

## TVET CERTIFICAT III ANIMAL HEALTH

ANHCF301

### Concentrates feeds preparation and distribution

Apply concentrates feeds preparation and distribution

Competence



**Credits: 7**  
**70**

**Learning hours:**

**Sector: Agriculture and food processing**  
**Sub-sector: Animal health**

**Module Note Issue date: October, 2020**

#### Purpose statement

This module covers the knowledge, skills and attitudes required to properly prepare and distribute

Feeds concentrates in domestic animals

- Upon completion of this module, the trainee will be able to:
  - ✓ Identify animal's feed ingredients;
  - ✓ Prepare animal's feeds ration Perform feeds concentrates preparation and conservation Distribute feeds and water to animals;

- ✓ Maintain animals shelters hygiene and feeding/ watering equipment

By the end of the module, the trainee will be able to:

Table of Contents

| Elements of competence and performance criteria              |                                                                                                                                                                                                                                                                                           | page |
|--------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Elements of competence                                       | Performance Criteria                                                                                                                                                                                                                                                                      |      |
| Learning Unit 1: SELECT ANIMAL'S FEED INGREDIENT             | 1.1. proper identification of proteins and amino acids<br>1.2. proper identification of ingredients energy providers<br>1.3. proper identification of minerals and vitamins<br>1.4. proper conservation of feed ingredients                                                               | 3    |
| L.U .2: PREPARE ANIMAL'S FEEDS RATIONS                       | 2.1. Correct use of Bromatological and nutrients requirement/ needs tables<br>2.2. Correct incorporation rates of ingredients<br>2.3. Correct formulation of feeding rations                                                                                                              | 18   |
| LU3: PERFORM FEEDS CONCENTRATES PREPARATION AND CONSERVATION | 3.1. proper preparation of ingredients<br>3.2. Proper mixing of ingredients.<br>3.3. Appropriate packaging and labelling of prepared concentrates<br>3.4. Proper Making of mineral block<br>3.5. Appropriate conservation conditions of concentrates and mineral block                    | 35   |
| L.U.4: Distribute animal feeds and water                     | 4.1. Correct calculation of concentrates, minerals, vitamins and water quantities to distribute.<br>4.2. Proper wetting of concentrates (with water or molasses)<br>4.3. Proper checking of quality of feed and water before distribution<br>4.4. Correct distribution of feeds and water | 41   |
| L.U.5: MANAGE NUTRITIONAL DEFICIENCIES AND EXCESSES          | 5.1. Adequate cleaning of animals shelters<br>5.2. Adequate cleaning of feeding and watering equipment<br>5.3. Correct disposal of refused feeds<br>5.4. Proper application of composting technique                                                                                       | 51   |

*LU & PC is linked in LO inside the content*

## Learning Unit 1: SELECT ANIMAL'S FEED INGREDIENT

A feed ingredient is a component part or constituent or any combination/mixture added to and comprising the feed. Feed ingredients might include grains, milling by-products, added vitamins, minerals, fats/oils, and other nutritional and energy sources. Animal feeds provide a practical outlet for plant and animal by-products not suitable for human consumption. Legally, any substance that is added to or is expected to become a component of animal food, either directly or indirectly, must be used in accordance with a food additive regulation unless it is generally recognized as safe for that use.

### L.O .1.1: Select protein feed stuffs and amino acids

#### • Content/Topic 1 (NUTRIENTS GROUP, THEIR FUNCTIONAL AND USUAL FORMS IN FOODS)

In order to survive, maintain, grow and reproduce, the animal requires a supply of essential nutrients. Those nutrients are present in various feedstuff and food which is eaten by animal and broken down into its component parts in the digestive tract.

These parts or basic nutrient pass into the bloodstream of animal and are then used for various function according the biological needs of animal.

The major groups of nutrients are:

- ✓ carbohydrates (energy),
- ✓ protein,
- ✓ mineral,
- ✓ Vitamin and water.

#### ✓ (Proteins)

Proteins are organic compounds that contain carbon, hydrogen, oxygen and nitrogen, sometimes phosphorus and Sulphur as well.

The amount of nitrogen in most proteins varies between 14% and 18%. They are formed from amino acids and are mostly found in living cells

The value of proteins in farm animals depends on the type of stock to which they are fed. For instance, to monogastric animals like pigs and poultry, the value depends on the rate of hydrolysis and the composition of amino acids.

#### Synthesis of proteins

The synthesis of protein in the body tissues requires an adequate supply of about twenty different amino acids in the proper proportions. Ten of these cannot be synthesized by the animals' metabolism and must therefore be supplied by the diet. These are called **essential amino acids**.

Essential amino acids must be provided in the feed or diet. If the feed lacks the EAA, the monogastric animals (eg: pig) will not grow and may not even survive. This is not the case for ruminants because the required Essential amino acid is covered by the microbial flora and fauna of rumen.

Other amino acids are synthesized by animal body itself, they are not necessary to be supplied in the feeds (**Non-essential Amino acids**). The quality of feed protein can be described in terms of the amino acids it supplies.

Table 1: Amino acids

| Essential AA  | Non-essential AA    |
|---------------|---------------------|
| Lysine        | Alanine             |
| Methionine    | Serine              |
| Threonine     | Glycine or glycolle |
| Tryptophan    | Aspartic acid       |
| Isoleucine    | Glutamic acid       |
| Histidine     | Proline             |
| Phenylalanine | Hydroxyproline      |
| Tyrosine      | Cystine             |
| Valine        |                     |
| Arginine      |                     |

### . Function of proteins in the body of animals

Proteins play an important role in the animal body:

- ❖ They are essential for growth in all living tissues. Farmers should give to their stock feeds rich in proteins to Holstein growth and bring about early maturity
  - ❖ They are required for body building, repair of old, worn out or damaged cells and tissues. Farm animals build up muscles or meat rapidly if the right types and amount of protein is fed to them at the right period.
  - ❖ They give a limited amount of energy compared to carbohydrates and fats
  - ❖ They are required in the formation of antibodies that help in fighting infection by foreign organisms like bacteria.
  - ❖ They are constituents of some hormones, e.g. Progesterone which prevents oestrus occurrence in cows.
  - ❖ They are required in the manufacture of enzymes which accelerate metabolic activities within the animal body
- They are components of some animals' products such as meat, milk and eggs

### L.O.1.2: Selection of energy provider ingredients feeds

These are organic compounds which contain carbon and water (hydrates). carbon (c), hydrogen (h) and oxygen (O) are the elements found in all carbohydrates. The ratio of hydrogen atoms to oxygen atoms is always 2:1.

Animals get their normal source of carbohydrates by direct feeding on crops such as cereal grains, root crops, fruits, legumes and grasses or by consuming concentrations which are artificially formulated.

Carbohydrate are categorized into monosaccharides (glucose, and fructose) disaccharides (sucrose, maltose, lactose) and polysaccharides (starch) and fibers (celluloses, hemicelluloses and lignin)

#### **Importance of carbohydrates in the body of animals:**

- ❖ **They supply energy and heat which animals require for all metabolic processes in the body.**
- ❖ **They form, together with other indigestible matter, roughages which keep food moving along the digestive track and prevent constipation.**
- ❖ They can be converted and stored as fats and used as sources of energy in the future.
- ❖ In ruminants, they provide a laxative effect, thereby preventing bloat

#### ✓ **(Fats and oils)**

Like carbohydrates, fats are organic compounds which contain carbon, hydrogen and oxygen. Fats are found in both animal's products such as fish meals milk, butter, lard and plants such as cotton seedcake, groundnut cake, and soybean cake. Fats are solids at room temperature while oils are liquid at room temperature

Most livestock feed stuff, e.g. concentrates (dry matter) consist of 2 to 6 percent oil, too much fatty feeds result into over fattening and an excessive increase in weight. This should be avoided, especially in pig feeding programs.

#### **. Importance of fats**

Fats in animal body are needed for different use. The following are the the main role of lipids:

- ❖ They are used to produce energy. They account for about 2.25 times more energy compared to carbohydrates.
- ❖ If stored under the skin, they help to keep the body warm and serve as a source of future energy.
- ❖ Little amounts of fat added to diet help to prevent the loss of appetite, i.e. increase appetite.
- ❖ They can be converted into amino acids and other organic compounds in animals' cells.

### ✓ . L.O.1.3: Select Mineral and vitamins ingredients feeds

In animal nutrition, minerals are referred to as chemical elements and form about 3 to 5 per cent of the animal body. These proportions are small in comparison to such other nutrients as proteins, carbohydrates and water.

Minerals play an important role in animals and they should be supplied as a balanced mineral mix in feeds or given as mineral supplements. Care should be taken not to give mineral elements over and above the animal's body requirements, otherwise general productivity and performance will drop, which is uneconomical for the farmer.

Natural, animals get their source of minerals from pasture plants and eating soil. Minerals are divided into two groups, depending on the demand by animals and their concentration within the animal body. The two groups are major or 'macro' elements and minor or micro or 'trace' elements.

### Functions of minerals in the animals' body

- ❖ They help to control chemical reactions within the body. This can be through the maintenance of a correct acid/base balance in cells tissues or body fluids.
- ❖ They form an important component of blood, fluids and body structures such as bones and teeth.
- ❖ They regulate the osmotic properties of body fluids.
- ❖ They are component of hormones and enzymes which greatly influence physiological activities within the body.
- ❖ They constitute important proteins and lipids which are required for muscle, blood and soft tissue formation.

➤ **Macro minerals and their specific functions**

Macro elements are those elements which are needed in large amounts by animal's body for proper growth.

Table 3: Micro minerals and their specific functions

| Mineral    | Function                                                                                                                                                                 | Sources                                                                                                                                              |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sodium     | Needed for proper fluid balance, nerve transmission, and muscle contraction                                                                                              | Table salt, soy sauce; large amounts in processed foods; small amounts in milk, breads, vegetables, and unprocessed meats                            |
| Chloride   | Needed for proper fluid balance, stomach acid                                                                                                                            | Table salt, soy sauce; large amounts in processed foods; small amounts in milk, meats, breads, and vegetables                                        |
| Potassium  | Needed for proper fluid balance, nerve transmission, and muscle contraction                                                                                              | Meats, milk, fresh fruits and vegetables, whole grains, legumes                                                                                      |
| Calcium    | Important for healthy bones and teeth; helps muscles relax and contract; important in nerve functioning, blood clotting, blood pressure regulation, immune system health | Milk and milk products; canned fish with bones (salmon, sardines); fortified tofu and fortified soy milk; greens (broccoli, mustard greens); legumes |
| Phosphorus | Important for healthy bones and teeth; found in every cell; part of the system that maintains acid-base balance                                                          | Meat, fish, poultry, eggs, milk, processed foods (including soda pop)                                                                                |
| Magnesium  | Found in bones; needed for making protein, muscle contraction, nerve transmission, immune system health                                                                  | Nuts and seeds; legumes; leafy, green vegetables; seafood; chocolate; artichokes; "hard" drinking water                                              |
| Sulphur    | Found in protein molecules                                                                                                                                               | Occurs in foods as part of protein: meats, poultry, fish, eggs, milk, legumes, nuts                                                                  |

### ➤ Micro-minerals

Micro elements are minerals which are needed in small amounts. The following table summarizes the micro-elements and their sources as well as specific functions.

Table 4: Micro minerals and their specific functions

| <b>Mineral</b>    | <b>Function</b>                                                                                                                                                                                                                   | <b>Sources</b>                                                                                                                                                                     |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Iron</b>       | Part of a molecule (hemoglobin) found in red blood cells that carries oxygen in the body; needed for energy metabolism                                                                                                            | Organ meats; red meats; fish; poultry; shellfish (especially clams); egg yolks; legumes; dried fruits; dark, leafy greens; iron-enriched breads and cereals; and fortified cereals |
| <b>Zinc</b>       | Part of many enzymes; needed for making protein and genetic material; has a function in taste perception, wound healing, normal fetal development, production of sperm, normal growth and sexual maturation, immune system health | Meats, fish, poultry, leavened whole grains, vegetables                                                                                                                            |
| <b>Iodine</b>     | Found in thyroid hormone, which helps regulate growth, development, and metabolism                                                                                                                                                | Seafood, foods grown in iodine-rich soil, iodized salt, bread, dairy products                                                                                                      |
| <b>Selenium</b>   | Antioxidant                                                                                                                                                                                                                       | Meats, seafood, grains                                                                                                                                                             |
| <b>Copper</b>     | Part of many enzymes; needed for iron metabolism                                                                                                                                                                                  | Legumes, nuts and seeds, whole grains, organ meats, drinking water                                                                                                                 |
| <b>Manganese</b>  | Part of many enzymes                                                                                                                                                                                                              | Widespread in foods, especially plant foods                                                                                                                                        |
| <b>Fluoride</b>   | Involved in formation of bones and teeth; helps prevent tooth decay                                                                                                                                                               | Drinking water (either fluoridated or naturally containing fluoride), fish, and most teas                                                                                          |
| <b>Chromium</b>   | Works closely with insulin to regulate blood sugar (glucose) levels                                                                                                                                                               | Unrefined foods, especially liver, brewer's yeast, whole grains, nuts, cheeses                                                                                                     |
| <b>Molybdenum</b> | Part of some enzymes                                                                                                                                                                                                              | Legumes; breads and grains; leafy greens; leafy, green vegetables; milk; liver                                                                                                     |

## ✓ (Vitamins)

Vitamins are organic chemical substances needed in small quantities to promote and maintain health in animals. Vitamins are obtained from forage that animal eat such as legumes, cereals, fodder, meat and fishmeal. Vitamin D is obtained from sunlight. Ruminants have ability to synthesize most of vitamin therefore vitamin deficiencies are rare.

### Function of vitamins

*Vitamins are vital organic matter which has the following roles in our bodies and in animal bodies' as well. The following are the major roles of vitamins:*

- ❖ They promote growth in animals;
- ❖ Help to maintain the proper functioning of all parts of the body;
- ❖ They protect animal from diseases;
- ❖ Vitamin improve fertility in livestock;
- ❖ Vitamin are components of enzymes;
- ❖ The vitamins regulate the absorption and use of certain nutrients in the body.

### ❖ Group of vitamins and their specific functions

Vitamins were initially called by the letters: A, B, C, D, E, etc. because their chemical nature was not known. It is now possible to give some their chemical names.

Vitamins occur in specific foods materials and perform specific functions. According to the ability to dissolve the vitamins are grouped into:

- *The vitamins dissolve in fat (Fat soluble vitamins)*
- *The vitamins dissolve in water (Water soluble vitamins)*

#### A) Fat soluble vitamins

- **Vitamin A:** a fat soluble vitamin also called retinol. It plays important role for growing and proper vision. Deficiencies in vit A causes night blindness, birth of blind newborn,

lacrimation of **eyes and nasal discharges, decrease in ovarian and testicular size, and increase in embryo-mortality.**

- **Vitamin D:** this has antirachitic property. Through the relationship of vit D with Ca and P, osteosynthesis is realized in body of animals. If the animal has the access to the sunlight vit D may be synthesized in adequate amount in the skin.
- **Vitamin E:** it acts as anti-oxidant; it has a close interaction with selenium. The deficiency in vit E will lead to reproduction disorder and milk production.
- **Vitamin K:** this vitamin is present in most green fodders and is not likely to be absent from natural diet. Vitamin K has important role in clotting of the blood. Deficiency will cause a increase in clotting time of blood, natural bleeding and subcutaneous haemorrhages.

#### **B) Water soluble vitamins**

- **Vitamin B:** vit B complex is a group of water soluble vitamin composed by different vitamins such as:
  - **Vit B1** or thiamin
  - **Vit B2** or riboflavin
  - **Vit B3** or niacin
  - **Vit B6** or pyridoxine
  - **Vit B7** also called vit I
  - **Vit B12** cyanocobalamin

All those above vitamin B have different functions. They are generally essential for productivity especially for maximum growth.

- **Vitamin C:** ascorbic acid, Vitamin C often fed extra amount to improve the immune response and resistance to infection. Lack of Vitamin C in diet will lead to weakness and haemorrhaging throughout the body.

#### **✓ (Water)**

As essential nutrients in life water is an essential nutrient. All body functions and processes require water. Water is the material in which all other nutrients are carried in solution. the body of animals is made up of 70% water. Water is also present between cells so that material can be moved between cells. Farm animals can go without food for several days, but not without water.

- ❖ Animals get water by:
  - Direct drinking
  - Feeding on plants and other solid foods

- Decomposition of carbohydrate, fats and proteins within the body. This is known as metabolic water. For instance, if 1kg of carbohydrate is oxidized, it will release 0.7kg of water.

Not all the water consumed is used in the body of animals. Some will be expelled from the body of animals through:

- The skin. Evaporation from the skin surface is one of the ways animals lose water.
- Expiration into the air. For instance, during the hot weather, panting animals expire hot, moist air at a higher rate than when it is cold.
- Faeces, the amount of water lost is high from animals experiencing frequent diarrheal.
- Urine passage. High ambient temperatures increase the rate of water consumption, but reduce urinary output.
- Milk production. The composition of milk from different mammals shows that four fifths of milk is water.

Water should be clean and free from chemicals and minerals. It should not contain harmful parasites or bacteria. Water should be easily available free-choice. If water consumption is restricted, growing animals will grow more slowly.

#### ❖ **Importance of water in animal body**

Water is essential for life and performs a variety of functions in the body. These functions include:

- It provides a medium for transporting food from the source to where it is required.
- Many biological activities take place in the presence of water
- It is a component of body cells and many body fluids
- It helps to maintain cell shape and internal biochemical reactions.
- It helps in the expulsion of waste products from animal body.
- Evaporation of water from body surface aids in regulating the body temperature.

#### ● **Content/Topic 1 (Feeds ingredients (class and their sources))**

Animal feed ingredients can be classified into specific categories based on their primary function in the diet, whether the feed is a protein, energy feed or mineral and vitamins source.

