect of non conventional

and conventional fodder on growth performance of goats in farmer field condition. *Nepal Journal of Science and Technology. Nepal Academy of Science and Technology Khumaltar, Lalitpur*

- **Upreti, C**. R. 2065. Livestock, Poultry and Fish Nutrition in Nepal. Pub. Balika Upreti,
- Uperti CR, D Yadev and S Upearti (2013). Goat feeds and feeding for different age groups in different management system. Proceeding of ational Workshop on Research and Development Strategies for Goat Enterprisesin Nepal 27-28 Sep 2012, Kathmandu, Nepal, Pp 56-63.
- Uperti CR and Pradhan SM. Lecture notes of Animal nutrition-I & II.
- Verma, D.N. A Text Book of Animal Nutrition, Kalyani Publisher, India
- Whitehead, C. C. (1991) Nutrition of the breeding bird and the developing embryo. In: Avian Incubation (Tullett, S. G., ed), pp. 227-238. Butterworth-Heinemann, London, U.K.
- http://www.forestrynepal.org
- *TECA* (http://teca.fao.org)
- .http://www.iaea.org/programmes/nafa/d3/faq-ummb.pdf
- Yadav JL and NR Devkota (2005). Feeds and feeding situation of livestock in the terai region of Nepal . Proceeding of the workshop on Fodder oats , Fodder TechnologyPackages and small Farm Income Generation, Kathmandu,Nepal 8-11 march.