



**Value Chain Alliance for Livestock Upgrading
and Empowerment**

GOAT FEEDS AND FEEDING

TRAINING MANUAL



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Introduction

1

The quality of feeds offered to goats influences their overall performance. Fast growth rate can be achieved through addressing nutritional deficiency and ensuring proper feeding is carried out. Providing high nutritive value feed to goats is associated with fast growth, increased rates of twinning, reduced age to reach puberty and slaughter weights hence the overall profitability of the goat enterprise. Mortality rate of both mature and young goat and their susceptibility to diseases can be significantly lowered with adequate provision of quality forages. For smallholder farmers to be profitable, they should pay extra attention to rangeland condition and the body condition score of their animals. When the rangelands are limited in quality due to seasonal fluctuate, farmers should provide supplements which address the nutritional deficiencies.

In Zimbabwe, seasonal fluctuation in forage quality affects fertility and overall performance of goat enterprises. Farmers should strategies and come up with nutrition security activities that can help him provide adequate quality forage for his or her goats. The performance of the current Goat Value Chain leaves a lot to be desired. The performance is suboptimal but has great potential if feeding issues and nutrition security activities are embraced. Most small to medium goat farmers have been operating with limited understanding of goat nutrition and its importance.

This training manual is designed to equip farmers with basic knowledge on goat nutrient requirement for maintenance, growth and reproduction. Forage production and conservation is also discussed to ensure nutrition adequacy and feed security at farm level. The target group is the small to medium farmers (including young and women farmers), lead farmers (anchor), farmer groups, Business Management Unit (BMU), syndicate or cooperatives and integrators, who will be trained in this program to enhance their skills at individual and organizational levels. The trainees are expected to utilize the skills in their respective activities in Goat Value Chains. The use of high protein browse and forage legumes in feeding goats will have a positive contribution to the overall growth and development of goat value chains in the country.

INFORMATION AND INSTRUCTIONS TO THE TRAINER

2

This manual should be used purely as a facilitator's guide. The sessions under each module are presented with an objective(s) to facilitate the assessment of participants' understanding and depth of knowledge at the end of each session. To enhance a participatory learning process, some methods of presentation and the steps to follow are also outlined. The manual also provides some background information on each session. The information is also meant to aid the facilitator in the preparation for the session. Like all participatory methods, the involvement of the participants in all stages of the learning process is vital. However, all users of this manual must study and research into the content of each module before presentation. Start each sub-topic and group activity by explaining the objective and learning outcomes expected of them, and ensure they are met. Though contents for each sub-topic are provided, lead the participants into giving their points, compare them with your points that you have prepared and then mention to them the items that were not pointed out by them.

The session should be interactive, participatory, lively and interesting. Let the participants express themselves in vernacular language as it helps them to understand the concepts. Encourage them to ask questions especially on concepts that they don't understand. Switch to either English or vernacular language when you find some or all of them do not understand you in one of the languages.

Start the session with greetings, welcoming remarks introduce yourself. Trainees will complete the end of course Evaluation Sheet on the conduct of the session by you, the trainer. Ensure you have the necessary stationeries for the trainees and equipment and materials: projector, flip charts or whiteboard, whiteboard markers, marking pens, and handouts. Be time conscious as you facilitate the Session

The Manual is divided into four units which are a) Introduction to nutrients in goat feeding (b) Nutrient requirement and how to make on-farm goat feed, (c) Feeding different classes of goats, and (d) Nutrition security and alternative feeding strategies.

3 Users of the manual

The manual is intended to be used by facilitators at various levels of the goat value chain in Zimbabwe.

4 Presentation methodology

The methods of presentation outlined in the manual are suggested as a guide to the facilitator. The facilitator is expected to use his or her judgement in selecting the appropriate method or combination of methods in presenting each session.

5 Assessment

At the end of each session, the facilitator is expected to assess/evaluate the participants' understanding and level of knowledge by using a simple question and answer session as appropriate. It is advisable to assess participants at the end of each unit. The facilitator is given a free hand in determining the kind of questions to be asked. However, all assessments must relate to the session.

6 Goat Feeding and Nutrition security

Participants will learn about goat feeding and nutrition security. Participants will be taught different nutrients to be supplied by each diet. The importance of such nutrients to the health and productivity of the animal will be emphasised. Furthermore, each participant will be assisted to identify feedstuff that can be used to feed different classes of animals. The Module is divided into four units as follows:

- Unit 1: Introduction to nutrients in goat feeding
- Unit 2: Nutrient requirement and how produce on-farm goat feeds
- Unit 3: Feeding different classes of goats,
- Unit 4: Nutrition security and alternative feeding strategies

Overall Objective: By the end of the training, participants will be able to identify feedstuffs with adequate nutrients, explain and analyse the importance of nutrients in influencing animal performance, blend these feedstuffs in a complete nutritionally balanced diet or feed which can be fed to specific classes of goats to maximise productivity and profitability of a goat enterprise.