Depending on cost, availability and age or type of livestock, some of the following products are also frequently used: by-products of cereal grains processed for human use, animal processing

waste, fishmeal, fat alfalfa meal, distillery or milk factory products etc. Vitamins and mineral are also added in the correct proportions

Table 5: Animal feeds ingredients most frequently used

| Sources                                               | Feeds ingredients                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Proteins and amino acids</b>                       | <ul style="list-style-type: none"> <li>• <b>Plant source:</b> <ul style="list-style-type: none"> <li>✓ Cotton</li> <li>✓ Palmist</li> <li>✓ sunflower meal</li> <li>✓ peas</li> <li>✓ soybean meal</li> <li>✓ Alfalfa meal</li> <li>✓ corn gluten meal</li> </ul> </li> <li>• <b>Animal source:</b> <ul style="list-style-type: none"> <li>✓ Fish meals</li> <li>✓ meat meal</li> <li>✓ feather meal</li> <li>✓ Blood meal</li> <li>✓ milk &amp; milk products</li> <li>✓ dried poultry manure</li> </ul> </li> <li>• <b>Synthetic products:</b> <ul style="list-style-type: none"> <li>✓ methionine</li> <li>✓ lysine</li> </ul> </li> </ul>                                                                                                          |
| <b>Energy (carbohydrates and fatty acids sources)</b> | <ul style="list-style-type: none"> <li>• <b>Cereals and their by-products:</b> <ul style="list-style-type: none"> <li>✓ maize (corn)</li> <li>✓ Maize bran</li> <li>✓ rice</li> <li>✓ rice by-products (bran, polishing)</li> <li>✓ barley</li> <li>✓ molasses</li> <li>✓ Sorghum</li> <li>✓ Wheat</li> <li>✓ wheat by-products (bran, shorts, screenings)</li> </ul> </li> <li>• <b>Fats and oil</b> <ul style="list-style-type: none"> <li>✓ lard,</li> <li>✓ coconut oil</li> <li>✓ palm oil</li> <li>✓ peanuts, ground nuts</li> <li>✓ poultry fat,</li> <li>✓ fish oil</li> </ul> </li> <li>• <b>Tubes</b> <ul style="list-style-type: none"> <li>✓ Cassava</li> <li>✓ Sweet potato meal</li> <li>✓ sweet potato peel meal</li> </ul> </li> </ul> |
| <b>Minerals and vitamins</b>                          | <ul style="list-style-type: none"> <li>• <b>Minerals sources:</b></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

|  |                                                                                                                                                                                                                                                                                                                |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <ul style="list-style-type: none"> <li>✓ Bone meal</li> <li>✓ Lime</li> <li>✓ limestone</li> <li>✓ Shells (eggs and snails)</li> <li>✓ Phosphate</li> <li>✓ Salt</li> <li>✓ as dicalcium phosphate</li> <li>✓ oyster or other marine shell</li> <li>✓ dicalcium or monocalcium phosphate and premix</li> </ul> |
|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

*(line space)*

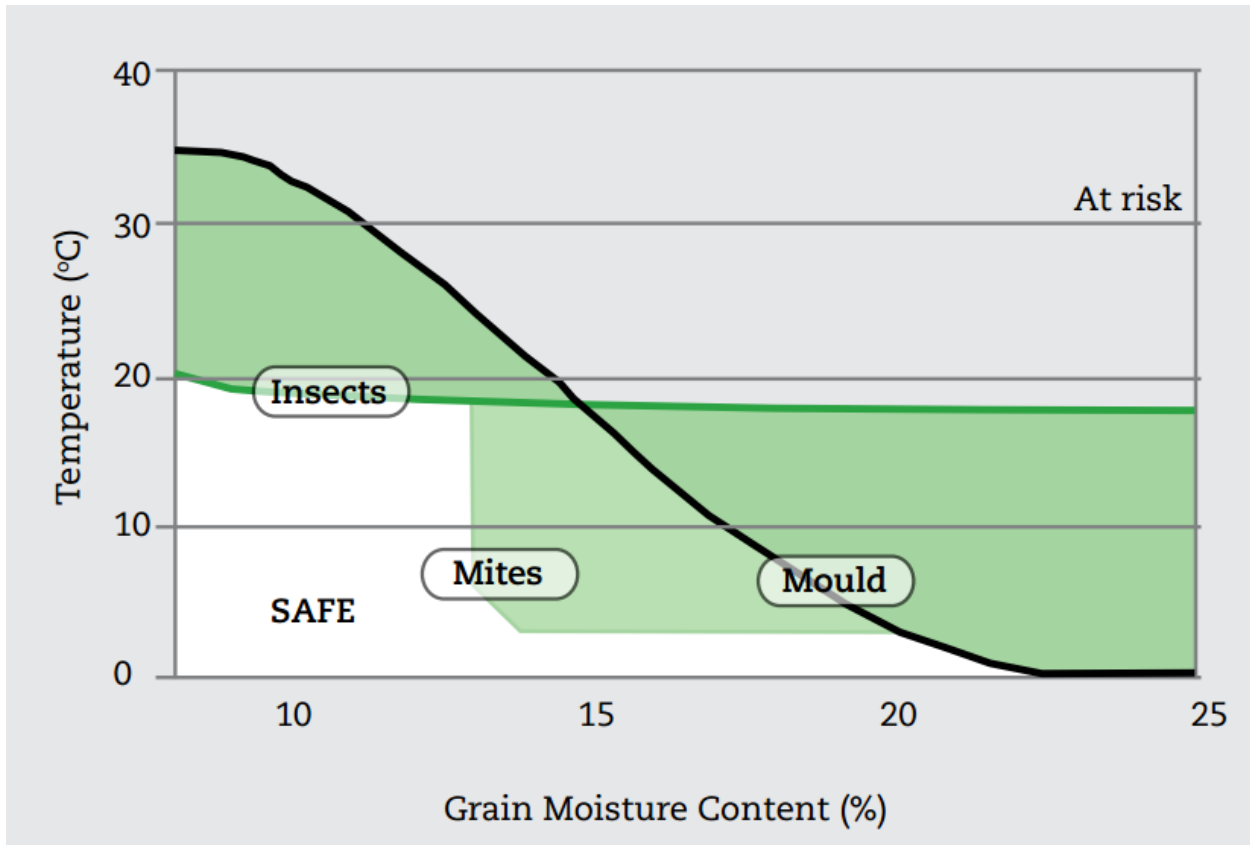
## L.U .2: PREPARE ANIMAL'S FEEDS RATIIONS

### L.O.2.1: Conserve feed ingredients

#### • (CONTENT /TOPIC 1 (Techniques and Parameters to store feed ingredients))

##### ✓ (Safe moistures and temperatures)

- ❖ To maintain the animal's feeds ingredients quality, the temperature and/or moisture must be quickly reduced to levels that will slow the onset of mould growth and infestation by insects or mites. Most of animals feeds ingredients for conventional storage over six months should be stored at a maximum of 16% moisture although preferably 14.5% and kept cool. At 18% moisture, it should be stored for a maximum six months and kept cool with low volume ventilation fans.
- ❖ The bags containing animal's feeds ingredients will not be placed on the floor but will preferably be stored on wooden pallets to avoid the contact with the ground, preventing the spread of soil moisture to the bags, and let the bags be more ventilated. Common spoilage microorganisms including mould grow well at relative humidity above 60%. For this reason, produce with moisture content (less than 15%) in equilibrium with 60% relative humidity at most tropical temperatures is acceptable for storage.



## Safe grain moisture and temperature

### (Ventilation)

- ✓ It is prudent to provide some level of ventilation to ensure that the animal's feeds ingredients can be kept cool and insect attacks can be controlled. The storage room should also be ventilated and have wooden pallets, to allow evacuation of CO<sub>2</sub> and water vapour resulted from of slowed life of stored feed. We shall store flours and supplements in game bags to facilitate air circulation, but prevent access to rodents. If the quality is important, we will put them in several various bags to prevent the spread of mold or insect in case of contamination.

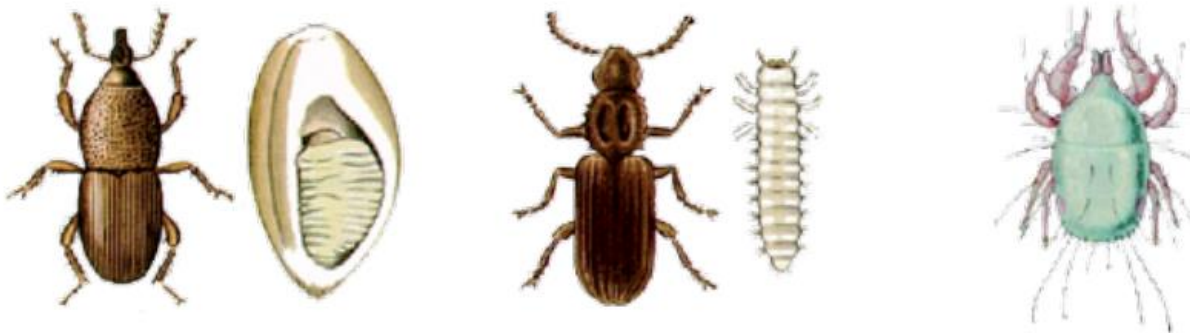


### (Time)

- ✓ Ingredients are stored for more or less long time depending on their nature. For middlings and oil cakes whose oil content is higher, their shelf life should not be long. Indeed, lipids they contain have been exposed to acid or rancidity. The rancidity begins after 6 weeks to release peroxide at 2-3 months. The storage should not exceed 3 months because rancid feed is toxic.

### • TOPIC/CONTENT 2 (Control of rodents and insects)

- ✓ The common pests associated with stored animal's feed ingredients are weevils, saw-toothed beetles and mites.



grain weevil

Saw toothed grain beetle Mite

Weevils damage grain by feeding on the endosperm and the saw-toothed beetles and mites by attacking the germ. Weevils were the traditional pest of stored grain because they bore into the grain. The saw-toothed grain beetle, a tropical species, became more dominant with the advent of

the combine harvester which damaged grain sufficiently to allow feeding. In addition to injuring the germ, mites cause tainting and may carry fungal spores and bacteria such as Salmonella.

- Different measures should be taken to prevent insects and pest:
  - ✓ good hygiene practices, especially the cleaning and disinfecting of the store before filling.
  - ✓ Well ventilated and grains should be free from cracks, crevices and dust traps.
  - ✓ pre-harvest store disinfection
  - ✓ Controlling animals feeds ingredients temperature with an adequate ventilation system.
  - ✓ When stores are emptied all remaining animals feeds ingredients residues should be removed and burnt.
  - ✓ Stores should be treated with insecticide.
  - ✓ Check scavenger rodents which may carry insects in their fur.
- **(Vermin, rodent and bird)**

The principal risks from these pests are disease transmission, animal's feeds ingredients spoilage and contamination, and structural damage. Buildings should be vermin proof by ensuring that doors are close fitting and other outlets are covered with close mesh wire. The store surrounds should be clean so as not to attract rats or mice.

Good management including frequent inspection and cleanliness is essential to keep stored grain free from pest damage.

Climate is the most important factor determining the effectiveness of a storage system for feed ingredients because of the close relationship between insect growth and ambient climatic conditions. An important relationship also exists between insects and micro-organisms in stored feedstuffs.

Total eradication of Vermin, rodent and bird from tropical warehouses for feed ingredients is not possible. The degree of infestation can however be brought to manageable proportions through a programme of vigilance and effective control measures:

- ✓ Heavily infested ingredients should not be brought into the store.
- ✓ Infested material, if accepted, should be kept separate until fumigated (this is to be done as soon as possible) to totally eradicate the pests.
- ✓ Control of moisture and temperature

## **L.O .2.2: Use of bromatological and animal's nutrients requirements/ needs tables**

- **Content/Topic 1 (Types of rations (diets))**

Practical feeding on the farm involves allocation of various feedstuffs to the animal that will supply nutrients needed for both maintenance and production on a daily basis. Such amount of food needed for maintenance and production in correct amount and proportion is referred to as balanced ration. For this reason, rations for farm animals are made up of a combination of various feedstuffs.

The principal objective of any rationing is to meet the animals' specific nutritional needs. It is also aims at making an efficient use of the available resources of food.

- There are three main types of rations:
  - ✓ Basic ration
  - ✓ Complementally ration
  - ✓ Supplementary method
- ✓ **(Basic ration)**

The major resources that fall into this category are straws and stovers, pasture grasses and agro-industrial by-products of sugar cane industry, that is bagasse and sugar cane tops. These are all categorised as poor quality forages which in general means that they are of low digestibility i.e. generally lower than 50% digestible and are low in protein and non-protein nitrogen (NPN) (often less than 6% CP) and variably deficient in a number of minerals. Mineral components of such biomass obviously depend on growing conditions including:

- soil fertility,
- Climate and stage of maturity of the plant at harvest.

These forages will need to be supplemented to correct their nutrient deficiencies

### **(Complementally ration)**

Complementary ration means compound feed which has a high content of certain substances but which, by reason of its composition, is sufficient for a daily ration only if used in combination with other feed

Complementary ration can be in many forms such as:

- powder,
- Liquid (e.g. mineral and vitamin drenches),
- Paste or block.

Supplements needed to maximize production from the basic ration resource are obviously variable and at times include:

- minerals - calcium, phosphorus, Sulphur, magnesium, sodium and trace minerals
- protein and the essential amino acid
- vitamins (premix)
- energy

### **✓ (Supplementary ration)**

Supplementary ration is often used in grazing system to help meet production requirements. This may be a regular part of the production cycle to help match feed demand to feed supply or reserved for times of drought. The extent to which supplementary feeding is used depends on the business objective and seasonal conditions.

The supplement chosen must make up for the main nutrient deficiencies in the Basic ration. Dry feed is often deficient in protein and sulphur. In cases where the feed is green but very short, it is the low energy intake which limits production.

The following principles for efficient use of supplements should be followed:

- Identify the most limiting components, usually protein, sulphur and/or metabolisable energy.
- Select supplements containing high levels of the identified limiting components.
- Cost out the program, taking into account alternative measures.
- Start feeding those animals with the greatest needs, for example pregnant cows of low fat score, or weaners below critical live weights.
- Monitor feed consumption, live weight and condition; so that you can confirm that your strategy is working.

Common feed stuffs used in supplementary feeding to meet particular requirements include:

- **Energy** - grain, molasses, silage.
- **Protein** - meals such as cotton seed meal, silage.
- **Roughage** - hay, silage.
- **Minerals** - lime fed as calcium carbonate ( $\text{CaCO}_3$ ), phosphorus (minerals are best fed as pre-prepared licks to ensure that livestock do not exceed recommended intakes).

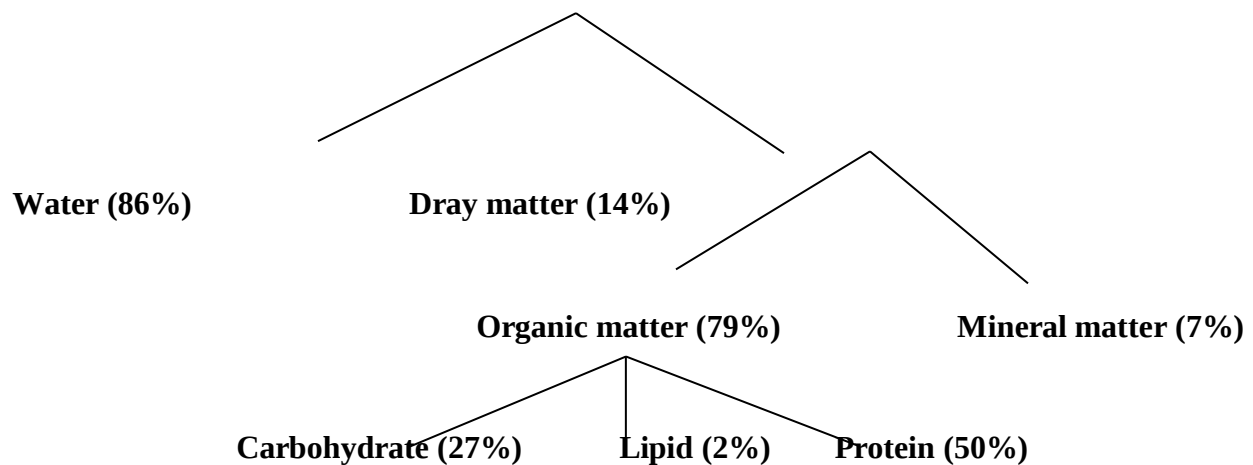
- **Content/Topic 2 (Types of feed Ingredients values)**

The nutrients content of various feeds used must be known. This knowledge is useful in preparing suitable feed mixtures that will meet nutrient requirements of the animal. It is also possible to compare different feeds stuffs and know their relative value in providing nutrients.

✓ **Composition of feed**

All feeds contain water and dry matter (DM). the DM is partitioned into five fractions: crude protein (CP), crude fiber (CF), ether extract or fat (EE), nitrogen free extract (NFW), and minerals which are expressed as a percentage of DM. CF is the indigestible fiber composed of cellulose, and FE is the more soluble carbohydrate consisting of starches and sugars.

**Fresh matter**



✓ **Systems of expressing nutrient content of feed**

Not all feeds have the same nutritive values. Some feeds ingredients used to formulate farm animal's feeds have a high value yet others have a low nutritive value. Below are some terms used to describe feeds values.

### **Energy**

The following systems are used to describe the energy content of feedstuffs.

#### **a) The starch equivalent (S.E)**

This system was introduced by a German scientist by the name of **Kellner**, after careful feeding experiments. He used pure starch as a standard for comparing energy content of feeds. Thus the starch equivalent of a feed is defined as the amount of pure starch which has the same energy as 100kg of that feed. For example, the S.E. of maize is 80. that means; 100kg of maize will yield the same energy as 80kg of pure starch.

#### **b) The total digestible nutrients (T.D.N)**

This system expresses the energy value of a feed on the basis of apparent digestibility of various feed components that yield energy upon completed metabolism. The T.D.N. of a feed is obtained by adding together the percentages of digestible carbohydrates, proteins and fats x2.25. Digestibility is a measure of that portion of food eaten by an animal that remains in the body after taking care of losses through faeces, urine and gases.

#### **c)The calorific value**

The total energy in a feed is determined by complete combustion in a bomb calorimeter. A small amount of feed is completely burnt and the total heat given off is considered. Thus chemical energy is converted into heat which can be determined. Calories are now converted into *joules* which are the internationally accepted energy units.

### **Protein**

The protein content of a feed is expressed in terms of the amount of nitrogen it has. Two methods are used and these are the **crude protein content** and the **digestible crude protein content**. The crude protein (**C.P**) content of a feed is determined by finding out the total nitrogen in that feed, and then the figure obtained is multiplied by a factor of 6.25. Thus,  $C.P = N\% \times 6.25$ . The digestible crude protein (D.CP) is a measure of the nitrogen in the feed consumed that is

retained in the body of the animal after subtracting losses through faeces. It is determined by digestibility trials.

## **Minerals and vitamins**

These are expressed in terms of the quantity present in the feed. For example, minerals, g per kg of feed dry matter. Vitamins are usually expressed in terms of weight i.e. milligrams or micrograms per kg of dry matter.

### ● Content /Topic3 (Ingredients incorporation rates)

There are substances which are essentials as nutrients at certain levels, but above those levels, they are harmful enough to be classed as toxic. There are other substances which if they are absent, prevent certain body reactions such as and therefore may cause toxic effects by their absence.

When a concentrate is being formulated, to determine ingredients incorporation the following should be considered:

- ✓ The type of animal; for example, dairy meal should be made for dairy cattle, layers mash for laying birds and broilers mash should be prepared for laying birds and broilers mash should be prepared for broilers.
- ✓ Age of the animal;
- ✓ Nutritive requirements of the animal
- ✓ Cost of ingredients
- ✓ Palatability of ingredients
- ✓ Wholesomeness; feed ingredients used should not cause harm to animals or spoil the animal products.
- ✓ Availability of the ingredients; use ingredients which are available that supply the required nutrients.

**Table 6: Incorporation rate, toxins/anti-nutrients, Limiting factors and inhibitors of some ingredients**

| Energy sources | Proteins and amino acids | Minerals and vitamins |
|----------------|--------------------------|-----------------------|
|                |                          |                       |

|                                                                                                                              |                                                                                                                                                       |                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>a) Cereals</b><br>✓ maize (corn)<br>✓ Maize bran<br>✓ rice<br>✓ barley<br>✓ <i>Sorghum</i> **<br>✓ Wheat                  | <b>a) Plant source:</b><br>✓ <i>Cotton</i> *<br>✓ Palmist<br>✓ sunflower meal<br>✓ peas<br>✓ soybean meal ***<br>✓ Alfalfa meal<br>✓ corn gluten meal | ✓ Bone meal<br>✓ Lime<br>✓ limestone<br>✓ Shells (eggs and snails)<br>✓ Phosphate<br>✓ Salt<br>✓ salt (NaCl)<br>✓ as dicalcium phosphate<br>✓ oyster or other marine shell<br>✓ dicalcium or monocalcium phosphate<br>✓ a premix |
| <b>b) Roots and tubers</b><br>✓ <i>cassava root meal</i> ****<br>✓ Sweet potato meal<br>✓ <i>Irish potato peel meal</i> **** | <b>b) Animal source:</b><br>✓ Fish meals<br>✓ meat meal<br>✓ feather meal<br>✓ Blood meal<br>✓ milk & milk products<br>✓ dried poultry manure         |                                                                                                                                                                                                                                  |
| <b>c) by-products</b><br>✓ rice bran,<br>✓ polishings<br>✓ molasses<br>✓ wheat bran,                                         | <b>c) Synthetic products:</b><br>✓ methionine<br>lysine                                                                                               |                                                                                                                                                                                                                                  |
| <b>d) Fats and oil</b><br>✓ lard,<br>✓ coconut oil<br>✓ palm oil<br>✓ peanuts,<br>✓ ground nuts<br>✓ poultry fat, fish oil   |                                                                                                                                                       |                                                                                                                                                                                                                                  |

\* = *gossypol*; \*\* = *Tannins*; \*\*\* = Protease inhibitors; \*\*\*\* = *cyanide* \*\*\*\*\* = *solanine*

(line space)

- Content/Topic 4 (nutrients requirements and needs)

**In order to determine what feedstuffs to put together and how much of each one to use to make a balanced ration, the feeder must know: the nutrient requirement for both maintenance and production**

Nutrients requirements are the daily minimum amounts of those nutrients required by an animal for specific functions such as maintenance, growth, milk production, work production, work production etc.

Nutrients requirements are influenced by many factors, such as weight of animal, sex, desired rate of growth, stage of lactation, environment and others.

#### ✓ (Maintenance requirements)

This is the quantity of nutrient required by animals to keep them alive without losing or gaining weight. It covers the requirements for normal health and its existence. Although the animal is in a non-producing state, it requires energy for movements and metabolic activities within the body. This energy is obtained from digested carbohydrates, fats and oil and fiber. The amounts of energy required for maintenance by an animal is proportional to its body weight or size.

The daily energy requirement for maintenance is influenced also by external factors such temperature, wind and rainfall.

In a cold environment, animals produce extra heat to maintain the body temperature. Under this condition, the stockman is advised to feed proportional energy giving foods. The opposite occurs when the surrounding temperature rises.

#### ✓ (Production requirements)

It is the quantity of food which is fed over and above the maintenance ration to enable farm animals to produce products of economic value.

A production ration may be fed for:

- ❖ Something that can be removed from an animal body, e.g. wool, milk or eggs.
- ❖ Fats required for fattening mature animals before selling or increasing the size and body weight.
- ❖ Growth which is characterized by an increase in body size
- ❖ The process of reproduction, e.g. extra food required for **steaming-up** and **flushing**.
- ❖ Power of doing work, e.g. bulls used for cultivation or donkey and camels for carrying loads require extra foods.

The amount production requirement varies with the species, within individuals and according to the different forms of production.

- **CONTENT/TOPIC5: Animal feed formulation**

The ration formulated should be able to meet the nutrient requirements of the animals for which it is formulated and should be wholesome. Certain basic considerations should be made when formulating rations.

- ✓ The nutrients requirements of the animal for which the ration is being made. These are checked in the feeding standards (nutrients requirements and ingredients bromatological values tables)
- ✓ The feedstuffs available with respect to the following:
  - ✚ Nutrient composition, e.g. soya bean meal and cotton seed cake for protein, and maize and sorghum or cassava for energy, etc..
  - ✚ Palatability or acceptability to the animals
  - ✚ Wholesomeness, in that the feedstuffs chosen should not cause harm to the animal or spoil the product
  - ✚ Physical nature of the final mixture; whether mash, or pelleted
  - ✚ Availability of the feeds
  - ✚ Cost of the feedstuffs, e.g. protein can be supplied by different feedstuffs at different prices.

- **Livestock production systems utilizing concentrates**

The major production systems in which concentrate feeds are used in Rwanda may be identified as:

- ✓ Dairy production
- ✓ Beef production
- ✓ Poultry meat production
- ✓ Poultry production
- ✓ rabbit production
- ✓ pigs' production
- ✓ Fish farming
- ✓ Sheep and goat production.

- **CONTENT/TOPIC 6: Requirement and needs variation among animal species**

Different animals are fed on different feeds depending on age, purpose of the animal and the cost of the feeds. Concentrate feeds which are usually given to animal include:

**Table 7: Concentrate feed for farm animals**

| <b>Animals</b> | <b>Purpose</b>  | <b>Age or period</b> | <b>Feeds</b>                                   |
|----------------|-----------------|----------------------|------------------------------------------------|
| Chicken layers | Eggs production | 0 to 8 weeks         | Chick or starter mash                          |
|                |                 | 9 to laying          | Grower mash                                    |
|                |                 | Laying period        | Layer mash                                     |
| Broilers       | Meat production | 0 to 3 weeks         | Starter mash                                   |
|                |                 | 4 to 5 weeks         | Grower mash                                    |
|                |                 | 6 to slaughtering    | Finisher mash                                  |
| Cattle         | dairy           |                      | Weaner meal                                    |
|                |                 |                      | Growers                                        |
|                |                 | Lactating period     | Dairy meal                                     |
| Cattle         | Beef            |                      | Growers                                        |
|                |                 |                      | Fattening                                      |
|                |                 |                      | Finisher                                       |
| Pigs           | Breeding        | Before weaning       | Creep feed for piglet                          |
|                |                 | After weaning        | Grower feed                                    |
|                |                 |                      | Sow and weaner meal (for gilt, sows and boars) |
| Pigs           | Pork (meat)     |                      | Creep feed                                     |
|                |                 |                      | Grower feed                                    |
|                |                 |                      | Finisher feed                                  |

- **Learning Outcomes. 2.3: Calculate rations**
- **CONTENT / TOPIC 1 Rations formulation methods**

The first step in formulating a ration is to define and decide on the nutritional needs of the animal. Estimates of nutrients requirements for animal are available from various sources (see Appendix). Secondly, the feed ingredients which are available need to be listed with their nutrient composition (see Appendix). The next step will be the calculations of the approximate proportions of ingredients to meet animal requirement (ration balancing).

Ration can be balanced or calculated by using the hand method or computer method. The hand calculation is also done by using:

- ✓ Pearson square method
- ✓ Algebraic method
- ✓ Mathematical programming (software)

✓ **(Pearson square method.)**

The Pearson square or box method of balancing rations is a simple procedure that has been used for many years. It is of greatest value when only two ingredients are to be mixed. In taking a close look at the square, several numbers are in and around the square. Probably one of the more important numbers is the number that appears in the middle of the square. This number represents the nutritional requirement of an animal for a specific nutrient. It may be crude protein or TDN, amino acids, minerals or vitamins. Simple way to formulate a feed ration is the use of a Pearson Square

In order to make the person square method works consistently, the following steps:

- ✚ Draw a square
- ✚ Put the protein content of the required feed in the centre. Put the protein content of the basal feeds at the top left hand corner and the bottom left corner.
- ✚ Subtract diagonally but ignore negative signs.
- ✚ The figure got on the right hand corners represent the proportion of each feeding ingredients to mix (use)
- ✚ Add up all the parts at the right hand corners. This represents the total parts to mix in the ration.
- ✚ Calculate accordingly using this total.

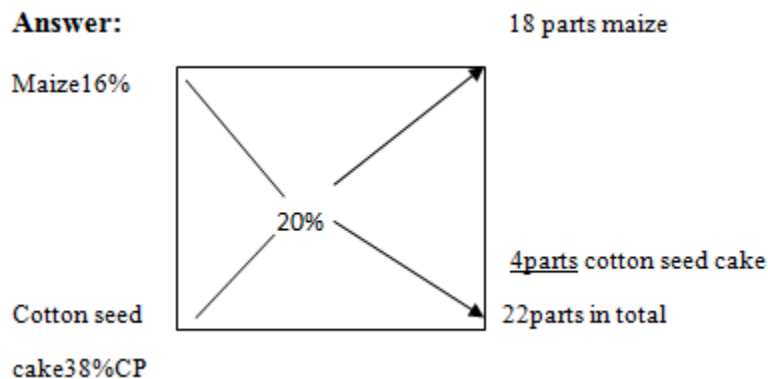
a) **Simple Pearson square**

The "Pearson Square" or simply the "Square" method, provides a simple and rapid method that allows blending of two feeds (or feed mixtures) with different nutrient concentrations into a mixture with the desired concentration. It is usually employed in cases of mixing feeds rich in energy with feeds rich in protein. For this method to work, the desired level of a nutrient should be a value between the compositions of the ingredients that constitute the mixture. The square method permits quick substitution of feed ingredients in response to market fluctuations without disturbing the content of the nutrient being considered. This is important to the feed manufacturer who has to respond quickly to changes in market prices of feed ingredients.

➤ **Person square using two ingredients**

**Example1**

1.A farmer would like to make a 20% CP ration using maize contains 16% CP and cotton seed cake contains 38% CP. In what proportions would the maize, cotton seed cake be mixed to get 100kg of chick mash?



Maize:  $\frac{18 \times 100\text{kg}}{22} = 82\text{kg}$

Cotton seed cake:  $\frac{4 \times 100\text{kg}}{22} = 18\text{kg}$

This means that during mixing, the farmer will take 82kg of maize and 18 kg of cotton seed cakes in order to formulate a diet containing 20% of crude protein.

➤ **Person square using more than two ingredients**

**Example 2**

A farmer wants to make a 14% CP ration from the following feedstuffs; maize 10%CP, maize brain 14% CP, cotton seed cake 35% CP and fish meal 64% CP.

What proportion would these ingredients be mixed if the ratios of 2:1 maize to maize brain and 2:1 cotton seed cake to fish meal are to be used to make 75 kg of dairy meal?

❖ **Answer**

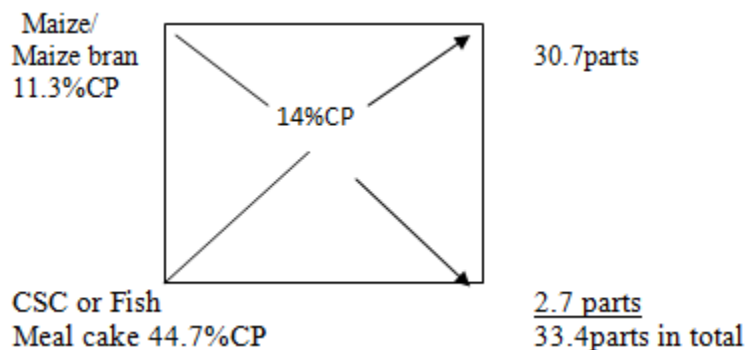
| Basal feeds; | Parts | CP% | Total |
|--------------|-------|-----|-------|
| Maize        | 2     | 10  | 20%   |
| Maize bran   | 1     | 14  | 14%   |
| Total        |       |     | 34%   |

Parts 2:1

2+1=3]

**Total average for protein feeds**  $\frac{134}{3} = 44.7\%$

Then use the person Square method. Put the average CP for the basal feed and protein feed on the left corners. Proceed as in the first example.



### Proportion of basal and protein feeds

$$\text{Basal feeds} = \frac{30.7 \times 75}{33.4} = 68.9\text{kg}$$

$$\text{Proteins} = \frac{2.7 \times 75}{33.4} = 6.1\text{kg}$$

But the ratios are 2:1 for both the protein feeds and basal feeds (Basal feeds) maize: maize  
Bran 2:1

$$\text{Maize} = \frac{2 \times 68.9}{3} = 45.9\text{kg of maize}$$

$$\text{Bran} = \frac{1 \times 68.9}{3} = 23.0\text{kg of maize bran}$$

Cotton seed cake; fish meal 2:1

$$\text{Cotton seed cake} \frac{2 \times 6.1}{3} = 4.1\text{kg}$$

$$\text{Fish meal} \frac{1 \times 6.1}{3} = 2.0\text{kg}$$

### **b) Double person's square**

In many situations we may want to have exact amounts of two major nutrients such as protein and energy from three feeds. We can accomplish this by going through 3 Pearson's squares.

#### **Example:**

We want to a final mix with 12%CP and 74% TDN. Given corn with 10% CP and 80% TDN, CSC with 40% CP and 68% TDN, sweet patato vines CPV with 15% CP and 55% TDN, the ingredient compositions or formula can be calculated as follows:

#### **Step 1:**

The first step is to make assumptions on the CP and TDN composition for two mixes namely mix1 and mix 2 in the type of feed formulation. This is where the name double pearson's square is derived.

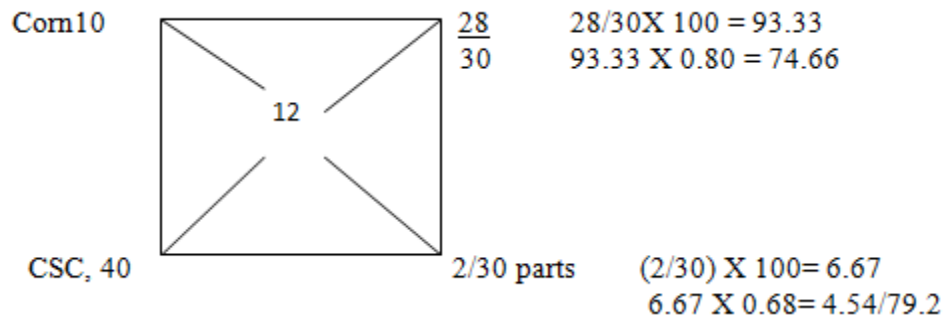
Assume mix 1 is CP = 12% TDN > 74%

Assume mix 2 is CP = 12%, TDN < 74%

#### **Step 2:**

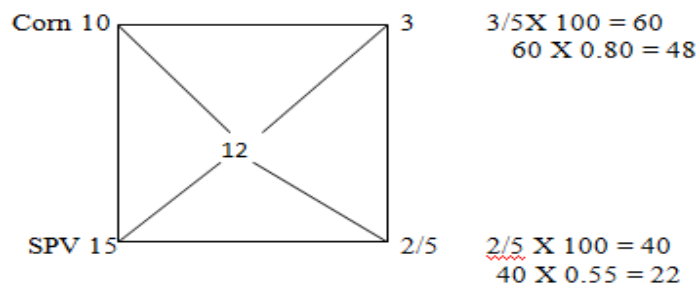
Use the Pearson's square method to calculate the proportions of maize bran and CSC and their total TDN in mix 1 and proceed as follows:

Mix 1, 12% CP, > 74% TDN compute TDN

**Step 3.**

Use the Pearson's square method to calculate the proportions of maize bran and SPV and their total TDN in mix 2 and proceed as follows:

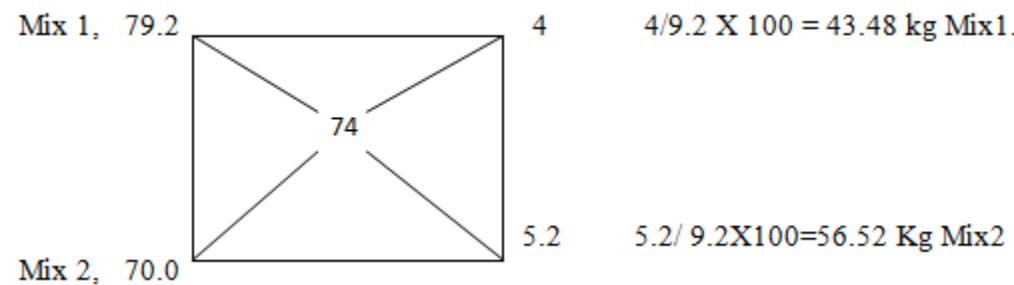
Mix 2: 12% CP, < 74% TDN Compe TDN

**Step4.**

Then solve for TDN:

Use results in step 2 and 3 to calculate the quantity of mix 1 and 2 required to have a final blend of 74% TDN in mix 3.

Mix 3 with 74% TDN



Mix 3 is 12% CP, 74% TDN with 43.48kg of Mix 1 and 56.52 kg of Mix 2.

Calculate the ingredient composition of the different mixes as follows:

Corn in Mix 1 = 93.33%

Therefore:

Corn in Mix 1 of Mix 3 =  $93.33\% \times 43.48 = 40.58\text{kg}$

Corn in Mix 2 = 60%

Therefore:

$$\text{Corn in Mix 2 of Mix 3} = 60\% \times 56.52 = 33.91$$

Total corn in ration 74.49kg

$$\text{CSC in Mix 1} = 6.67\%$$

Therefore:

$$\text{CSC in Mix 1 of Mix 3} = 6.67\% \times 43.48 = 2.9 \text{ kg}$$

$$\text{SPV in Mix 2} = 40\%$$

Therefore:

$$\text{SPV in Mix 2 of Mix 3} = 40\% \times 56.52 = 22.61 \text{ kg}$$

Total 100.00kg

Check for TDN

$$80\% \times 74.49 \text{ (CORN)} + 68\% \times 2.9 \text{ (CSC)} + 55\% \times 22.61 \text{ (SPV)} = 74$$

Check for CP

$$10\% \times 74.49 \text{ (corn)} + 40\% \times 2.9 \text{ (CSC)} + 15\% \times 22.61 \text{ (SPV)} = 12$$

### ✓ (Balancing ration with algebraic method)

In this method we use simultaneous equation to solve simple diet formulation. The amount of ingredients in the mixture is unknown.

#### **Example**

Use the algebraic method to calculate a ration for piglet using fish meal and maize bran. From the feeding table, the protein requirement of such piglet is 20%. Fish meal contains 48% of protein while maize bran contains 8.9 % of protein.

Solution

X=% of fish meal in the mixture

Y=% of maize bran in the mixture

$$X + Y = 100 \text{ (equation i)}$$

$$0.48X + 0.089Y = 20 \text{ (equation ii)}$$

By using the equation (i)  $X = 100 - Y$  (equation iii)

Now substitute, the value of X in the equation (ii)

$$0.48(100 - Y) + 0.089Y = 20$$

$$48 - 0.48Y + 0.089Y = 20$$

$$-0.48Y + 0.089Y = -48 + 20$$

$$-0.441Y = -28$$

$$Y = 28 / 0.441$$

$$Y=63.5$$

Using the equation (i)

$$X+Y=100$$

$$X=100-Y$$

$$X=100-63.5$$

$$X=36.5$$

### ✓ **(Mathematical programming (software))**

Ration formulation lends itself to computer programming, and most feed companies and larger operations now formulate on a computer. A database of available ingredients and their cost can be maintained in the computer, and the computer programme can then rapidly solve a whole series of trial and error operations to arrive at the required diet specification at minimum cost.

There are several advantages to utilizing a computer program for ration balancing:

- Some programs generate the nutrient requirements after entering the animal description; therefore, looking up nutrient requirements from a table is not required.
- Computer programs also provide a list of feed ingredients and their nutrient composition to choose from.
- Computer programs show the balance of all nutrients simultaneously. This eliminates the additional time involved in balancing and rechecking each individual nutrient,
- Allows for easier balancing of rations containing several feed ingredients. Formulas are built into the program,
- Mathematical mistakes are also eliminated.
- Animals will gain more efficiently and economically with a balanced ration.
- You should be able to balance rations that will meet the needs of most farm animals.

**NB; WITH COMPUTER PROGRAMS THE TRAINER SHOULD PROVIDE A LIST OF FEED INGREDIENTS AND THEIR NUTRIENTS COMPOSITION TO BALANCE ALL NUTRIENTS SIMULTANEOUSLY (FORMULAS ARE BUILT INTO THE PROGRAM THROUGH EXCELL).**

Learning Outcome .2.4. Incorporate ingredients feeds.

- Content/Topic 7 (Requirements and needs variation among animal species)

Different animals are fed on different feeds depending on age, purpose of the animal and the cost of the feeds. Concentrate feeds which are usually given to animal include:

**Table 7: Concentrate feed for farm animals**

| Animals        | purpose         | Age or period     | Feeds                                          |
|----------------|-----------------|-------------------|------------------------------------------------|
| Chicken layers | Eggs production | 0 to 8 weeks      | Chick or starter mash                          |
|                |                 | 9 to laying       | Grower mash                                    |
|                |                 | Laying period     | Layer mash                                     |
| Broilers       | Meat production | 0 to 3 weeks      | Starter mash                                   |
|                |                 | 4 to 5 weeks      | Grower mash                                    |
|                |                 | 6 to slaughtering | Finisher mash                                  |
| Cattle         | dairy           |                   | Weaner meal                                    |
|                |                 |                   | Growers                                        |
|                |                 | Lactating period  | Dairy meal                                     |
| Cattle         | beef            |                   | Growers                                        |
|                |                 |                   | Fattening                                      |
|                |                 |                   | Finisher                                       |
| Pigs           | Breeding        | Before weaning    | Creep feed for piglet                          |
|                |                 | After weaning     | Grower feed                                    |
|                |                 |                   | Sow and weaner meal (for gilt, sows and boars) |
| Pigs           | Pork (meat)     |                   | Creep feed                                     |
|                |                 |                   | Grower feed                                    |
|                |                 |                   | Finisher feed                                  |

## LU3: PERFORM FEEDS CONCENTRATES PREPARATION AND CONSERVATION

After determining how much feed ingredients to use to prepare a desired ration, the ingredients are prepared and mixed. The final mixture is in form of flour (mash).

### LO 3.1: Prepare Feed ingredients

- Content/Topic1 (Steps for ingredients preparation)

A number of methods of processing grains exist as part of the preparation of concentrates. Therefore, it is important to be aware of the characteristics of the grains used for production of concentrates and therefore if possible to apply the relevant method.

#### ✓ (Cleaning feeds ingredients (peeling, winnowing, Sieving, Washing.)

Is designed to remove the shell (outer layer), of the grains in order to reduce the total amount of raw fiber that reduces the total digestibility in non-ruminants. As a result, certain industries produce significant amounts of peelings that can be used as concentrate components for ruminants. Soy is peeled to increase the total quantity of proteins by removing the excess amount of fiber, other grains winnow, sieved, and washed to separate chaff from grain.

#### ✓ (Grinding feeds ingredients)

Is the oldest and most used method that uses mechanical force to physically break up the cells as well as the outer layer. Some of the first steps in feed processing is the grinding.

Feeding fine, medium or coarse mash feeds results in an increase in feed consumption and less feed wastage with the coarser feed. Grinding to medium size particles (like sugar) has been proven to be most effective as dust or flour size particles of grinding, tends to increase wastage during using, storing and transport and cause digestive problems, especially in young animals.

During grinding, attention should be devoted to limiting the presence of foreign materials and contaminants.