Figure 3.5 Saanen breed

INTRODUCTION TO NUTRIENTS IN GOAT FEEDING

7

Unit One

7.1 Unit Objectives

1. To introduce learners to the required nutrients for maintenance, optimum goat growth and reproductive performance.
2. To classify nutrients and their sources.
3. To inform learners of the negative and positive results of supplying the nutrients.
4. To educate farmers on the effects of supplying different nutrients in a diet.

7.2 Outcomes

1. Learners should be able to list all nutrients required in goat feeding.
2. Learners should be able to identify the nutrient, sources, location and deficiencies.

7.3 Introduction to feeds and feeding

- Feed is the most important input in goat production.
- More than any other factor identified in veterinary management of goats, the diet has a profound effect on the general health of both individual animal and herd.
- The diet offered has a great impact on both health and productivity.
- When feeding goats, the most important goal is to achieve optimal health as reflected in
 - Productivity
 - Reproduction
 - Performance
- Goats are active foragers/browsers; they tend to select a highly digestible portion of grass and shrubs.
- They tend to perform poorly compared to sheep and cattle on flat, improved, monoculture pastures but do extremely well in areas with abundant shrubs and several plant species to graze.
- This, therefore, implies that goats are the best species for degraded and invaded rangelands of savannah rangelands with abundant plant shrubs.
- Under normal circumstances, if goats are given a choice, they would prefer a diet made up of 15 to 20% grass and 80 to 85% browse.

- For a profitability goat enterprise, 80% of nutrient requirement should come from forages and good quality hay.
- It should be noted that it is of paramount importance to feed goats with diets that supply adequate nutrients for each intended purpose of production.
- The feed must contain the nutrients in the right quantities and a correct method of feeding should be used.
- Farmers who fail to adhere to a correct feeding regime at each production stage may not be able to realise profits.
- Goat farmers should aim at minimizing feed costs if profits are to be maximized hence, it may be necessary to use least-cost high performing ration.
- Successful farmers manipulate feed ingredients to maximize productivity.

7.4 What is a feed?

- Feed or feedstuff is all edible material, which after ingestion by the animal is capable of being broken down into simple molecules called nutrients.
- Nutrient is the name given to the different constituents of feed that are utilized by the body.
- Most feeds contain several kinds of nutrients but no one ingredient has all the nutrients that the body needs hence there is a need to use a variety of ingredients.
- These ingredients/sources are broadly grouped into five namely:
 - Energy sources, e.g. hay, maize stover, sorghum stover grain, cereal grains.
 - Protein sources, e.g. cotton seed cake, browse legume hay, forage legumes, sunflower cake, cowpeas, velvet bean, lablab, non-protein nitrogen (urea),etc.
 - Mineral supplements, e.g. commercial mineral and vitamin premix, limestone, etc.
 - Vitamin supplements
 - Feed additives or non-nutritive additives, e.g. molasses ,etc.
- A total mixed ration contains all the above nutrients to satisfy the nutrient requirement for each stage of production.
- Every stage of production, level of productivity, age, breed and physiological status demand a specific ration hence the level of inclusion of these feedstuffs varies accordingly.
- Hence, there is no universal feed, one glove fits all.

7.5 Nutrients

- Nutrients are any food /feed constituents or groups of food/feed constituents of the same general chemical composition that aid in the support of life.

- The nutrients obtained from feedstuffs are important for energy release, growth, repair, various secretions, storage, and transport, maintenance of internal osmotic and pH environment.
- This implies that nutrients in feed are responsible for preserving life and growth.
- Goats require six categories of nutrients namely protein, carbohydrates, fats, vitamins, minerals and water.
- Feeds are digested; nutrients absorbed and assimilated utilised to satisfy metabolic needs i.e. being transformed into body elements of the animal.
- If the six nutrients are not provided in sufficient quantities suboptimal reproduction, stunted growth and poor animal productivity will be experienced.
- Furthermore, if there are shortages of nutrients, metabolic or deficiency diseases and death may occur.
- It is therefore mandatory that any diet given to any animals should have these nutrients to remain healthy and productive.
- Deficiencies in nutrient supply in female animals are like contraceptive pills which can stop the oestrus cycle, a condition called nutritional anoestrus.