Grinding reduces particle size of feed ingredients, which makes them more digestible. Grinding also enables easy mixing of feed ingredients.

### ✓ (Heat treatment (roasting and burning))

Processing can render such feedstuffs good for use in animal feeding, soybeans must be roasted before they are used do not burn the soybean because this spoils the useful nutrients and will not be of value to animals. Beans must also be boiled before feeding to animals. (Drying feeds ingredients)

Dry feeds ingredients will not become mouldy in storage. Drying makes feeds ingredients more palatable and more digestible. Drying also removes factors that inhibit proper digestion/utilization of feed ingredients

### ✓ (Weighing feeds ingredients)

Weighing feed ingredients leads to peace of mind that your animal is meeting its nutrient requirements and often feed costs can be cut through determining how much of each feed is required.

To determine dietary requirements, animal characteristics are first considered. These include age, breed, workload, metabolism, and weight.

Learning Outcomes .3.2: Mix feed ingredients

### • Content/Topic1 (INGREDIENTS MIXING)

Mixing is important in order to homogenize the structure of the concentrates and to enable equal composition in every scoop of concentrates. In addition, it prevents animals from eating only components they prefer from the mix.

Ingredients can be mixed using mechanical mixer or mixed manually on a clean concrete floor or canvas.

Sometimes feeds to be mixed are put on a concrete floor or canvas in a cone shape. Basal feeds such as maize bran are placed first since they form the bulk. The protein supplement is poured on top of the basal feed. The protein supplement spreads over the basal feed. Mineral supplement and pre-mix vitamin are sprinkled on top of the cone. A shovel/spade is used to mix the ingredients by turning the heap several times maintaining the cone shape.

**N.B. FIGURE SHOW MANUAL MIXING SHOULD BE ILLUSTRATE**

✓ **(Mechanical mixing)**



A hand-operated mixer is used to mix feed ingredients

Efficient mixing is the key to good feed production. The feed will not be the balanced formulation it is designed to be unless it is properly mixed. Dry mixers are a mechanical means of achieving this.

Mechanical mixing uses the machine which has a feed hopper where ingredients are put. A rotary shaft operated by the hand mixes the ingredients. On subsistence scale, farmers use a drum fixed on a metal frame. The ingredients are put in the drum and the drum rotated using a handle fixed on the drum. The ingredients get mixed inside the drum.

**L.O.3.3: Package concentrates**

- Content /Topic1(Objectives of packaging and labelling)

The principal roles of feed packaging are to protect feed products from outside influences and damage, the goal of food packaging is to contain feed in a cost-effective way that satisfies industry requirements and purchasers desires, maintains feed safety and minimizes environmental impact.

Concentrate packaging can retard product deterioration and maintain or increase the quality and safety of food. In doing so, packaging provides protection from 3 major classes of external influences:

- ✓ Chemical (gases, moisture, light)
- ✓ biological, (insects, rodents, and other animals)
- ✓ Physical (mechanical damage).

The most common packaging materials for concentrate feed is plastic bags.

- Content/Topic 2(Types of concentrates packaging)

- ✓ Aseptic processing
- ✓ Use Trays
- ✓ Use bags
- ✓ Use Boxes
- ✓ Use cans
- ✓ Use cartons, coated paper
- ✓ Use flexible packaging
- ✓ Use pallets

*(line space)*

- Content/Topic 3 (Major labelling information)

Labelling is the primary means of communication between the feed manufacturer and the purchasers of that concentrate feed. It is suggested that the label contains the following information:

- ✓ Information provided should be in one of the official's language
- ✓ Indicates the net weight of feeds
- ✓ Company branch name or trade name and address
- ✓ Product name
- ✓ Purpose statement: the specific purpose of the feed, the species of animal for which intended and directions for use must be stated.
- ✓ Warning or caution statement
- ✓ Feeding instructions as well as the storage conditions

- ✓ Feed ingredients used: use the common name of each ingredients
- ✓ Detailed use directions
- ✓ manufacturing date
- ✓ lot identification;
- ✓ The minimum storage life

### • . L. O 3.4. Make mineral blocks

Forage mineral composition is dependent on many factors, including soil characteristics, stage of growth, fertilization practices, etc. This can lead to highly variable mineral content in forages, necessitating a regular mineral supplement to satisfy the needs of the animal.

Feeding inadequate mineral levels will result generally in non-specific symptoms like poor growth, lower productivity and higher culling rates. The most-known disorder related to Ca deficiency is milk fever, especially in older dairy cows shortly after calving.

The primary effect of chronic deficit of P in ruminants is a lower feed intake and utilization, reduced milk yield (together with Ca), weight loss, reduced fertility and in case of severe or prolonged P deficiency, enlarged and deformed joints and bones. Insufficient available Mg in the feed of cattle can result in hypomagnesaemia or even grass tetany, especially in early lactating dairy cows grazing on lush spring pastures. Nutritional imbalance: low content in protein, nitrogen, minerals, vitamins and low digestibility. Thus, those minerals play a limiting factor either for the growth of young animals, or the productivity of dairy cows.

#### • Content/Topic 1 (Mineral lick block purpose)

- ✓ **Use of licks for livestock is still a relatively common practice; several reasons are commonly cited for their use:**

- ✚ Animals need salt.
- ✚ Animals are licking patches of soil, so they must be lacking in something.
- ✚ There is a need to provide extra vitamins and minerals.
- ✚ Licks help prevent specific diseases and conditions in the animals ( e.g Milk fever).
- ✚ Animals will eat what they need.
- ✚ Licks provide energy and protein.

- **Content /Topic2(Steps to make mineral lick blocks)**

The preparation of mineral lick requires operations that involve a mixing to balance animal requirements in minerals. That preparation of mineral lick comprises the following steps:

❖ **Preparing the mixture:**

- Mixing in a bucket the cement and maize bran
- Properly dissolving in another bucket the salt, urea, in water
- Pouring that mixture into the bucket of cement and maize bran
- Mixing all with hands

❖ **Molding:**

- Pouring the final mixture into moulds

❖ **Drying:**

- When moulds are still soft, inserting a stick through them and that will serve as the suspension hole of lick. Licks are then placed in dry place, well ventilated, with direct sun for two to three weeks.

**Table 8: Examples of formulated mineral licks**

| Type of mineral lick                     | Ingredients             | Composition (%) |
|------------------------------------------|-------------------------|-----------------|
| <b>1.Molasses/Urea Blocks</b>            | Molasses                | 50              |
|                                          | Urea                    | 10              |
|                                          | Salt                    | 5               |
|                                          | Calcium oxide or cement | 10              |
|                                          | Maize bran              | 25              |
| <b>1 Mineral lick with urea</b>          | Urea                    | 9               |
|                                          | Salt                    | 9               |
|                                          | Maize bran              | 53.5            |
|                                          | Bone meal               | 9.5             |
|                                          | Cement                  | 18              |
| <b>2 Mineral lick without urea</b>       | Salt                    | 52              |
|                                          | Bone meal               | 26              |
|                                          | Cement                  | 9               |
|                                          | Maize bran              | 13              |
| <b>4.Mineral lick without maize bran</b> | Lime                    | 27.3            |
|                                          | Bone meal               | 19.3            |

|  |           |      |
|--|-----------|------|
|  | Magnesium | 2.2  |
|  | Salt      | 41.2 |
|  | Cement    | 10   |
|  |           |      |

*(line space)*

### **LO .3.5: Conserve/Preserve concentrates and mineral lick block**

- **Content/Topic 1 (Storage conditions and storage methods)**

Animal feeds have a shelf life, beyond which they become expired. Feeds can be attacked by insects (e.g. weevils), rodents (e.g. rats), fungi (e.g. mould), bacteria and other things. These pests reduce the quality and quantity of the feed by eating it or producing poisonous substances.

The feed becomes easier to attack when kept on damp ground or in containers with a lot of moisture in very cold environments. Such conditions may also expose the feed to fungal contamination some of which can produce toxins. It is important that such places are avoided. Good feed storage should provide protection against extreme temperatures (high or low), humidity, moisture, insects, and other pests such as rodents.

Animal feed bags should be stored in a cool dry room with the bags put in small piles on the wooden rack and should not lean on the walls.

### **L.U.4: Distribute animal feeds and water**

The on-farm feed distribution system should ensure that the correct feed is sent to the right specie and group of animals. During distribution and feeding, feed should be handled so that biological and chemical contamination does not occur from contaminated storage areas and

equipment. Non-medicated feeds should be handled separately from medicated feeds to prevent contamination.

Avoid overfilling the animals' feeding troughs, adapting the quantity to the physiological requirements. Feed and feed ingredients should not be produced, processed, stored, transported or distributed in facilities or using equipment where incompatible operations may affect their safety and lead to adverse effects on animal 'health.

. L.O.4.1: Determine animal feeds and water quantities to distribute

- **Content/Topic 1 (calculation of forage, concentrates and water quantities to distribute)**

✓ (Water distribution in farm animals)

Livestock need water for blood circulation, food digestion, temperature control and production. Water intake occurs through eating and of course drinking. As the body temperature of an animal increases, so do its water requirements due to fluid loss through sweating and/or panting in an effort to keep cool. This means that not only do animals need more water in hotter conditions but also when being driven or worked. Lactation requires a huge amount of water to produce milk.

A lactating female need at least 50% more water than a dry animal. On average it takes 4 - 5 litres of water to produce 1 litre of milk. This does not take into account the requirements for the maintenance of the animal.

✓ (Water quality)

Good quality water is clean, clear, odourless and without a high mineral content. Water quality is lowered by soluble salts, algae, pollution (dead animals, bird faeces or debris) and clay (in-suspension). These materials may cause the animals to refrain from drinking the water, go off their feed, lose condition, stop lactating or die from disease or toxicity.

✓ **(Water voluntary intake)**

Livestock and poultry water consumption depend on a number of physiological and environmental conditions such as:

✚ type and size of animal or bird

- ✚ physiological state (lactating, pregnant or growing)
- ✚ activity level
- ✚ type of diet – dry hay, silage or lush pasture
- ✚ temperature – hot summer days above 25°C can sometimes double the water consumption of animals raised outside
- ✚ water quality – palatability and salt content

**Table 9: Normal water intakes of animals**

| Animal                            | Daily Consumption<br>(litres a day) |
|-----------------------------------|-------------------------------------|
| Sheep - weaners                   | 2-4                                 |
| - adult dry sheep - grass land    | 2-6                                 |
| - salt bush                       | 4-12                                |
| - Ewes with lambs                 | 4-10                                |
| Cattle - weaners                  | 25-50                               |
| - dry stock                       | 35-80                               |
| - lactating cow - grass land      | 40-100                              |
| - saltbush                        | 70-140                              |
| Dairy cattle                      | 70-250                              |
| Horses                            | 40-50                               |
| Pigs – sow and litter             | 25-45                               |
| - Boar or dry sow                 | 12-15                               |
| - grower 23 – 90 kg               | 3-12                                |
| Poultry (100 birds) - laying hens | 33                                  |
| - broilers                        | 6-32                                |

In general water should be provided ad libitum or free access to animals this mean that water should be available to all animals at all times in adequate quantities.

- **CONTENT 2/ Calculation of forage, concentrates, minerals and vitamins**
- ✓ **(Determine animal feeds)**

Measuring amount feed to distribute is the only way to determine the amount of each nutrient consumed by animal. Once amount of feed intake is known, dietary concentration of nutrients can be adjusted to ensure that animal consume the proper amount of each nutrient required for maintenance and productive functions.

Underfeeding can result in loss of production. Overfeeding will cause wastage of expensive feed. Thus, both overfeeding and underfeeding have serious economic consequences which affect the viability of the farm.

✓ **(Determine amount of forage to distribute)**

The DM amount that animal can ingest is limited by the size of the stomach. This maximum amount varies depending on various criteria: the LW of the animal, ambient temperature, the production level, the individual, the health status, race, watering; it is given in kg DM per kg of live weight. For example, a young bull ingests approximately 2.5 kg DM/100kg of live weight.

- The DM amount calculation that can be ingested is based on the development stage of the animal:
  - ✓ for a 40kg cattle, appetite is 3.5 to 4 kg DM /100kg LW
  - ✓ for a 100kg cattle, appetite is 3-3.5 kg DM/100kg LW
  - ✓ for a 200kg cattle, appetite is 2.5 to 2.8kg /100kg LW
  - ✓ when the animal has a milk production, we add 0.250kg of DM/ litter of milk produced

Forage to distribute many times is in form of fresh matter. However, the calculation of ingestible amounts is based on forage dry weight (DM). So we must convert the amount calculated in fresh matter. In general, fresh forage contains 60 to 80% of water depending on its growth stage and cultivation conditions.

✓ **(Determine amount of concentrate feed to distribute)**

The primary role of concentrate feeds is to provide concentrated sources of necessary nutrients for livestock production. These nutrients include not only macro-nutrients of energy and protein but also important specific nutrients such as amino acids, fatty acids, enzymes, vitamins, minerals and others. Both monogastric and ruminant livestock are fed concentrates. Monogastric livestock have a limited capacity to digest fibre and thus require diets of higher nutrient density with a higher proportion of concentrate feeds and less roughage, particularly for intensive poultry and pig production systems.

### A) Guidelines for concentrate feeding in cows

Locally available concentrates for feeding dairy cows are of several types.  
The most common is the commercial dairy concentrate (referred to locally as Dairy meal).

- **Guideline 1**
  - ✓ Up to 7kg of milk, no concentrate feed
  - ✓ For every extra 1.5kg of milk above 7kg, given 1kg of concentrate feed
- **Guideline 2**
  - ✓ Forage- concentrate ratio
  - ✓ Pasture or fodder 70%
  - ✓ Concentrate feeds 30%

### B) Feeding Schedules for Chickens

Poultry feeds are referred to as "complete" feeds, because they are designed to contain all the protein, energy, vitamins, minerals, and other nutrients necessary for proper growth, egg production, and health of the birds. Feeding any other ingredients, mixed with the feed or fed separately, upsets the balance of nutrients in the "complete" feed. Feeding additional grain or supplement with the complete poultry feed is not recommended.

The quantities of feed per day for different categories of chickens are summarized in appendix.

L.O:4.2: Wet concentrates ( with water and molasses)

Forage availability does not limit intake, but poor forage quality does not allow an animal to consume forage to its intake potential. As a result, nutrient intake is depressed and cattle performance fails to meet expected production goals. A pre-treatment program should provide the nutrients limiting animal performance in addition to stimulating forage intake.

- Content /Topic1 (forage chopping)

Chopped forage to 5 cm or a little longer can be easily eaten. Chopping also minimizes selection and facilitates mixing with other feeds. Chopping some of the coarser green feeds such as elephant grass will also increase the amount eaten. Chopping can be done using a machete knife or by special manual or motor-driven choppers that are very efficient. Moistening chopped dry roughages can also improve utilization through increasing intake and digestibility

- Content/Topic 2 (Molasses dilution)

Molasses is mostly used as an energy supplement or as a carrier for urea in utilizing non-protein nitrogen (NPN) whereas oilcakes are incorporated into diets as protein supplements. Because of their high protein content, oilcakes could also be used to upgrade low-quality roughage to a maintenance diet

Molasses can be used for all classes of livestock. However, the use of molasses in rations for cattle feeding is more extensive than with any other livestock species. As an energy supplement, molasses can be used as a substitute for grain. As such, molasses has often been used to supplement cattle grazing poor-quality roughages when energy intake is a limiting factor.

However, molasses is a poor source of protein and needs to be supplemented with urea as a non-protein source of nitrogen for sustaining higher levels of production. The constraint in utilizing high levels of molasses is its toxicity. Experience indicates that molasses may be toxic when fed in large quantities. As a result, recommended inclusion rates do not usually exceed 15% for cattle and 8% for sheep.

### **L.O:4.3: Distribute concentrates and water**

The nutrition of animals is the most important factor affecting performance. Poor nutrition results in low rates of production, often defined by growth and reproduction. It also affects the immune system and the ability of an animal to fight disease. In extreme conditions of malnutrition, death can occur. In many animal production systems, approximately two-thirds of improvements in livestock productivity can be attributed to improved nutrition. Proper feed should first take into account animal feeding behaviours

- Content/Topic 1 (Food stuffs)

There are ten major groups of materials which can be used in animal feeding.

- |                                |                                    |
|--------------------------------|------------------------------------|
| 1. Grasses                     | 5. Root crops                      |
| 2. Legumes                     | 6. Cereals                         |
| 3. Miscellaneous fodder plants | 7. Oil-bearing seeds and oil cakes |
| 4. Fruits and vegetables       | 8. Feeds of animal origin          |

9. Miscellaneous feedstuffs

10. Additive

✓ **(Total mixed rations)**

Total mixed ration is a blend of all of the constituents of a ration fed to a confined animal, mixed to prevent separation to a specific nutrient concentration and fed at free will to the cow. In the total mixed ration feeding system, the concentrates and roughage are mixed either by hand, in small-scale operations, or in a mixer wagon. Where a mixer wagon is used, the mix is often dispensed to the cow directly from the wagon.

The total mixed ration feeding regime has several advantages over feeding ingredients separately:

- It is possible to use a wide range of feedstuffs.
- Total mixed ration allows greater accuracy in ration formulation.
- Cows are able to consume large amounts of feed, especially in early lactation when high intake is helpful.
- Total mixed ration allows energy and protein to be used more efficiently by microorganisms in the rumen. This also results in good rumen health with few metabolic disturbances.
- By mixing roughage and concentrates and feeding the mix at free will, the total nutrient intake for a group of cows can be regulated by the degree of concentration of nutrient in the feed.
- Total mixed ration allows use of ingredients that singly are not very palatable.

The main disadvantage of total mixed ration is the high initial investment in equipment.

✓ **(Partly mixed rations)**

The partly mixed ration regime combines total mixed ration and individual feeding of concentrates. Roughage is mixed with some of the concentrates manually or with a mixer. The concentrate level in the mix is adjusted to fit the lower-yielding cows.

The high-yielding cows are fed extra concentrates in the parlour.

- **Content /Topic3(Method of feeding farm animals)**

Farmers handle animal in a number of ways while feeding them. These vary with the types of animal and its purpose.

- ✓ **(Adlibitum feeding)**

In adlibitum feeding, animal is provided with unlimited amount of feeds. They feed according to appetite. This is common with beef cattle, lactating animals, pigs, poultry animal feed throughout the day.

- ✓ **(Fixed amount)**

This is a method of feeding where animals are given fixed amount of feed at fixed times. It is sometimes a way of controlling excessive weight gain. At other times, the farmer is trying to economize a particular type of feeds which is scarce and others are abundant. Pigs that have reached market weight have restricted feeding if they are meant to provide pork.

- ✓ **(Challenge feeding)**

Challenge feeding is used on lactating cows. A cow is provided with more concentrates until such a point when its milk yield does not increase. Thereafter that cow should not be given more or less of the concentrates.

- ✓ **(Force feeding)**

It is an emergency method used to feed young animals that have failed to eat. Young turkeys may fail to eat in their first days of life therefore need force feeding. It can also be used on other animals to increase their chances of survival.

*(line space)* L.O:4.4: Maintain hygiene of shelters, Feed trough and water trough

Good housing of animals is essential for obtaining maximum benefits from livestock. A clean shelter also adds the benefits of increasing the comfort level of animal and presenting positive impacts on the health of the animal. Proper hygienic condition helps to avoid bacterial, viral, and parasitic infection and related illness in animals.

- **Content/Topic 1 (precautions for maintaining animal house hygiene)**

General precautions while maintaining animal house clean:

- ✓ Provide clean food and water to animals; put the drinking bowls and hay racks so high up that dung and urine cannot fall into the food and water.
- ✓ Remove faeces from animal enclosures frequently (at least once a day).
- ✓ Do not keep animals overcrowded.
- ✓ Vaccinate animals against the important diseases prevalent in the region.
- ✓ Be careful with carcasses; bury or burn the dead animals.
- ✓ When an animal suddenly dies, always suspect anthrax.
- ✓ Keep animals in clean, dry places. Move enclosures and stables regularly and keep them clean, to avoid build up of diseases in one place.
- ✓ Make sure that the air in the stables is well ventilated. Ventilation removes the dampness. Many microbes need dampness to survive in the environment and to grow and multiply.
- ✓ Do not mix healthy animals with animals that are not healthy. If you purchase a new animal and you are not sure if it is healthy, keep it separate from the herd for a few weeks and check the animal for diseases

- **Content/Topic 2 (Cleaning and disinfecting animal shelter)**

Cleaning and disinfecting the house and all equipment is one of the most important aspects of disease prevention. The house and equipment should be completely cleaned and disinfected. Complete cleaning and disinfecting of the house and equipment should include the following aspects:

- ✓ All litter should be completely removed from the houses
- ✓ Spider webs, dirt and other dry debris should be knocked down from the surfaces and completely removed.
- ✓ Cleaning of surfaces- all inside surfaces and equipment should be thoroughly washed, preferably with a high-pressure sprayer. Everything should be allowed to dry prior to disinfection.

- **Content /Topic3 (Wastes disposal, handling and treatment)**

Remove the waste from the vicinity of animals on a daily basis. Disposing of wastes can be done by applying directly in garden. Cover with a layer of the soil to avoid loss of nutrients, bad odour and gathering of breeding flies. Alternatively make a pit into which the waste is emptied on a daily basis. It should be close to the animal house to avoid extra work. It can be a concrete or simple earth pit. The pit should be covered and emptied at variable intervals depending on the capacity. Animal wastes can also be utilized in biogas production.

## L.U.5: MANAGE NUTRITIONAL DEFICIENCIES AND EXCESSES

Nutrition is important for a variety of reasons. Animals need the proper nutrition for growth and maintenance, and to provide energy for work and vital functions.

Proper nutrition is also needed to maintain body temperature, produce milk, reproduce, and develop proper bone structures.

Without proper nutrition, animals can develop health problems, which could result in treatment costs or even fatality. Good nutrition is essential for all of the systems of an animal to function and work together properly.

### L.O:5.1 Manage mineral deficiencies

Animals require essential minerals as part of their feed for tissue growth and regulation of body functions. If one of these minerals is missing in the diet, symptoms of deficiency occur; if any mineral is in excess, the animal experiences toxicity.

In general mineral deficiency is characterized by:

- poor fertility: lack of heat signs and low conception rate
- low milk production
- poorly developed bones in young animals (rickets)
- health disorders, for example, milk fever
- poor body condition, which may be accompanied by a change in coat colour

A more detailed of symptoms of each mineral deficiency are identified below ;

- **CONTENT/ TOPIC (clinical signs of Mineral deficiency)**

- ❖ ☐ Calcium:

- ✓ ☐ Agalactia
- ✓ ☐ Fractures
- ✓ ☐ Hypocalcemia
- ✓ ☐ Milk fever
- ✓ ☐ Osteomalacia
- ✓ ☐ Paralysis
- ✓ ☐ Rickets
- ✓ ☐ Soft shells (poultry)

- ❖ ☐ Iron

- ✓ ☐ Iron deficiency anemia
- ✓ ☐ Poor growth

- ❖ Manganese

- ✓ Ataxia
- ✓ ☐ Infertility
- ✓ ☐ Poor growth

## ❖ Magnesium

- ✓ ☐ Hypomagnesemia tetany (grass tetany)
- ✓ ☐ Infertility
- ✓ ☐ Lameness
- ✓ ☐ Poor growth

## ❖ Phosphorus

- ✓ ☐ Poor growth
- ✓ ☐ Rickets
- ✓ ☐ Soft bones
- ❖ ☐ Potassium
- ✓ ☐ Anorexia
- ✓ ☐ Incoordination
- ✓ ☐ Poor growth
- ❖ ☐ Sodium (salt)
- ✓ ☐ Low water intake
- ✓ ☐ Poor growth
- ❖ ☐ Zinc
- ✓ ☐ Dermatitis/parakeratosis
- ✓ ☐ Poor appetite

**L.O.5.2: Manage vitamins deficiencies**

Vitamins are complex organic substances which are required in small quantities in the diets of animals. They occur in specific foods materials and perform certain specific functions.

When giving food to animals, certain factors have to be considered due to the delicate nature of vitamins. These factors include:

- The temperature at which the feeds are kept in the store. High temperatures cause vitamins to disintegrate, since they are organic compounds. This either reduces or destroys their potential effect on the body.
- Expose an environment that promotes vitamin disintegration through chemical activities such as oxidation.
- Time taken for feeds to be kept in the store. If feeds are stored for long periods, the chances for vitamin to disintegrate will be high.

Failure to observe these factors may cause illness due to lack of vitamins.

The following tables give details on the most important types of vitamin, their sources, specific functions and deficiency symptoms in animals.

**CONTENT/ TOPIC 1 (Clinical signs of Vitamin deficiency)**

- ☐ Anoestrus

- ☐ Dermatitis
- ☐ Infertility
- ☐ Lameness
- ☐ Paralysis
- ☐ Poor appetite
- ☐ Poor growth
- ☐ Poor hoof quality

❖ Vitamin A

- ☐ Infertility
- ☐ Incoordination
- ☐ Poor sight
- ☐ Congenital defects

❖ Vitamin D3

- ☐ Lameness
- ☐ Fractures
- ☐ Rickets
- ☐ Osteomalacia (rubbery bones)

❖ Vitamin E

- ☐ Agalactia
- ☐ Oedema

❖ Vitamin K

- ☐ Haemorrhage by poor blood clotting

### **L.O.5.3: Manage proteins and amino acids deficiencies and disorders**

Amino Acids are the building blocks of the body. When protein is broken down by digestion the result is 22 known amino acids. Eight are essential (cannot be manufactured by the body) the rest are non-essential (can be manufactured by the body with proper nutrition). Sometimes the non-essential should still be supplemented to ensure an optimal available quantity.

Besides building cells and repairing tissue, amino acids form antibodies to combat invading bacteria and virus; they are part of the enzyme and hormonal system; they build nucleoproteins (RNA and DNA); they carry oxygen throughout the body, and are part of all muscular activity.

- Content/Topic 1 (Prevention of protein and amino acids deficiency)

The prevention of protein deficiency requires:

- ✓ The provision of the nutrient requirements of the animals according to age, stage of pregnancy and production, the environmental temperature and the cost of the feeds.
- ✓ Body-condition scoring of cattle and sheep can be used as a guide to monitor body condition and nutritional status.
- ✓ Regular analysis of feed supplies will assist in the overall nutritional management program. The published nutrient requirements of domestic animals are only guidelines to estimated requirements since they were determined in experimental animals

Under practical conditions, all of the common factors that affect requirements must be considered.

#### **CONTENT /TOPIC1(Clinical signs of Proteins and amino acids deficiency)**

- ☐ Alopecia
- ☐ Feather pecking and cannibalism (poultry)
- ☐ Hypoproteinemic oedema
- ☐ Growth retardation
- ☐ Low production (meat, milk, eggs, wool)
- ☐ Low quality of products

#### **CONTENT /TOPIC2 (Manage energy deficiency)**

A deficiency of energy is the most common nutrient deficiency limiting performance of farm animals. There may be inadequate amounts of feed available, or the feed may be of low quality. Supplies of feed may be inadequate because of overgrazing, drought, snow covering, or it may be too expensive to be fed to the animals. Available feed may be of such low quality and digestibility that animals cannot consume enough to meet energy requirements. In some cases, forage may contain a high concentration of water, which limits total energy intake.

❖ clinical signs of energy metabolic disorder

- ☐ Over weight
- ☐ Lameness
- ☐ Ketosis
- ☐ Acetonemia (cattle)
- ☐ Pregnancy toxaemia (sheep)

## APPENDIX

### Appendix 1: Pests of stored feed ingredients

| Insect species            | Grains affected                         |
|---------------------------|-----------------------------------------|
| Weevils                   | Maize, sorghum, wheat, rice,            |
| Lesser grain borer        | Wheat, maize                            |
| Khapra beetles            | Maize, sorghum, wheat, rice             |
| Saw-toothed grain beetles | Maize, wheat, groundnuts                |
| Pulse beetles             | Cowpeas, yams, beans                    |
| Flat beetles              | Beans                                   |
| Angoumois grain moth      | Groundnuts                              |
| Tropical warehouse moth   | Maize, Rice, groundnuts                 |
| Indian meal moth          | Maize, groundnuts                       |
| Rice moth                 | Maize, wheat, rice, sorghum, groundnuts |

### Appendix 2 Nutritive value of feed stuffs(ruminants)

| Feeds | DM(%FM | FU/ kgFM | DCP(g/kg FM) | Ca(g/kgFM ) | P(g/kgFM) |
|-------|--------|----------|--------------|-------------|-----------|
|       |        |          |              |             |           |

|                                            |       |           |       |      |      |
|--------------------------------------------|-------|-----------|-------|------|------|
| <b>I. Green fodder</b>                     |       |           |       |      |      |
| - <b>Pasture grasses in average:</b>       |       |           |       |      |      |
| Rain Season (RS)                           | 22-28 | 0.12-0.15 | 10-11 | 0.6  | 0.25 |
| Dry Season (DS)                            | 25-40 | 0.09-0.12 | 7-10  | 0.5  | 0.20 |
| - <b>Setaria sphacelata</b>                |       |           |       |      |      |
| RS before flowering                        | 18    | 0.15      | 20    | 0.8  | 0.40 |
| RS flowering                               | 20    | 0.13      | 10    | 0.6  | 0.30 |
| RS grains                                  | 28    | 0.12      | 7     | 0.5  | 0.25 |
| RS regrowth 30days                         | 25    | 0.12      | 10    | 0.6  | 0.30 |
| - <b>Pennisetum purpureum</b>              |       |           |       |      |      |
| RS, 1.50m of height (40 days)              | 17    | 0.11      | 15    | 0.8  | 0.40 |
| RS, 2m of height (50days)                  | 20    | 0.13      | 15    | 0.6  | 0.30 |
| RS, 1m of height (40 days)                 | 20    | 0.11      | 15    | 0.7  | 0.35 |
| RS, + 1m of height and yellow              | 25    | 0.10      | 7     | 0.4  | 0.2  |
| - <b>Tripsacum laxum</b>                   |       |           |       |      |      |
| RS, 5 months                               | 25    | 0.13      | 14    | 0.50 | 0.30 |
| RS, 7 Months                               | 27    | 0.16      | 11    | 0.70 |      |
| DS, 5 months (regrowth)                    | 25    | 0.14      | 13    | 0.50 | 0.40 |
| - <b>Desmodium</b>                         |       |           |       |      |      |
| RS, beginning of flowering                 | 22    | 0.16      | 30    | 1.50 | 0.3  |
| RS, flowering                              | 25    | 0.14      | 25    | 1.20 | 0    |
| DR, after flowering                        | 28    | 0.12      | 15    | 0.80 | 0.8  |
| - <b>Mucuna pruriens</b>                   |       |           |       |      |      |
| Before flowering                           | 18    | 0.13      | 21.6  | 1.80 | 0    |
| grains /seeds                              | 86    | 0.91      | 197.8 | 1.29 | 0.70 |
| DS, flowering                              | 28    | 0.15      | 25    | 1    | 0.4  |
| - <b>Luzerne(Medicago sativa, alfalfa)</b> |       |           |       |      |      |
| RS, beginning of flowering                 | 24    | 0.18      | 35    | 2    | 5    |
| RS, flowering                              | 24    | 0.15      | 25    | 1.7  | 0.36 |
| - <b>Stylosanthes gracilis</b>             |       |           |       |      |      |
| RS Before flowering                        | 20    | 0.14      | 25    | 3.0  | 4.3  |
| DS, 45days                                 | 22    | 0.16      | 25    | 3.0  |      |
| DS, 70 days                                | 33    | 0.20      | 30    | 4,0  | 0.70 |
| - banana ( leaves+ trunk )                 | 17    | 0.11      | 10    | 0.1  | 0.70 |
| - Potato vines                             | 18    | 0.13      | 10    | 0.1  |      |
| - Cabbage                                  | 17    | 0.11      | 15    | 0.8  |      |
| - Cabbage pommé                            |       |           |       |      |      |

|                                         |    |      |    |     |  |
|-----------------------------------------|----|------|----|-----|--|
| - <b>Panicum maximum</b><br>RS, 40 days | 17 | 0.10 | 12 | 0.8 |  |
|                                         | 20 | 0.10 | 12 | 0.8 |  |
| DS, 40 days                             |    |      |    |     |  |
| - <b>Andropogon gayanus</b>             |    |      |    |     |  |
| RS, 40days                              | 24 | 0.10 | 12 | 0.8 |  |
| DS, 30 days                             | 24 | 0.14 | 9  | 0.6 |  |

### Appendix 3 Nutritional value of feeds for cattle, sheep and goats (as fed basis or crude matter)

| Feeds                                              | DM (%) | FU   | DCP (g) | Ca (g) | P (g) |
|----------------------------------------------------|--------|------|---------|--------|-------|
| <b>I. Hay ,straw and Stover</b>                    |        |      |         |        |       |
| Stove of rice after harvesting                     | 87     | 0.30 | 9       | 1.7    | 0.7   |
| Stover of sorghum after harvesting                 | 86     | 0.35 | Traces  | 3      | 0.9   |
| Straw of groundnut after harvesting                | 91     | 0.55 | 40      | 8      | 1.5   |
| Straw of soybean after harvesting                  | 84     | 0.25 | 29      | 6      | 1.5   |
| Straw of beans after harvesting                    | 86     | 0.22 | 25      | 4      | 0.8   |
| Straw of peas after harvesting                     | 86     | 0.22 | 39      | 5      | 1     |
| Hay of Alfa alfa                                   | 83     | 0.50 | 100     | 9      | 2     |
| <b>II. Silage</b>                                  |        |      |         |        |       |
| Pennisetum                                         | 22     | 0.11 | 12      | 4      | 0.2   |
| Maize pasty                                        | 27     | 0.12 | 8       | 0.5    | 0.4   |
| <b>III. Cereals and legumes<br/>(grains/seeds)</b> |        |      |         |        |       |
| Barley                                             | 87     | 1    | 70      | 0.5    | 3     |
| Wheat                                              | 87     | 1.05 | 102     | 0.6    | 3.1   |
| Cargo rice                                         | 88     | 0.90 | 66      | 0.7    | 2.2   |
| Broken rice                                        | 91     | 1.06 | 68      | 0.3    | 1.7   |
| Sorghum                                            | 90     | 0.98 | 62      | 0.3    | 3.5   |
| Maize                                              | 86     | 1.11 | 60      | 0.5    | 3     |

|                 |    |      |     |     |     |
|-----------------|----|------|-----|-----|-----|
| Soyabean        | 90 | 1.20 | 337 | 2.5 | 5.9 |
| Beans           | 89 | 0.95 | 200 | 1.2 | 4.5 |
| Mucuna pruriens | 86 | 1.04 | 198 | 1.2 | 4.5 |
| Peas            | 86 | 1.01 | 194 | 0.8 | 4.4 |
| Groundnut       | 94 | 1.50 | 270 | 0.6 | 4.2 |
| Sunflower       | 90 | 1    | 130 | 2.5 | 9   |

**Appendix 4 Nutritional value of feeds for cattle, sheep and goats (as fed basis or crudmatter) Con`d**

| Feeds                             | DM (%) | FU   | DCP (g) | Ca (g) | P (g) |
|-----------------------------------|--------|------|---------|--------|-------|
| <b>IV. Industrial by-products</b> |        |      |         |        |       |
| Groundnut cake                    | 93     | 1.13 | 438     | 1      | 6     |
| Cotton seed cake                  | 94     | 1.13 | 310     | 2.1    | 9.3   |
| Soybean cake                      | 90     | 1.21 | 370     | 2.9    | 6.5   |
| Rice bran                         | 90     | 0.60 | 63      | 1.3    | 7     |
| Rice fine                         | 90     | 0.76 | 81      | 1.4    | 15.6  |

|                        |    |      |     |     |      |
|------------------------|----|------|-----|-----|------|
| Wheat bran             | 88 | 0.75 | 77  | 2   | 8.7  |
| Pollards               | 87 | 0.76 | 121 | 1.3 | 10.5 |
| Mill or wheat run      | 90 | 0.81 | 135 | 1.7 | 12.1 |
| Molasse                | 83 | 0.83 | 0   | 6   | 0.80 |
| Brewers' draff (fresh) | 19 | 0.14 | 33  | 0.5 | 0.7  |
| Yeast                  | 20 | 0.20 | 105 | 0.5 | 3.2  |
| Bagasses               | 89 | 0.31 | 0   | 0.8 | 0.2  |
| Sugar cane tops        | 26 | 0.15 | 9   | -   | -    |

### Appendix 5 Nutritional value of feeds for cattle, sheep and goats (as fed basis or crude matter) cont'd

| Feeds                       | DM (%) | FU   | DCP(g) | Ca (g) | P (g) |
|-----------------------------|--------|------|--------|--------|-------|
| <b>II. Roots and tubers</b> |        |      |        |        |       |
| Canna edulis                | 28     | 0.35 | 50     | 0.3    | 0.4   |
| Sweet potatoes              | 33     | 0.35 | 4      | 0.4    | 0.6   |
| Fresh cassava               | 35     | 0.35 | 0      | 0.5    | 0.4   |
| Cassava meal                | 88     | 0.88 | 1      | 0.5    | 0.4   |
| Fresh yam                   | 29     | 0.29 | 5      | 0.04   | 0.1   |
| Taro (Colocasia esculenta)  | 40     | 0.41 | 12     | 0.04   | 0.1   |
| <b>III. Animal products</b> |        |      |        |        |       |
| Whole milk                  | 12.8   | 0.25 | 35     | 1.2    | 1     |
|                             | 9      | 0.12 | 35     | 1.2    | 1     |

|                            |    |      |     |     |     |
|----------------------------|----|------|-----|-----|-----|
| Fresh skimmed milk         | 93 | 1.10 | 330 | 13  | 11  |
| Powder skimmed milk        | 87 | 0.95 | 700 | 2.1 | 1.8 |
| Blood meal                 | 93 | 0.57 | 450 | 90  | 40  |
| Meat and bone Powder       | 92 | 0.71 | 510 | 54  | 30  |
| Fish meal                  | 93 | 0.39 | 230 | 230 | 104 |
| Bone meal (fresh bone)     | 98 | -    | -   | 350 | 155 |
| Bone meal calcined (burnt) | -  | 2.75 | -   | -   | -   |
| Lard                       |    |      |     |     |     |
| <b>IV. Minerals</b>        | -  | -    | -   | 233 | 176 |
| – Dicalcium phosphate      | -  | -    | -   | 375 | -   |
| – Dietary chalk            |    |      |     |     |     |

### Appendix 6 Nutritive value of feed for pigs and poultry

| Feeds       | FU<br>Pig | ME<br>(Kcal)<br>poultry | CP<br>(g) | DCP (g) |         | Lysine<br>(g) | M+C(g) | Ca<br>(g) | P (g) |
|-------------|-----------|-------------------------|-----------|---------|---------|---------------|--------|-----------|-------|
|             |           |                         |           | Pig     | Poultry |               |        |           |       |
| Barley      | 1         | 2820                    | 98        | 73      | 69      | 3.9           | 4.7    | 0.4       | 3.5   |
| Wheat       | 1.12      | 3145                    | 125       | 101     | 103     | 3.7           | 5      | 0.4       | 3.5   |
| Cargo rice  | 0.92      | 3070                    | 74        | 70      | 70      | 3.5           | 7.5    | 0.5       | 2.8   |
| Broken rice | 1.20      | 3530                    | 75        | 77      | 72      | 3.6           | 7.7    | 0.3       | 1.8   |
| Sorghum     | 1.07      | 3450                    | 91        | 65      | 78      | 2.3           | 3.2    | 0.3       | 3     |

|                     |      |      |     |     |     |      |     |     |     |
|---------------------|------|------|-----|-----|-----|------|-----|-----|-----|
| Maize               | 1.11 | 3240 | 97  | 65  | 64  | 2.9  | 4.3 | 0.2 | 2.7 |
| Backwheat(Sarrasin0 | 0.76 | 2350 | 100 | 75  | 75  | 5.9  | 4.3 | 0.9 | 3.1 |
| Millet              | 0.80 | 3078 | 85  | 33  | 51  | -    | -   | 3.8 | 2.5 |
| Soya bean           | 1.33 | 3700 | 379 | 330 | 320 | 24.7 | 12  | 2.5 | 6   |
| Bean                | 1    | 1635 | 230 | 198 | 97  | 24.2 | 5   | 1.2 | 4.5 |
| Vigna               | 1.10 | 3085 | 232 | 219 | 128 | 13.4 | 6   | 1.2 | 3.1 |
| Pea                 | 0.98 | 2850 | 225 | 202 | 194 | 12.7 | 4   | 0.8 | 4.4 |
| Sunflower           | 0.89 | 2500 | 152 | 126 | 120 | 8    | 22  | 2.5 | 9   |