Raw materials and their nutrient Composition

Table 7.1

SOURCES	Raw Material	DM %	CP %	ME (MJ/kg)	Fibre %	lysine (g/kg)	Meth cyst (g/kg)	Ca%	P%
ENERGY	White maize crushed	87.3	9.8	14.2	2	2.5	2.3	0.3	2.7
	Wheat feed crushed	88	12.4	12	6	3.1	2.1	0.5	3.5
	Sorghum crushed	88	10.8	12	4	2.1	1.6	0.5	3.5
	Millet	88	12.1	13	9.3			0.6	3.1
	Brewers Grain air dried	26	21.8	11.5	17	6.8	3.4	1.7	3.7
PROTEIN	Soyabean meal	88.5	44	10.5	7	28.5	7.9	3.5	6.8
	Soyabeans Full Fat (whole)	88	40	14	5	28.5	7.9	3.5	6.8
	Cotton seed cake	94.4	37.9	11.1	17.1	17.1	5.2	1.9	12.4
	Sunflower cake	88.0	33.6	9.5	26.5	10.1	7.5		
	Eddie beans	90	26.7	13.3	9.1	15.6	1.8	1	5.5
	Groundnut meal	90	34.5	14	9	16.4	5.5	2.9	6.8
	Fish meal	91.1	69.3	14.2	0	48.2	15.2	79	44
	Meat and bone meal	88	60	13	6	22	8.5	120	58
Mineral & Vitamin	Limestone flour	100	0	0	0				
	Rock salt	100	0	0	0				
	DI-Calcium Phosphate	100	0	0	0				
	Vitamin mineral mix	100	0	0	0				

7.6 Water

- This is a major constituent of the animal body.
- A newly born animal is 65 to 70% water, while at slaughter water content in the body of the animals 40 to 50%.
- A 10 % of water loss can be detrimental to the animal
- There is a great increase in water intake roughly by 126% from the first 1 to 5 months of gestation.
- Water intake is greater for females carrying twins than those carrying singles.
- Lactating does consume twice as much water as non-lactating females approximately 7-15 litres/day vs. 3.5 to 7 litres /day
- A goat requires approximately 3.5 to 15 litres of water/head/day.
- The amount of water required per day depends on
 - Animal factors such as breed, age, sex and physiological status.
 - The weather conditions.
 - Dry matter of feed provided.
 - Type of feed provided
 - Level of feed eaten
- It is necessary for all body functions such as
 - digestion,
 - excretion,
 - circulation and
 - is the media in which all biochemical reactions occur etc.
- Dehydration and death will occur once the provision of clean fresh water is compromised.

7.7 Energy

- Energy is required for the maintenance of normal body functions.
- It is usually the first limiting nutrient under the most practical conditions for goats under rangelands and pasture grazing.
- Energy requirement varies greatly depending on the level and stage of production, level of activity and intended use.
- In goat production, energy requirements can be met with medium to high-quality forage.
- It should be emphasized that energy deficiency diets can result in
 - Poor growth rates,
 - Low body condition score,
 - Decreased immune function,
 - Increased susceptibility to parasitic diseases and
 - Pathologic conditions.
- The main source of energy in goats is obtained from the rumen breakdown of structural carbohydrates from roughages.

7.8 Protein

- As a general rule, a minimum of 7% dietary crude protein is needed for normal rumen bacterial growth and function for ruminants.
- Below 7% crude protein, forage intake and digestibility are depressed.
- Protein is a macronutrient that is essential to building muscle (meat) mass.
- It is commonly found in animal products, though is also present in other sources, such as nuts and legumes.
- Protein is important for growth and body repair.
- Protein deficiency is associated with
 - Slow growth rate,
 - Depressed immune function,
 - Anaemia,
 - Depressed feed use,
 - Oedema and
 - Death.
- The sources of protein include Feedstuffs of animal origin: Fish, Blood meal, Poultry and Fish processing wastes. Feedstuffs of plant origin: Soybean, Beans, Cottonseed cake, Sunflower cake, browse and forage legumes and good quality grass hay.
- Therefore, in goat quantity of dietary protein is much important than the quality.
- The opposite is true for pre-ruminant kids.
- Crude protein in grasses varies with maturity. Most natural grasses may have crude protein content ranging from 2 to 12 % crude protein whereas legumes in vegetative form could be having 28% or more crude protein.
- For maintenance, the minimum protein content required should be 7 to 8% where during lactation the minimum protein content of the diet should be 13 to 15% depending on the number of offspring.
- Whenever grass hay is used, protein deficiency should be a cause for concern especially for growing and lactating animals.