### Appendix 7. Typical nutrient content of some crop by-products

| By-product                      | DM (%) | CP (%) | CF (%) |
|---------------------------------|--------|--------|--------|
| Sugar cane bagasse              | 95     | 3.0    | 43.1   |
| Rice straw                      | 92     | 4.2    | 42.3   |
| Maize stover                    | 91     | 6.0    | 42.0   |
| Cassava leaves (dried)          | 90     | 24.7   | 17.3   |
| Wheat straw                     | 86     | 4.0    | 42.0   |
| Barley straw                    | 86     | 4.0    | 42.0   |
| Sugar cane tops                 | 26     | 5.0    | 32.6   |
| Sorghum stover                  | 25     | 6.0    | 28.1   |
| Banana stem                     | 5      | 3.2    | 19.1   |
| Lucerne hay<br>(for comparison) | 90     | 19.0   | 25.0   |

DM – dry matter, CP – crude protein, CF – crude fibre



## Appendix 8 Chemical composition of feeds for cattle

| Feed name and description      | Dry matter % | Protein |                  | Energy for small ruminants |              |         | Ca (%) | P (%) |
|--------------------------------|--------------|---------|------------------|----------------------------|--------------|---------|--------|-------|
|                                |              | CP (%)  | Dig. Protein (%) | DE (Mcal/Kg)               | ME (Mcal/Kg) | TDN (%) |        |       |
| Poultry litter                 | 89           | 26.1    | 14.8             | 2.57                       | 2.15         | 60      | 2.25   | 1.80  |
| Cottonseed meal, solv. extd.   | 91           | 41.6    | -                | 2.99                       | 2.57         | 72      | 0.23   | 1.07  |
| Cottonseed meal, mech. extd.   | 92           | 36.5    | 21.2             | 3.23                       | 2.81         | 68      | 0.25   | 1.15  |
| Peanut meal, w pods mech extd. | 93           | 45.3    | 40.4             | 3.33                       | 2.92         | 81      | 0.21   | 0.64  |
| - w some pods solv. extd.      | 90           | 30.8    | 38.4             | 2.81                       | 2.39         | 67      | -      | -     |
| - w/o pods mech. extd.         | 92           | 48.5    | 42.6             | 3.51                       | 3.10         | 80      | 0.22   | 0.71  |
| -w/o pods mech. extd.          | 94           | 46.4    | 42.2             | 4.68                       | 4.27         | 90      | 0.17   | 0.57  |
| Soybean meal, solv. extd.      | 92           | 46.4    | 42.8             | 3.53                       | 3.12         | 88      | 0.33   | 0.72  |
| Sunflower meal, solv. extd.    | 88           | 19.6    | -                | 1.72                       | 1.34         | 37      | 0.25   | 0.85  |
| Brewers grains, dried          | 92           | 21.7    | -                | 2.52                       | 2.13         | 60      | 0.27   | 0.50  |
| Brewers grains, wet            | 24           | 7.1     | 3.8              | 0.68                       | 0.58         | 16      | 0.07   | 0.12  |
| Barley, Grain                  | 90           | 9.8     | 7.8              | 3.10                       | 2.72         | 76      | 0.08   | 0.30  |
| Corn, grain dent white         | 87           | 8.1     | 5.0              | 3.29                       | 2.93         | 82      | 0.04   | 0.26  |
| - bran                         | 90           | 9.6     | 6.9              | 2.86                       | 2.48         | 71      | 0.04   | 0.14  |
| -ears, ground                  | 86           | 7.6     | 4.6              | 2.99                       | 2.63         | 73      | 0.04   | 0.47  |
| Cotton, seeds                  | 90           | 19.9    | -                | 2.84                       | 2.46         | 69      | 0.16   | 0.65  |
| Oats, grain                    | 88           | 10.8    | 9.0              | 2.75                       | 2.39         | 67      | 0.11   | 0.34  |
| Sorghum, grains                | 89           | 11.0    | 7.6              | 3.28                       | 2.92         | 82      | 0.03   | 0.31  |
| Sun flower, seed               | 94           | 16.8    | -                | 3.12                       | 2.73         | 76      | 0.17   | 0.52  |
| Wheat, grain                   | 93           | 11.5    | 9.1              | 3.41                       | 3.02         | 84      | 0.15   | 0.34  |
| - bran                         | 90           | 13.3    | 8.5              | 2.81                       | 2.35         | 65      | 0.14   | 1.27  |
| - mill run, < 9.5% fbr         | 91           | 15.6    | 14.0             | 2.74                       | 2.36         | 69      | 0.45   | 0.23  |
| Oat straw                      | 93           | 4.6     | 0.9              | 2.00                       | 1.60         | 45      | 0.24   | 0.09  |
| Soybean straw                  | 89           | 3.9     | 0.4              | 1.77                       | 1.39         | 39      | 1.30   | 0.05  |
| Wheat straw                    | 92           | 3.1     | 0.9              | 1.97                       | 1.57         | 45      | 0.21   | 0.07  |
| Corn Stover                    | 85           | 5.9     | 1.4              | 2.09                       | 1.73         | 48      | 0.45   | 0.08  |
| Corn cobs                      | 90           | 2.5     | 0.8              | 1.89                       | 1.51         | 42      | 0.11   | 0.04  |

## Appendix 9: Recommended chemical composition of feeds for intensively reared rabbits of different categories

| Components of feed, assumed to contain 89 percent dry matter | Young rabbit (4 to 12 weeks) | Lactating doe | Peri-weaning | Mixed (maternity + fattening) |
|--------------------------------------------------------------|------------------------------|---------------|--------------|-------------------------------|
| Crude proteins (%)                                           | 16                           | 18            | 15           | 17                            |
| Digestible proteins (%)                                      | 11.5                         | 13.3          | 10.8         | 12.4                          |
| <b>Amino acids</b>                                           |                              |               |              |                               |
| Methionine + cystine (%)                                     | 0.60                         | 0.60          | 0.55         | 0.60                          |
| Lysine (%)                                                   | 0.70                         | 0.90          | 0.65         | 0.70                          |
| Arginine (%)                                                 | 0.90                         | 0.80          | 0.80         | 0.90                          |
| Threonine (%)                                                | 0.55                         | 0.70          | 0.55         | 0.60                          |
| Tryptophane (%)                                              | 0.13                         | 0.20          | 0.12         | 0.13                          |
| Histidine (%)                                                | 0.35                         | 0.43          | 0.35         | 0.40                          |
| Isoleucine (%)                                               | 0.60                         | 0.70          | 0.67         | 0.65                          |
| Phenylalanine + tyrosine (%)                                 | 1.20                         | 1.40          | 1.10         | 1.25                          |
| Valine (%)                                                   | 0.70                         | 0.85          | 0.68         | 0.80                          |
| Leucine (%)                                                  | 1.05                         | 1.25          | 1.00         | 1.20                          |
| <b>Energy and bulk</b>                                       |                              |               |              |                               |
| Digestible energy (kcal/kg)                                  | 2500                         | 2650          | 2400         | 2550                          |
| Metabolizable energy (kcal/kg)                               | 2380                         | 2520          | 2280         | 2420                          |
| Fats (%)                                                     | 3-5                          | 4-5           | 3            | 3-4                           |
| Crude fibre (%)                                              |                              |               |              |                               |
| Indigestible crude fibre (%)                                 | 12                           | 10            | 14           | 12                            |
| ADF (%)                                                      | 18                           | 14            | 20           | 18                            |
| Ratio digestible proteins/digestible energy (g/1000 kcal)    | 45                           | 51            | 46           | 48                            |

|                               |      |       |       |       |
|-------------------------------|------|-------|-------|-------|
| <b>Minerals</b>               |      |       |       |       |
| Calcium (%)                   | 0.40 | 1.20  | 1.00  | 1.10  |
| Phosphorus (%)                | 0.30 | 0.50  | 0.50  | 0.60  |
| Potassium (%)                 | 0.60 | 0.90  | 0.60  | 0.90  |
| Sodium (%)                    | 0.30 | 0.30  | 0.30  | 0.30  |
| Chlorine (%)                  | 0.30 | 0.30  | 0.30  | 0.30  |
| Magnesium (%)                 | 0.25 | 0.25  | 0.25  | 0.25  |
| <b>Vitamins</b>               |      |       |       |       |
| Vitamin A (IU/kg)             | 6000 | 10000 | 10000 | 10000 |
| Vitamin D (IU/kg)             | 1000 | 1000  | 1000  | 1000  |
| Vitamin E (ppm)               | 50   | 50    | 50    | 50    |
| Vitamin K (ppm)               | 0    | 2     | 2     | 2     |
| Vitamin C (ppm)               | 0    | 0     | 0     | 0     |
| Vitamin B <sub>1</sub> (ppm)  | 2    | -     | 2     | 2     |
| Vitamin B <sub>2</sub> (ppm)  | 6    | -     | 6     | 4     |
| Vitamin B <sub>6</sub> (ppm)  | 2    | -     | 2     | 2     |
| Vitamin B <sub>12</sub> (ppm) | 0.01 | 0     | 0.01  | 0.01  |
| Folic acid (ppm)              | 5    | -     | 5     | 5     |
| Pantothenic acid (ppm)        | 20   | -     | 20    | 20    |
| Niacin (ppm)                  | 50   | -     | 50    | 50    |
| Biotin (ppm)                  | 0.2  | -     | 0.2   | 0.2   |

Source: Lebas, 1989.

### Appendix 10: Maintenance and growth requirement of bovines

| Live weight (Kg) | DM (kg) | Maintenance |         |        |       |          | Maintenance + 250 DWG |         |        |       |         |
|------------------|---------|-------------|---------|--------|-------|----------|-----------------------|---------|--------|-------|---------|
|                  |         | FU          | DCP(g ) | Ca (g) | P (g) | Salt (g) | UF                    | DCP (g) | Ca (g) | P (g) | Salt(g) |
| 100              | 3.4     | 1.2         | 50      | 5      | 3     | 5        | 1.5                   | 225     | 10     | 5     | 6       |
| 150              | 4.5     | 1.6         | 75      | 8      | 5     | 8        | 2                     | 250     | 12     | 6     | 9       |
| 200              | 5.6     | 2           | 100     | 10     | 6     | 10       | 2.5                   | 275     | 13     | 7     | 11      |
| 250              | 6.7     | 2.4         | 125     | 13     | 8     | 13       | 3                     | 300     | 15     | 10    | 13      |
| 300              | 7.8     | 2.8         | 150     | 15     | 9     | 15       | 3.5                   | 325     | 16     | 12    | 16      |
| 350              | 8.7     | 3.2         | 175     | 18     | 11    | 18       | 3.9                   | 350     | 18     | 14    | 18      |
| 400              | 9.6     | 3.5         | 200     | 20     | 12    | 20       | 4.3                   | 375     | 20     | 15    | 21      |
| 450              | 10.3    | 3.8         | 225     | 23     | 14    | 23       | 4.5                   | 375     | 22     | 18    | 23      |
| 500              | 11      | 4           | 250     | 25     | 15    | 25       | 4.8                   | 375     | 23     | 20    | 26      |
| 550              | 11.5    | 4.3         | 275     | 28     | 17    | 28       | 5                     | 400     | 24     | 23    | 28      |
| 600              | 12      | 4.5         | 300     | 30     | 18    | 30       | 5.3                   | 400     | 25     | 25    | 30      |

**Table 10 (cont'd)**

| Live Weight (Kg) | DM(kg) | Maintenance + 500 g DWG |        |        |       |         | Maintenance + 750 g DWG |         |        |       |         |
|------------------|--------|-------------------------|--------|--------|-------|---------|-------------------------|---------|--------|-------|---------|
|                  |        | FU                      | DCP(g) | Ca (g) | P (g) | Salt(g) | FU                      | DCP (g) | Ca (g) | P (g) | Salt(g) |
| 100              | 3.4    | 2.1                     | 300    | 15     | 8     | 6       | 2.7                     | 340     | 21     | 10    | 7       |
| 150              | 4.5    | 2.6                     | 325    | 17     | 9     | 9       | 3.2                     | 410     | 23     | 11    | 9       |
| 200              | 5.6    | 3.1                     | 350    | 18     | 10    | 11      | 3.7                     | 425     | 24     | 13    | 12      |
| 250              | 6.7    | 3.6                     | 375    | 20     | 13    | 14      | 4.3                     | 450     | 26     | 15    | 14      |
| 300              | 7.8    | 4.2                     | 400    | 21     | 15    | 16      | 5                       | 475     | 27     | 18    | 17      |
| 350              | 8.7    | 4.7                     | 425    | 24     | 18    | 19      | 5.5                     | 500     | 29     | 20    | 19      |
| 400              | 9.6    | 5.1                     | 450    | 26     | 20    | 21      | 6                       | 525     | 30     | 23    | 22      |
| 450              | 10.3   | 5.4                     | 450    | 27     | 23    | 24      | 6.3                     | 525     | 32     | 25    | 24      |
| 500              | 11     | 5.7                     | 450    | 28     | 25    | 26      | 6.5                     | 525     | 33     | -     | 27      |
| 550              | 11.5   | 5.9                     | 475    | 29     | 28    | 29      | 6.8                     | 550     | 35     | 28    | 29      |
| 600              | 12     | 6.2                     | 475    | 30     | 30    | 31      | 7.1                     | 550     | 36     | 30    | 32      |

**DM**= Dry matter, **FU**=Forage Unit, **DCP**= Digestible Crude Protein, **Ca**= calcium, **P**=phosphorus,  
**DWG** = Daily Weight Gain

**Appendix 11: Requirement for milk production (for 1 L of milk)**

| BFC(Butter Fat Content) | FU  | DCP(g) | Ca (g) | P (g) | NaCl (g) |
|-------------------------|-----|--------|--------|-------|----------|
| 38 - 47‰                | 0.4 | 60     | 3      | 2     | 2        |
| 48 - 65‰                | 0.5 | 70     | 3      | 3     | 2        |

Notice: 0.250-0.280kg de DM/L of milk

**Appendix 12: Requirement for gestation (for 100 kg of LW)**

| Stage of gestation     | FU  | DCP (g) | Ca (g) | P (g) | NaCl (g) |
|------------------------|-----|---------|--------|-------|----------|
| 7 <sup>th</sup> months | 0.1 | 15      | 1.5    | 1     | 1        |
| 8 <sup>th</sup> months | 0.2 | 20      | 3      | 1.5   | 1        |
| 9 <sup>th</sup> months | 0.3 | 30      | 2.5    | 1.5   | 1        |

**Appendix 13: Requirement for gestation (for 100 kg of LW)**

| Stage of gestation     | FU  | DCP (g) | Ca (g) | P (g) | NaCl (g) |
|------------------------|-----|---------|--------|-------|----------|
| 7 <sup>th</sup> months | 0.1 | 15      | 1.5    | 1     | 1        |
| 8 <sup>th</sup> months | 0.2 | 20      | 3      | 1.5   | 1        |
| 9 <sup>th</sup> months | 0.3 | 30      | 2.5    | 1.5   | 1        |

**Appendix 14: Requirement for maintenance and milk production**

| Production<br>(L) | Cow of 400 kg of Live weight |      |        |       |      |         | Cow of 500 kg of Live weight |      |        |       |      |         |
|-------------------|------------------------------|------|--------|-------|------|---------|------------------------------|------|--------|-------|------|---------|
|                   | DM(kg)                       | FU   | DCP(g) | Ca(g) | P(g) | Salt(g) | DM(kg)                       | FU   | DCP(g) | Ca(g) | P(g) | Salt(g) |
| 4                 | 9-10                         | 5.1  | 480    | 30    | 20   | 28      | 10-11                        | 5.4  | 540    | 35    | 23   | 33      |
| 5                 | 10                           | 5.9  | 600    | 36    | 24   | 32      | 11                           | 6.2  | 660    | 41    | 27   | 37      |
| 8                 | 10-11                        | 6.7  | 720    | 42    | 28   | 36      | 11-12                        | 7    | 780    | 47    | 31   | 41      |
| 10                | 11                           | 7.5  | 840    | 48    | 32   | 40      | 12                           | 7.8  | 900    | 53    | 35   | 45      |
| 12                | 11-12                        | 8.3  | 960    | 54    | 36   | 44      | 12-13                        | 8.6  | 1020   | 59    | 39   | 49      |
| 14                | 12                           | 9.1  | 1080   | 60    | 40   | 48      | 13                           | 9.4  | 1140   | 65    | 43   | 50      |
| 15                | 12-13                        | 9.9  | 1200   | 65    | 44   | 52      | 13-14                        | 10.2 | 1260   | 71    | 47   | 57      |
| 18                | 13                           | 10.7 | 1320   | 72    | 49   | 56      | 14                           | 11   | 1380   | 77    | 51   | 61      |
| 20                | 13-14                        | 11.5 | 1440   | 78    | 52   | 60      | 14-15                        | 11.8 | 1500   | 83    | 55   | 65      |
| 22                | 14                           | 12.3 | 1560   | 84    | 56   | 64      | 15                           | 12.5 | 1520   | 89    | 59   | 69      |
| 24                | 14-15                        | 13.1 | 1680   | 90    | 60   | 68      | 15-16                        | 13.4 | 1740   | 95    | 63   | 73      |

### Appendix 15: Nutritional requirement of cattle

| (400 kg)<br>Head per day | Unit | Cows lacta-<br>tion and after<br>weaning | Lactating<br>cows first<br>1/2 of lacta-<br>tion | Dry pregnant<br>cows 2<br>months before<br>calving | Heifer 1<br>month, 40 kg<br>and growth<br>650 g/day |
|--------------------------|------|------------------------------------------|--------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|
| <b>Feed unit</b>         | --   | 6.70                                     | 8.30                                             | 6.40                                               | 2.30                                                |
| <b>Exchange energy</b>   | MJ   | 82.00                                    | 98.00                                            | 79.00                                              | 16.90                                               |
| <b>Dry matter</b>        | g    | 10.50                                    | 12.00                                            | 9.80                                               | 0.80                                                |
| <b>Digest protein</b>    | g    | 570.00                                   | 780.00                                           | 704.00                                             | 220.00                                              |
| <b>Fat</b>               | g    | 214.00                                   | 266.00                                           | 211.00                                             | 190.00                                              |
| <b>Fiber</b>             | g    | 3015.00                                  | 3400.00                                          | 2867.00                                            | 65.00                                               |
| <b>Sugar</b>             | g    | 489.00                                   | 626.00                                           | 540.00                                             | 200.00                                              |
| <b>Calcium</b>           | g    | 50.00                                    | 63.00                                            | 60.00                                              | 10.00                                               |
| <b>Phosphorus</b>        | g    | 27.00                                    | 36.00                                            | 35.00                                              | 5.00                                                |
| <b>Magnesium</b>         | g    | 0.00                                     | 0.00                                             | 0.00                                               | 0.00                                                |
| <b>Potassium</b>         | g    | 0.00                                     | 0.00                                             | 0.00                                               | 0.00                                                |
| <b>Sulfur</b>            | g    | 19.00                                    | 23.00                                            | 18.00                                              | 0.00                                                |
| <b>Hardware</b>          | mg   | 526.00                                   | 720.00                                           | 492.00                                             | 40.00                                               |
| <b>Copper</b>            | mg   | 70.00                                    | 86.00                                            | 68.00                                              | 6.00                                                |
| <b>Zinc</b>              | mg   | 302.00                                   | 448.00                                           | 324.00                                             | 35.00                                               |
| <b>Manganese</b>         | mg   | 475.00                                   | 604.00                                           | 440.00                                             | 30.00                                               |
| <b>Cobalt</b>            | mg   | 5.40                                     | 7.20                                             | 4.80                                               | 0.50                                                |
| <b>Iodine</b>            | mg   | 4.00                                     | 6.00                                             | 4.50                                               | 0.30                                                |
| <b>Carotene</b>          | mg   | 248.00                                   | 320.00                                           | 250.00                                             | 30.00                                               |
| <b>Vitamin D</b>         | MO   | 5.40                                     | 7.60                                             | 6.40                                               | 700.00                                              |
| <b>Vitamin E</b>         | mg   | 234.00                                   | 315.00                                           | 256.00                                             | 30.00                                               |

**Appendix 16: Daily Nutrient requirements of Sheep (Ewes and Lambs  
Maintenance, Growth, non-lactating and first 15 weeks of gestation)**

| Body weight<br>(kg) | Daily<br>gain (g) | Dry matter intake |          | Energy    |             | Protein   |                | Ca (g) | P (g) |
|---------------------|-------------------|-------------------|----------|-----------|-------------|-----------|----------------|--------|-------|
|                     |                   | Kg/day            | % Live W | ME (Mcal) | TDN<br>(Kg) | Total (g) | Digestible (g) |        |       |
| 10                  | 0                 | .33               | 3.3      | .52       | .14         | 26        | 12             | 2.2    | 1.5   |
|                     | 25                | .36               | 3.6      | .64       | .18         | 30        | 15             | 2.2    | 1.5   |
|                     | 50                | .39               | 3.9      | .76       | .21         | 35        | 18             | 2.3    | 1.5   |
|                     | 100               | .42               | 4.2      | 1.00      | .28         | 43        | 24             | 2.3    | 1.6   |
|                     | 150               | .39               | 3.9      | 1.24      | .34         | 49        | 30             | 2.4    | 1.6   |
| 15                  | 0                 | .45               | 3.0      | .71       | .20         | 36        | 17             | 2.7    | 1.7   |
|                     | 25                | .49               | 3.3      | .87       | .24         | 42        | 21             | 2.7    | 1.7   |
|                     | 50                | .53               | 3.5      | 1.04      | .29         | 49        | 25             | 2.8    | 1.8   |
|                     | 100               | .56               | 3.7      | 1.37      | .38         | 58        | 33             | 2.9    | 1.9   |
|                     | 150               | .52               | 3.5      | 1.69      | .47         | 65        | 41             | 3.0    | 2.0   |
| 20                  | 0                 | .55               | 2.8      | 0.88      | .24         | 44        | 21             | 3.2    | 2.1   |
|                     | 25                | .61               | 3.0      | 1.08      | .30         | 52        | 26             | 3.2    | 2.2   |
|                     | 50                | .66               | 3.3      | 1.29      | .36         | 59        | 31             | 3.3    | 2.3   |
|                     | 100               | .71               | 3.6      | 1.69      | .47         | 72        | 41             | 3.4    | 2.4   |
|                     | 150               | .65               | 3.3      | 2.10      | .58         | 81        | 50             | 3.6    | 2.4   |
| 25                  | 0                 | .65               | 2.6      | 1.04      | .29         | 53        | 25             | 4.0    | 2.6   |
|                     | 25                | .72               | 2.9      | 1.28      | .36         | 61        | 31             | 4.1    | 2.7   |
|                     | 50                | .78               | 3.1      | 1.52      | .42         | 70        | 36             | 4.1    | 2.7   |
|                     | 100               | .83               | 3.3      | 2.00      | .55         | 85        | 48             | 4.2    | 2.8   |
|                     | 150               | .77               | 3.1      | 2.48      | .69         | 96        | 60             | 4.3    | 2.9   |
| 30                  | 0                 | .75               | 2.5      | 1.19      | .33         | 59        | 27             | 4.4    | 3.0   |
|                     | 50                | .89               | 3.0      | 1.74      | .48         | 81        | 42             | 4.6    | 3.1   |
|                     | 100               | .95               | 3.0      | 2.29      | .63         | 98        | 55             | 4.8    | 3.2   |
|                     | 125               | .94               | 3.1      | 2.57      | .72         | 103       | 60             | 4.9    | 3.3   |
|                     | 140               | .87               | 2.9      | 2.73      | .75         | 106       | 66             | 5.0    | 3.3   |
| 35                  | 0                 | .85               | 2.4      | 1.34      | .37         | 68        | 32             | 5.6    | 3.1   |
|                     | 50                | .99               | 2.8      | 1.96      | .54         | 100       | 47             | 5.7    | 3.1   |
|                     | 100               | 1.07              | 3.1      | 2.58      | .71         | 111       | 62             | 5.8    | 3.2   |
|                     | 125               | 1.06              | 3.1      | 2.89      | .80         | 117       | 69             | 5.9    | 3.3   |
|                     | 140               | .98               | 2.8      | 3.07      | .85         | 121       | 74             | 5.9    | 3.4   |

# **Appendix 17: Daily Nutrient requirements of Sheep(Early weaned lambs of 5 to 30 Kg)**

| Maintenance and Growth |                |                   |               |           |          |           |                |        |       |
|------------------------|----------------|-------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
| Body weight (kg)       | Daily gain (g) | Dry matter intake |               | Energy    |          | Protein   |                | Ca (g) | P (g) |
|                        |                | Kg/day            | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 5                      | 50             | .10               | 2.0           | .44       | .12      | 36        | 29             | 1.8    | 1.3   |
|                        | 100            | .12               | 2.3           | .50       | .14      | 45        | 36             | 1.8    | 1.3   |
|                        | 150            | .13               | 2.7           | .57       | .15      | 48        | 38             | 1.9    | 1.3   |
|                        | 200            | .15               | 3.0           | .64       | .17      | 54        | 43             | 1.9    | 1.3   |
|                        | 250            | .16               | 3.2           | .69       | .19      | 58        | 46             | 2.0    | 1.4   |
| 10                     | 50             | .18               | 1.8           | .73       | .20      | 61        | 49             | 2.1    | 1.5   |
|                        | 100            | .21               | 2.1           | .84       | .23      | 70        | 56             | 2.1    | 1.5   |
|                        | 150            | .24               | 2.4           | .96       | .27      | 80        | 64             | 2.2    | 1.5   |
|                        | 200            | .27               | 2.7           | 1.07      | .30      | 90        | 72             | 2.3    | 1.6   |
|                        | 250            | .30               | 3.0           | 1.18      | .33      | 99        | 79             | 2.4    | 1.7   |
| 15                     | 50             | .26               | 1.7           | .99       | .27      | 82        | 66             | 2.6    | 1.8   |
|                        | 100            | .30               | 2.0           | 1.14      | .31      | 95        | 76             | 2.7    | 1.8   |
|                        | 150            | .34               | 2.3           | 1.30      | .36      | 109       | 87             | 2.7    | 1.9   |
|                        | 200            | .38               | 2.5           | 1.45      | .40      | 121       | 97             | 2.8    | 2.0   |
|                        | 250            | .42               | 2.8           | 1.60      | .44      | 134       | 107            | 2.9    | 2.0   |
| 20                     | 100            | .41               | 2.0           | 1.42      | .39      | 119       | 95             | 3.1    | 2.2   |
|                        | 150            | .46               | 2.3           | 1.61      | .44      | 135       | 108            | 3.2    | 2.2   |
|                        | 200            | .51               | 2.6           | 1.80      | .50      | 150       | 120            | 3.4    | 2.4   |
|                        | 250            | .57               | 2.8           | 1.99      | .55      | 166       | 133            | 3.5    | 2.4   |
| 25                     | 100            | .47               | 1.9           | 1.47      | .41      | 122       | 98             | 4.0    | 2.8   |
|                        | 150            | .55               | 2.2           | 1.69      | .47      | 141       | 113            | 4.0    | 2.8   |
|                        | 200            | .62               | 2.5           | 1.91      | .53      | 160       | 128            | 4.1    | 2.8   |
|                        | 250            | .69               | 2.8           | 2.14      | .59      | 179       | 143            | 4.2    | 2.9   |
|                        | 300            | .76               | 3.0           | 2.36      | .65      | 198       | 158            | 4.3    | 3.0   |
| 30                     | 100            | .64               | 2.1           | 1.92      | .53      | 161       | 129            | 4.6    | 3.2   |
|                        | 150            | .73               | 2.4           | 2.18      | .60      | 182       | 146            | 4.7    | 3.2   |
|                        | 200            | .81               | 2.7           | 2.44      | .67      | 204       | 163            | 4.8    | 3.3   |
|                        | 250            | .90               | 3.0           | 2.69      | .74      | 225       | 180            | 4.9    | 3.3   |

### Appendix18: Daily Nutrient requirements of Sheep (Maintenance, Growth, Non lactating and First 15 weeks of Gestation)

| Body weight (kg) | Daily gain (g) | Dry matter intake |               | Energy    |          | Protein   |                | Ca (g) | P (g) |
|------------------|----------------|-------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
|                  |                | Kg/day            | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 40               | 0              | .93               | 2.3           | 1.48      | .41      | 75        | 36             | 5.7    | 3.1   |
|                  | 50             | 1.10              | 2.8           | 2.16      | .60      | 100       | 52             | 5.7    | 3.1   |
|                  | 100            | 1.19              | 3.0           | 2.85      | .79      | 121       | 68             | 5.9    | 3.2   |
|                  | 125            | 1.18              | 3.0           | 3.19      | .88      | 131       | 77             | 6.0    | 3.3   |
|                  | 140            | 1.10              | 2.7           | 3.40      | .94      | 133       | 82             | 6.1    | 3.4   |
|                  |                |                   |               |           |          |           |                |        |       |
| 50               | 0              | 1.10              | 2.2           | 1.75      | .48      | 89        | 42             | 5.9    | 3.1   |
|                  | 50             | 1.30              | 2.6           | 2.56      | .71      | 118       | 61             | 6.0    | 3.3   |
|                  | 100            | 1.41              | 2.8           | 3.37      | .93      | 144       | 81             | 6.1    | 3.4   |
|                  | 125            | 1.40              | 2.8           | 3.77      | 1.04     | 154       | 90             | 6.2    | 3.4   |
|                  | 140            | 1.30              | 2.6           | 4.01      | 1.11     | 157       | 96             | 6.3    | 3.5   |
|                  |                |                   |               |           |          |           |                |        |       |
| 60               | 0              | 1.27              | 2.1           | 2.00      | .55      | 102       | 48             | 6.0    | 3.1   |
|                  | 50             | 1.50              | 2.5           | 2.93      | .81      | 135       | 70             | 6.2    | 3.3   |
|                  | 100            | 1.60              | 2.7           | 3.85      | 1.06     | 164       | 92             | 6.4    | 3.5   |
|                  | 125            | 1.60              | 2.7           | 4.32      | 1.19     | 177       | 104            | 6.5    | 3.5   |
|                  | 140            | 1.48              | 2.5           | 4.60      | 1.27     | 180       | 110            | 6.5    | 3.6   |

### Appendix 19: Daily Nutrient requirements of Sheep (Last 6 weeks of Gestation or Last 8 Weeks of Lactation)

| Body weight (kg) | Daily gain (g) | Dry matter intake |               | Energy    |          | Protein   |                | Ca (g) | P (g) |
|------------------|----------------|-------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
|                  |                | Kg/day            | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 20               | 100            | .90               | 4.5           | 2.31      | .64      | 103       | 62             | 3.9    | 3.7   |
| 30               | 125            | 1.20              | 4.0           | 3.42      | .94      | 148       | 92             | 3.9    | 3.7   |
| 40               | 100            | 1.48              | 3.7           | 3.90      | 1.08     | 174       | 105            | 4.0    | 3.8   |
| 50               | 75             | 1.70              | 3.4           | 4.20      | 1.16     | 191       | 113            | 4.1    | 3.9   |
| 60               | 50             | 1.80              | 3.0           | 4.35      | 1.20     | 199       | 117            | 4.4    | 4.1   |
| 70               | 25             | 1.96              | 3.8           | 4.37      | 1.21     | 206       | 118            | 4.5    | 4.3   |

Source: Kearn, 1982

## Appendix 20: Daily Nutrient requirements of Sheep (First 8 weeks of Lactation)

| Body weight (kg) | Daily gain (g) | Dry matter intake Kg/day | Energy        |           |          | Protein   |                | Ca (g) | P (g) |
|------------------|----------------|--------------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
|                  |                |                          | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 20               | 5              | .99                      | 5.0           | 2.34      | .55      | 105       | 60             | 9.5    | 6.9   |
| 30               | 5              | 1.35                     | 4.5           | 2.99      | .75      | 143       | 82             | 9.8    | 7.1   |
| 40               | -10            | 1.67                     | 4.2           | 3.37      | .93      | 176       | 101            | 10.4   | 7.4   |
| 50               | -20            | 1.97                     | 3.9           | 3.99      | 1.10     | 209       | 120            | 10.9   | 7.8   |

Source: Kearl, 1982

## Appendix 21: Daily Nutrient requirements of Sheep (Rams)

| Maintenance and Growth |                |                   |               |           |          |           |                |        |       |
|------------------------|----------------|-------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
| Body weight (kg)       | Daily gain (g) | Dry matter intake |               | Energy    |          | Protein   |                | Ca (g) | P (g) |
|                        |                | Kg/day            | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 30                     | 120            | 1.15              | 3.8           | 2.59      | .72      | 113       | 62             | 5.9    | 3.2   |
| 40                     | 110            | 1.43              | 3.6           | 3.07      | .85      | 137       | 74             | 6.3    | 3.5   |
| 50                     | 100            | 1.69              | 3.4           | 3.48      | .96      | 159       | 84             | 6.8    | 3.8   |
| 60                     | 100            | 1.94              | 3.2           | 3.99      | 1.10     | 181       | 96             | 7.2    | 4.0   |
| 70                     | 80             | 2.18              | 3.1           | 4.08      | 1.13     | 194       | 98             | 7.5    | 4.3   |

Source: Kearl, 1982

## Appendix 22: Daily Nutrient Requirements of Goats (Maintenance, Growth and Early gestation

| Body weight (kg) | Daily gain (g) | Dry matter intake |               | Energy    |          | Protein   |                | Ca (g) | P (g) |
|------------------|----------------|-------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
|                  |                | Kg/day            | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 5                | 0              | .19               | 3.8           | .35       | .10      | 15        | 10             | .5     | .4    |
|                  | 25             | .22               | 4.4           | .52       | .14      | 22        | 15             | .8     | .6    |
|                  | 50             | .21               | 4.2           | .69       | .19      | 29        | 20             | 1.1    | .9    |
| 10               | 0              | .32               | 3.2           | .58       | .16      | 25        | 17             | .9     | .7    |
|                  | 25             | .36               | 3.6           | .75       | .21      | 32        | 22             | 1.2    | .9    |
|                  | 50             | .37               | 3.7           | .92       | .25      | 39        | 26             | 1.5    | 1.2   |
|                  | 75             | .35               | 3.5           | 1.09      | .30      | 46        | 31             | 1.9    | 1.5   |
| 15               | 0              | .44               | 2.9           | .79       | .22      | 33        | 23             | 1.2    | .9    |
|                  | 25             | .45               | 3.0           | .86       | .24      | 36        | 25             | 1.5    | 1.1   |
|                  | 50             | .50               | 3.3           | 1.13      | .31      | 48        | 33             | 1.9    | 1.4   |
|                  | 75             | .50               | 3.3           | 1.30      | .36      | 55        | 37             | 2.2    | 1.7   |
| 20               | 0              | .54               | 2.7           | .98       | .27      | 41        | 28             | 1.5    | 1.1   |
|                  | 25             | .58               | 2.9           | 1.15      | .32      | 49        | 33             | 1.8    | 1.3   |
|                  | 50             | .60               | 3.0           | 1.32      | .36      | 56        | 38             | 2.1    | 1.6   |
|                  | 75             | .62               | 3.1           | 1.49      | .41      | 63        | 43             | 2.4    | 1.9   |
|                  | 100            | .62               | 3.1           | 1.66      | .46      | 70        | 48             | 2.8    | 2.1   |
| 25               | 0              | .64               | 2.7           | 1.16      | .32      | 49        | 33             | 1.8    | 1.3   |
|                  | 25             | .68               | 2.7           | 1.33      | .37      | 56        | 38             | 2.1    | 1.5   |
|                  | 50             | .71               | 2.8           | 1.50      | .41      | 63        | 43             | 2.4    | 1.8   |
|                  | 75             | .73               | 2.9           | 1.67      | .46      | 71        | 48             | 2.7    | 2.1   |
|                  | 100            | .74               | 3.0           | 1.84      | .51      | 78        | 53             | 3.1    | 2.3   |
|                  | 125            | .71               | 2.8           | 2.03      | .56      | 86        | 58             | 3.4    | 2.5   |
| 30               | 0              | .74               | 2.5           | 1.33      | .37      | 56        | 38             | 2.1    | 1.5   |
|                  | 25             | .77               | 2.6           | 1.50      | .41      | 63        | 43             | 2.4    | 1.7   |
|                  | 50             | .80               | 2.7           | 1.67      | .46      | 71        | 48             | 2.7    | 2.0   |
|                  | 75             | .83               | 2.8           | 1.84      | .51      | 78        | 53             | 3.1    | 2.3   |
|                  | 100            | .84               | 2.8           | 2.01      | .56      | 89        | 58             | 3.4    | 2.5   |
|                  | 125            | .84               | 2.8           | 2.18      | .60      | 92        | 63             | 3.7    | 2.7   |

## Appendix 22 (Continued).

| Body weight (kg) | Daily gain (g) | Dry matter intake |               | Energy    |          | Protein   |                | Ca (g) | P (g) |
|------------------|----------------|-------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
|                  |                | Kg/day            | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 50               | 0              | 1.08              | 2.2           | 1.94      | .54      | 82        | 56             | 3.0    | 2.3   |
|                  | 50             | 1.15              | 2.3           | 2.28      | .63      | 96        | 66             | 3.6    | 2.8   |
|                  | 100            | 1.20              | 2.4           | 2.62      | .72      | 111       | 75             | 4.3    | 3.3   |
|                  | 125            | 1.23              | 2.5           | 2.79      | .77      | 118       | 80             | 4.6    | 3.5   |
|                  | 150            | 1.24              | 2.5           | 2.96      | .82      | 125       | 85             | 5.0    | 3.8   |
|                  | 175            | 1.24              | 2.5           | 3.13      | .86      | 132       | 90             | 5.3    | 4.1   |
| 60               | 0              | 1.24              | 2.1           | 2.23      | .62      | 94        | 64             | 3.4    | 2.6   |
|                  | 50             | 1.31              | 2.2           | 2.57      | .71      | 109       | 74             | 4.0    | 3.1   |
|                  | 100            | 1.37              | 2.3           | 2.90      | .80      | 123       | 84             | 4.7    | 3.6   |
|                  | 125            | 1.40              | 2.3           | 3.17      | .88      | 134       | 91             | 5.0    | 3.8   |
|                  | 150            | 1.42              | 2.4           | 3.34      | .92      | 141       | 96             | 5.4    | 4.1   |
|                  | 175            | 1.42              | 2.4           | 3.51      | .97      | 148       | 101            | 5.7    | 4.4   |
| 70               | 0              | 1.40              | 2.0           | 2.50      | .69      | 106       | 72             | 3.9    | 2.9   |
|                  | 50             | 1.46              | 2.1           | 2.84      | .78      | 120       | 82             | 4.5    | 3.4   |
|                  | 100            | 1.52              | 2.2           | 3.18      | .88      | 135       | 92             | 5.2    | 3.9   |
|                  | 125            | 1.55              | 2.2           | 3.35      | .93      | 142       | 96             | 5.5    | 4.1   |
|                  | 150            | 1.57              | 2.2           | 3.52      | .97      | 149       | 101            | 5.9    | 4.4   |
|                  | 200            | 1.59              | 2.3           | 3.86      | 1.07     | 163       | 111            | 6.2    | 4.9   |

Source: Kearn, 1982

### Appendix 23: Daily Requirements of Goats (Last 8 weeks of Gestation & Last 8 weeks of Lactation)

| Body weight (kg)            | Daily gain (g) | Dry matter intake |               | Energy    |          | Protein   |                | Ca (g) | P (g) |
|-----------------------------|----------------|-------------------|---------------|-----------|----------|-----------|----------------|--------|-------|
|                             |                | Kg/day            | % Live weight | ME (Mcal) | TDN (Kg) | Total (g) | Digestible (g) |        |       |
| 20                          | 100            | .72               | 3.6           | 2.17      | .60      | 92        | 90             | 3.0    | 2.1   |
| 25                          | 100            | .85               | 3.4           | 2.57      | .71      | 109       | 95             | 3.0    | 2.1   |
| 30                          | 100            | .98               | 3.3           | 2.71      | .75      | 115       | 100            | 4.0    | 2.8   |
| 35                          | 120            | 1.10              | 3.1           | 2.76      | .76      | 117       | 110            | 4.0    | 2.8   |
| 40                          | 120            | 1.21              | 3.0           | 3.05      | .84      | 129       | 115            | 4.0    | 2.8   |
| 50                          | 120            | 1.43              | 2.9           | 3.61      | 1.00     | 153       | 120            | 5.0    | 3.5   |
| 60                          | 120            | 1.65              | 2.8           | 4.13      | 1.14     | 175       | 129            | 5.0    | 3.5   |
| First 10 Weeks of Lactation |                |                   |               |           |          |           |                |        |       |
| 20                          | -20            | 1.13              | 5.6           | 2.74      | .76      | 116       | 88             | 4.0    | 2.8   |
| 25                          | -20            | 1.34              | 5.4           | 3.02      | .83      | 128       | 97             | 4.0    | 2.8   |
| 30                          | -20            | 1.53              | 5.1           | 3.29      | .91      | 139       | 105            | 5.0    | 3.5   |
| 35                          | -20            | 1.72              | 4.9           | 3.54      | .98      | 150       | 113            | 5.0    | 3.5   |
| 40                          | -20            | 1.90              | 4.8           | 3.79      | 1.05     | 160       | 121            | 5.0    | 3.5   |
| 50                          | -20            | 2.25              | 4.5           | 4.16      | 1.15     | 176       | 133            | 6.0    | 4.2   |
| 60                          | -20            | 2.58              | 4.3           | 4.71      | 1.30     | 199       | 151            | 6.0    | 4.2   |

Source: kearl, 1982

- Dry matter intake calculated as 76.3 g/Wkg<sup>0.75</sup>.
- Twenty percent was added to the ME requirement for first kidding goats (20 to 25 kg weights) and 10% for second kidding goats ( 40 kg weight) to compensate for body growth.
- Includes ME requirement for 1 kg 4% FCM.