7.9 Vitamin

- These are important for the maintenance of normal health, growth, proper skeletal development, and normal reproduction.
- Deficiency in ruminants is rare because rumen microbes have the capacity to synthesis most of them.
- The sources of vitamins for goats include green fresh forages and bought in sources such as vitamin premixes.
- Most critical vitamin required in goat production is vitamin A and E.
- Vitamin A is very important for growth and epithelial tissue integrity.
- Deficiencies are associated with weight loss, depressed immune function,

night blindness, hair loss and most importantly decreased fertility.

- Forages and green grass meet daily requirements for goats.
- Vitamin E is also very important since deficiencies cause white muscle disease, depressed immune function and depressed fertility.

7.10 Minerals

- Minerals are grouped into two groups namely macro and micro minerals. This grouping is not according to importance, but the quantities required.
- Macro minerals are expressed in percentage terms while micro expressed in ppm or mg/kg.
- There are very important for strong bones and normal body function.
- The sources include browse and forage legumes, bone ash, common salt, soil, vitamin-mineral premix, limestone and mono - and di-calcium phosphates.
- There are seven important macro-minerals which should be supplemented to goats namely:
 - Calcium
 - Phosphorous
 - Sodium
 - Chlorine
 - Magnesium
 - Potassium and
 - Sulphur
- There are eight micro-minerals namely;
 - Copper,
 - Molybdenum,
 - Cobalt,
 - Iron,
 - Iodine,
 - Zinc,
 - Manganese and
 - Selenium
- Micro mineral deficiency is less common than energy, protein and macro-mineral deficiencies.

7.10.1 Calcium and Phosphorus

- Calcium and phosphorus are interrelated, with almost all calcium found in the body and most of the phosphorus being found in the skeletal tissues.
- Diets with less of the calcium and phosphorus may delay growth and development in kids and predispose them to metabolic bone diseases such as rickets.

- In lactating does, deficiency of these two can cause a reduction in milk production resulting in slow growth rate in kids
- Phosphorus deficiency is the most commonly encountered mineral deficiency by animal grazing on rangeland during winter or dry season.
- Most forage legumes are high in calcium and low in phosphorus.
- Therefore, browse and forage legumes are a good source of calcium.
- For lactating does it is important to supplement calcium and phosphorus.
- Goat feeding on browse may need less supplemental phosphorus.
- Deficiencies in phosphorus result in slow growth, depressed fertility and depraved appetite or pica
- Grain is a good source of phosphorus hence supplementing lactating does with grain may resolve deficiency issues.

7.10.2 Sodium and Chlorine

- These are integral components of many body functions.
- Salt should be fed ad-libitum or should be incorporated at 0.5% of the diet.
- Goats in deficiency of salt chew wood, lick the soil or consume other unlikely plants and debris,
- The salt content in the feed may be increased to 5% particularly for feeding bucks to increase water intake and reduce the incidence of urolithiasis (urinary bladder stones).
- Salt can also be used as an intake limiter for energy-protein supplements
- 10 to 15% salt added to two parts ground maize or cereal and one-part sunflower cake/cotton seed cake with approximately 15 % crude protein can be used to limit intake to roughly 450g per day in adult goats.

7.10.3 Other minerals

- Browse Legumes and legumes mixed pastures are a good source of magnesium.
- Deficiencies of magnesium can lead to grass tetany.
- Sulphur is also important, with its deficiencies resulting in anorexia, reduced weight gain, decreased milk production, excessive salivation and finally death.
- Browsing on high tannin-containing browse can cause a decrease in Sulphur availability.
- Sulphur availability also depresses rumen degradation, digestion, microbial protein production, reduces the use of non-protein nitrogen and thus lowers the rumen microbial population.

- Selenium is very important, and its absorption is enhanced by vitamin E, A and histidine.
- Legumes are a better source of minerals than grasses while grasses are better than grains,
- Signs of deficiencies are nutritional muscular dystrophy, retained placenta, poor growth, weakness or premature birth/stillbirth of kids, depressed immune function mastitis and metritis.

7.11 Activities

1. **Task 1:** List all sources of energy, protein, vitamin and mineral available in your area.
2. **Task 2:** Together with the trainer, identify locally available feedstuffs that can be used to provide named nutrients to goats.
3. **Task 3:** Together with the trainer identify production bottlenecks that could be a result of nutrient deficiencies.
4. **Task 4:** Discuss farmers' experiences on the uses of some the feedstuffs and the noted benefits.

Nutrient requirement and Ration Formulation

8

Unit Two

8.1 Objective

1. To classify nutrients and their sources.
2. To know which body processes and the required specific nutrient supply.
3. To introduce learners to methods of blending different ingredients to make a balanced diet for the different classes of goats.