**Appendix 24: Nutrient requirement for energy, protein, amino acid and minerals for pig in reproduction stage and pig in growing stage (in % of feed)**

| Physiological stage                                                                        | Sow in gestation  | Sow in lactation  |
|--------------------------------------------------------------------------------------------|-------------------|-------------------|
| 1. energy (Kcal DE/Kg of feed)<br>- scale of variation<br>-average of energy concentration | 2800-3300<br>3000 | 3000-3300<br>3100 |
| 2. Crude protein (%)                                                                       | 12                | 14                |
| 3. Lysine                                                                                  | 0.40              | 0.60              |
| 4. M + C                                                                                   | 0.27              | 0.33              |
| 5. Ca                                                                                      | 1.00              | 0.80              |
| 6. Total P                                                                                 | 0.55              | 0.76              |
| 7. Available P                                                                             | 0.27              | 0.38              |
| 7. Na Cl                                                                                   | 0.5               | 0.5               |
| 8. Amount of feed /day (kg)                                                                | 2.5               | 4.5-5.5           |
| 9. Energy supplied/day (kcal DE)                                                           | 7500              | 14000-17000       |

**NB: ME= 0, 95 DE**

**Appendix 25: Chicken nutrient requirements**

| Nutrient          | Starter (0-8sem) | Grower (9 – 20 weeks) | Layer (21- 72-80 week) | Parent stock (21 weeks and over) | Starter broilers (0-3weeks) | Growth-finishing (4-8weeks.) |
|-------------------|------------------|-----------------------|------------------------|----------------------------------|-----------------------------|------------------------------|
| ME (kcal/kg)      | 2800             | 2600                  | 2650                   | 2700                             | 2900                        | 3000                         |
| CP %, min         | 20               | 16                    | 18                     | 18.5                             | 22                          | 19-22                        |
| Lysine %, min     | 1                | 0.7                   | 0.5                    | 0.5                              | 1.2                         | 1.2                          |
| Methionine %, min | 0.45             | 0.25                  | 0.25                   | 0.25                             | 0.45                        | 0.35                         |
| Na, g/kg          | 1.5              | 1.5                   | 1.5                    | 1..5                             | 1.5                         | 1.5                          |
| Ca %, min         | 1                | 1                     | 3-3.5                  | 3-3.5                            | 1                           | 1                            |
| P %, min          | 0.5              | 0.5                   | 0.5                    | 0.5                              | 0.5                         | 0.5                          |

|                         |       |       |       |       |       |       |
|-------------------------|-------|-------|-------|-------|-------|-------|
| Ratio<br>energy/protein | 140:1 | 162:1 | 147:1 | 146:1 | 132:1 | 158:1 |
|-------------------------|-------|-------|-------|-------|-------|-------|

### Appendix 26: Amount of feed and water required in poultry feeding (broilers)

| Weeks (age) | Amount of feed (g)<br>per day | Amount of water(ml) per day | Average body weight(g) |
|-------------|-------------------------------|-----------------------------|------------------------|
| 1           | 20                            | 40-50                       | 130-150                |
| 2           | 30                            | 60-80                       | 260-300                |
| 3           | 50                            | 100-120                     | 460-520                |
| 4           | 70                            | 140-160                     | 750-800                |
| 5           | 90                            | 180-200                     | 1000-1200              |
| 6           | 105                           | 210-230                     | 1300-1500              |
| 7           | 115                           | 230-280                     | 1600-1800              |
| 8           | 120                           | 240-300                     | 1900-2300              |
| 9           | 125                           | 250-320                     | 2100-2300              |
| 10          | 130                           | 260-350                     | 2200-2400              |

### Appendix 27: Amount of feed and water required in poultry feeding (layers)

| Weeks | Amount of feeds | Amount of water(ml) | Average body weight |
|-------|-----------------|---------------------|---------------------|
| 1     | 10              | 20-30               | 50                  |
| 2     | 20              | 40-50               | 100                 |
| 3     | 25              | 50-60               | 150                 |
| 4     | 30              | 60-70               | 200                 |
| 5     | 35              | 70-80               | 300                 |
| 6     | 40              | 80-100              | 400                 |
| 7     | 45              | 100-120             | 500                 |
| 8     | 50              | 120-130             | 650                 |
| 9     | 55              | 130-140             | 800                 |
| 10    | 60              | 150-160             | 900                 |
| 11    | 60              | 160-165             | 1000                |
| 12    | 65              | 165-170             | 1100                |
| 13    | 65              | 170-175             | 1200                |
| 14    | 70              | 175-180             | 1300                |
| 15    | 70              | 180-190             | 1400                |
| 16    | 75              | 190-195             | 1500                |
| 17    | 80              | 195-200             | 1600                |

|             |         |         |      |
|-------------|---------|---------|------|
| 18          | 85      | 205-210 | 1700 |
| 19          | 90      | 210-220 | 1750 |
| 20          | 95      | 220-230 | 1800 |
| Laying hens | 120-130 | 240-260 | 2000 |

## Appendix 28: Source of macro minerals and symptoms of their deficiency

| Mineral                        | Source of supply                                                                                                                                                                                                                                                       | Role within the body                                                                                                                                                                                                                                                                                                | Deficiency symptoms                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Calcium and Phosphorus         | <ul style="list-style-type: none"> <li>Vegetable and some fruits.</li> <li>Legumes, cereal grains, grass, calcium, diphosphate.</li> <li>Feeds supplemented with smashed limestone and shell.</li> <li>Milk and milk products,</li> <li>eggs and bone meal.</li> </ul> | <ul style="list-style-type: none"> <li>Hardening of bones, teeth and eggs shells. About 95 per cent phosphorous and about 95 percent of calcium is found in skeleton and teeth.</li> <li>Required for blood plasma formation, promotes clotting of blood.</li> <li>Controls muscle and nerve activities.</li> </ul> | <ul style="list-style-type: none"> <li>Occurrence of ricket (bone disease).characterized by weak, soft and deformed bones especially in piglets, calves and lamb.</li> <li>In lactating animal, it causes milk fever characterized by muscular spasm, paralysis and coma.</li> <li>Anorexia- loss of appetite that leads to loss of weight, reduced growth and rough coat.</li> <li>Very poor teeth formation and development.</li> <li>Oestemalacia-bones become soft as calcium and phosphorous is removed for metabolic activities. <ul style="list-style-type: none"> <li>Lambing sickness in ewes.</li> <li>Lower productivity, e.g eggs and milk.</li> </ul> </li> </ul> |
| Sodium, potassium and chloride | Vegetable crops, salt lick                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>Component of body fluids in particular intercellular fluid and blood.</li> <li>Neutralizes acids within the rumen thus helping to maintain pH equilibrium.</li> <li>Controls muscular and</li> </ul>                                                                         | <ul style="list-style-type: none"> <li>Reduce milk yield in lactating animals and egg production in layers.</li> <li>Low food intake although the animal frequently may lick soil and patches of urine.</li> <li>In poultry, it induces cannibalism. Growth rate and body weight will be lowered.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                   |

|           |                                                                                                                                                                                           |                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                                                                                                                                                                                           | nerve activities.<br><ul style="list-style-type: none"> <li>Chlorine is component of hydrochloric acid which is secreted in the gastric juice during digestion</li> <li>Sodium promotes the use of energy and protein</li> </ul>                       | <ul style="list-style-type: none"> <li>Acute potassium deficiency causes degeneration of kidney tissue and prevents injuries.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                       |
| Magnesium | <ul style="list-style-type: none"> <li>Green herbage,</li> <li>cereal grains,</li> <li>drinking water with magnesium salt,</li> <li>feeding mixture containing magnesium oxide</li> </ul> | <ul style="list-style-type: none"> <li>Activates metabolic enzymes.</li> <li>Component of the skeleton. About 60% of magnesium is found in bones and teeth-and only 1% in body fluids.</li> <li>Regulates activities of the nervous system.</li> </ul> | <ul style="list-style-type: none"> <li>Flushing of the coat due to lowering of blood pressure, a condition known as peripheral vasodilation.</li> <li>Tetany (grass tetany or grass staggers) which is characterized by convulsions and tremors in cattle especially dairy cows and breeding ewes.</li> <li>Animal head and heels bends backwards as the body bows forward.</li> <li>Reduced growth due to low conversion feed efficiency.</li> <li>Animals experience muscular twitching and excessive salivation.</li> </ul> |
| suphur    | <ul style="list-style-type: none"> <li>Most food containing proteins, in organic sulphate (salt lick)</li> </ul>                                                                          | <ul style="list-style-type: none"> <li>Component of some proteins and promotes the formation of amino acids which constitute sulphur in the rumen.</li> </ul>                                                                                          | <ul style="list-style-type: none"> <li>Lower growth rate, reduces feed efficiency, poor growth of hair, wool and feathers.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                          |

## Appendix 29: Source of micro minerals and symptoms of their deficiency

| Mineral | Source of supply                                                                                             | Role within the body                                                                                                                                                                                                                                                                                      | Deficiency symptoms                                         |
|---------|--------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Iron    | Available in most solid foods (cereal grain, green herbage, legumes, liver and meat meal) and mineral salts. | <ul style="list-style-type: none"> <li>Constituent of haemoglobin which is found in red blood corpuscles and is required for oxygen transportation to all body tissues.</li> <li>Component of certain proteins that play important role in the kidney and liver.</li> <li>Component of certain</li> </ul> | Nutritional aneamia which is characterized by unthriftiness |

|           |                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|           |                                                                                                                                      | <p>important tissue activities.</p> <ul style="list-style-type: none"> <li>• Required in milk production.</li> </ul>                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Zinc      | Solid food as for iron. Feed supplements, mineral brick and blocks.                                                                  | <ul style="list-style-type: none"> <li>• Constituent of certain enzymes systems.</li> <li>• Aids in the transportation of carbon dioxide in the blood stream during respiration.</li> </ul>                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>• Parakeratosis which is a disorder of the skin and especially in piglets and calves.</li> <li>• Reduced growth rate with poor fathering in poultry.</li> <li>• Increased embryonic anomalies and hatchability is lowered. Reduced feed conversion efficiency.</li> </ul>                                                                                                                                                       |
| copper    | Pulse , crops grains, green herbage, copper sulfate mixed with feed especially for pregnant ewes and piglets but not breeding stock. | <ul style="list-style-type: none"> <li>• Help in the formation of hair and wool pigments.</li> <li>• Requirement for haemoglobin formation as catalyst.</li> <li>• Influences the activities of certain enzymes</li> <li>• Excessive intake causes liver damage and death ( copper poisoning).</li> <li>• Improve the rate of growth and feed conversion efficiency in piglets and calves.</li> <li>• Promotes the uptake of iron within the body.</li> </ul> | <ul style="list-style-type: none"> <li>• Development of white, stunted stinky wool in sheep and bleached hair in cows.</li> <li>• Depigment of feather in poultry.</li> <li>• Reduced growth rate in heifers. Such heifers show high cases of infertility when they mature</li> <li>• Swayback condition in lambs, characterized by inability to rise or walk properly due to uncoordinated muscular activity.</li> <li>• Animals may stagger and collapse.</li> </ul> |
| manganese | Available in most cereal, pulse and legume crops, salt licks.                                                                        | <ul style="list-style-type: none"> <li>• Component of most of tissue animal body accelerates enzyme activity. For instance it activates enzymes that breakdown carbohydrates fats and proteins.</li> </ul>                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>• Causes irregular ovulation.</li> <li>• Delayed maturity in females and may induce sterility in males.</li> <li>• Weak calves, piglets, kids or lambs at birth.</li> </ul>                                                                                                                                                                                                                                                     |
| Cobalt    | Minerals salts fed in licks or broadcasted on pastures green herbage.                                                                | <ul style="list-style-type: none"> <li>• Component of vitamin B12.</li> <li>• Activates enzyme activities.</li> <li>• Increases the appetite of ruminants as it acts on rumen flora</li> </ul>                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>• Stocks suffer from pine of ill-thrift characterized by loss of appetite, reduced growth rate and body weight.</li> <li>• Animal becomes anaemic.</li> <li>• Premature birth (abortion).</li> <li>• Low milk yields.</li> <li>• Poor coat, e.g .rough hair</li> </ul>                                                                                                                                                          |

|            |                                                        |                                                                                                                                                                                                  |                                                                                                                                        |
|------------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
|            |                                                        |                                                                                                                                                                                                  | scaliness of animal skin.                                                                                                              |
| Molybdenum | Mineral block                                          | <ul style="list-style-type: none"> <li>• Component of enzyme system. Causes conditional copper deficiency, i.e suppresses the absorption of copper by animal cells</li> </ul>                    | <ul style="list-style-type: none"> <li>• Excessive intake causes scouring.</li> <li>• Unthriftiness and loss of weight.</li> </ul>     |
| Iodine     | Mineral block, drinking water mixed with mineral salt. | <ul style="list-style-type: none"> <li>• Component of thyroxine which is secreted by thyroid gland to control growth rate.</li> <li>• Regulates metabolic activities within the body,</li> </ul> | <ul style="list-style-type: none"> <li>• Goitre- swollen neck in kids and lambs.</li> <li>• Excessive body hair in piblets.</li> </ul> |

### Appendix 30: Fat soluble vitamins source, functions and symptoms of their deficiency

| Vitamin  | Chemical name  | sources                                                                                                                                                    | Functions in the animal body                                                                                                                                                                                                                                                                                            | Deficiency symptoms                                                                                                                                                                                                                           |
|----------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A        | Retinol        | <ul style="list-style-type: none"> <li>• Green vegetables.</li> <li>• Dried grass, milk,</li> <li>• butter, egg yolk,</li> <li>• fish liver oil</li> </ul> | <ul style="list-style-type: none"> <li>• Concerned with bone formation,</li> <li>• Improve vision, ability to see in dim light.</li> <li>• Prevents eye inflammation in cattle and poultry.</li> <li>• Improves vigour, normal health growth.</li> <li>• Increases body resistance against certain diseases.</li> </ul> | <ul style="list-style-type: none"> <li>• Cause night blindness.</li> <li>• Animal fail to see in dim light.</li> <li>• Reduces body resistance against such infections as bronchitis</li> <li>• Animal coat becomes dry and scaly.</li> </ul> |
| C        | Ascorbic Acid  | <ul style="list-style-type: none"> <li>• Green crops, fresh fruits,</li> <li>• Synthesized in body tissue.</li> </ul>                                      | <ul style="list-style-type: none"> <li>• Prevent anaemia.</li> <li>• Helps the body to build resistance against infections, e.g pneumonia</li> </ul>                                                                                                                                                                    | <ul style="list-style-type: none"> <li>• Scuby characterized by bleeding from the body especially the gums.</li> </ul>                                                                                                                        |
| D2<br>D3 | Ergocalciferol | <ul style="list-style-type: none"> <li>• Manufactured by exposure of animal to sunlight.</li> </ul>                                                        | <ul style="list-style-type: none"> <li>• Promotes the uptake of phosphorus for</li> </ul>                                                                                                                                                                                                                               | <ul style="list-style-type: none"> <li>• Rickets characterized by soft and deformed bones and teeth.</li> </ul>                                                                                                                               |

|   |              |                                                                                                                                                                  |                                                                                                                                     |                                                                                                                                |
|---|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
|   |              | <ul style="list-style-type: none"> <li>• Sundried herbage and fish.</li> <li>• Colostrums, fish</li> <li>• Liver oils and animal fats</li> </ul>                 | <p>strengthening bones.</p> <ul style="list-style-type: none"> <li>• Metabolism of calcium and phosphorus</li> </ul>                |                                                                                                                                |
| E | Tocopherol   | <ul style="list-style-type: none"> <li>• Green foods, cereal grains</li> <li>• Meat meal concentrate mixed with animal fat</li> <li>• Cotton seed oil</li> </ul> | <ul style="list-style-type: none"> <li>• Component of most enzyme system</li> <li>• Control the occurrence of sterility.</li> </ul> | <ul style="list-style-type: none"> <li>• Muscles of the heart and skeleton degenerate.</li> <li>• Causes sterility.</li> </ul> |
| K | Phyloquinone | <ul style="list-style-type: none"> <li>• Synthesis in digestive system.</li> <li>• Green vegetable.</li> </ul>                                                   | <ul style="list-style-type: none"> <li>• Component of most enzymes systems.</li> <li>• Promote blood clotting.</li> </ul>           | <ul style="list-style-type: none"> <li>• Reduces the spread of blood to clot.</li> </ul>                                       |

### Appendix 31: Water soluble vitamins source, functions and symptoms of their deficiency

| Vitamin   | Chemical name                                                                                                                        | sources                                                                                                                                                                                                                                      | Functions in the animal body                                                                                                                                                                        | Deficiency symptoms                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| B-complex | <ul style="list-style-type: none"> <li>• Thiamine</li> <li>• Riboflavin,</li> <li>• Biotin,</li> <li>• Cynocobalamin, etc</li> </ul> | <ul style="list-style-type: none"> <li>• Green crops,</li> <li>• Seed coats</li> <li>• Beans</li> <li>• Nuts</li> <li>• Fruits skins</li> <li>• Egg yolk, fish</li> <li>• Synthesized in ruminants,</li> <li>• Meat and bone meal</li> </ul> | <ul style="list-style-type: none"> <li>• Assist in energy production</li> <li>• Regulates the distribution of carbohydrates to body tissues.</li> <li>• Component of body enzyme system.</li> </ul> | <ul style="list-style-type: none"> <li>• B1 (thiamine) deficiency causes beri-beri which is characterized by weakening of the muscles (paralysis) and eventual death.</li> <li>• B2 (riboflavin) deficiency causes sore skin round the mouth and reduced growth.</li> <li>• Niacin deficiency causes pellagra characterized by rashes, sore skin and joints, diarrhea and nervous disorder.</li> </ul> |

## REFERENCES

1. Cockerell, Y., B. Francis and D. Halliday, 1971 Changes in nutritive value of concentrate feeding-stuffs during storage. In Proceedings of the Conference on the development of feed resources and improvement of animal feeding methods in the CENTO region countries. London, Tropical Products Institute, Pp. 181-192,
2. Howe, R.W., 1965 Losses caused by insects and mites in stored foods and feedingstuffs. Nutr.Abstr.Rev., 35(2):285-303
3. *The Ruminant Animal – Digestive Physiology and Nutrition*. 1988. D.C. Church (Ed.), Prentice Hall, Englewood Cliffs, NJ.
4. *Nutritional Ecology of the Ruminant – 2<sup>nd</sup> Edition*. 1994. P.J. Van Soest, Cornell University Press, Ithaca, NY.
5. *Rumen Microbiology and Its Role in Ruminant Nutrition*. 2002. J.B. Russell. Cornell University. Ithaca, NY.
6. *Quantitative Aspects of Ruminant Digestion and Metabolism – 2<sup>nd</sup> Edition*. 2005. J. Dijkstra, J.M. Forbes and J. France (Ed.). CABI Publishing. Oxfordshire, UK and Cambridge, MA.
7. *Protein Nutrition in Ruminants*. 1982. E.R. Orskov. Academic Press. London, New York.
8. *Ruminant Nitrogen Usage*. 1985. Subcommittee on Nitrogen Usage in Ruminants. National Research Council. National Academy Press. Washington, DC.
9. *Nutrient Requirements of Beef Cattle – 7<sup>th</sup> Edition*. 1996. Subcommittee on Beef Cattle Nutrition. National Research Council. National Academy Press. Washington, DC.