8.2 Outcomes

1. Learners should be able to categories feedstuff into protein, energy, mineral and vitamin sources.
2. Learners should be able to identify processes and nutrient requirements when feeding animals at different stages of life and production.
3. Learners to make their balanced diets using locally available feedstuffs.

8.3 Nutrient requirement for goats

8.3.1 Introduction

- No single feedstuff can supply all the nutrients required for all body functions.
- The different feedstuffs must be mixed in proportions to satisfy the nutritional requirements for a particular type of goat.
- Feedstuffs from animal sources are better (but expensive) than feedstuffs from plant sources as they have a better balance of nutrients.
- The availability of feedstuffs usually limits production especially in arid and semi-arid areas and certain seasons.

8.3.2 Feeding standards

- It is a prescription
 - Prescribes the amount of dry matter and the amount and proportion of various digestible nutrients to be fed to a specific animal.

- The quantity of nutrients required by an animal to remain healthy and highly productive.
- Are set in accordance with:
 - Productivity
 - Milk, meat,
 - Composition of the product
 - Fat content in milk
 - Physiological condition
 - Growth, foetal development
- It also differs from animal according to;
 - Breed
 - Age
 - Intended use
 - Consideration is also given to varying regional conditions.
- Feeding standards are just but approximate guide regarding these various requisites of rations.
- No feeding standard yet gives any concrete advice.
- May be expressed in quantities of nutrients or the proportion of the diet.
- Energy requirements of ruminants' may be stated in net energy, metabolic energy or feed units

8.3.3 Feeding standards in summary

- Quantities of feed an animal requires to remain healthy and highly productive.
- Set in accordance with productivity, the composition of the product and physiological status.
- Varies with the breed, age, sex, intended use and environmental factors.
- The total animal requirement in feed units such as digestible protein, calcium, P and carotene.
- A set of tables which include the amounts of each dietary constituent required by each age and class of animal for maintenance and different levels of production. When complemented by tables of the composition of feeds it is then possible to accurately formulate rations for individuals or groups of animals, a process essential for the operation of a least-cost ration feeding program.
- Are not permanent but changes with production technology and production targets.
- Feed rations are based on feeding standards.
- A healthy animal grows quickly, making the best use of the feed it is given and will produce good quality meat, milk, wool and leather for

humans to use. A sick or suffering animal will not grow quickly so it costs more to feed.

- It is in farmers' best interests to make sure that the animals in their care are kept healthy throughout their lives.



Figure 8 1: Goat with twin kids has an increased demand for nutrients

8.4 Nutrient requirements

- Metabolism is defined as all the chemical and physical processes that take place in the body.
- There are two types of metabolism namely anabolism and catabolism.
- Anabolism is a metabolism that builds tissues.
- Catabolism is a metabolism that breaks down materials.

8.5 Body Maintenance requirement:

- It is whereby the body is maintained without an increase or decrease in body weight, and with no production or work being done.
- Approximately 50% of feed is used for maintenance and this must be met before supplying nutrients for other functions.
- Maintenance needs are related to body size hence it can be expressed as $Wt^{0.75}$ metabolic body weight.
- Maintenance energy is required for
 - Ion transport across cell membranes
 - Body tissues repair
 - Resting muscle activity and the obligatory turnover of tissue protein

- Control of body temperature,
 - Energy to keep vital organs functioning,
- Water balance maintenance
- Farmers should note that every activity that is carried out by the animal should be funded with nutrients.
- All activities have cost implications to the animals as shown in Table 8-1.

Energy cost of physical activity in a 30kg goat

Table 8.1

Activity	Cost per kg W	Duration of activity	Cost per day (kJ)
Standing	0.4kJ/h	9 h/day	180
Changing position	0.26kJ	6 times/day	78
Walking	2.6kJ/km	5km/day	650
Climbing	28kJ/km	0.2km/day	280
Eating	2.5kJ/h	2-8 h/day	250-1000
Ruminating	2.0kJ/h	8 h/day	800
Fasting metabolism			4300

Estimates of Energy costs of activity for a 65kg goat based on ARC (1980) and Lachica et al (1997).

Table 8.2

Activity	Energy Cost	Energy Cost for 65kg
Goat		
Horizontal movement	3.5 J/kg/m	0.238 MJ/km
Vertical movement	28 J/kg/m	0.182 MJ/100 meters
Standing	10 kJ/kg daily	0.650 MJ/d
One position change	0.26 kJ/kg	0.017 MJ/change

NB It should, therefore, be known that every activity done by an animal Table 8-1 during the day is a cost.

8.6 Growth and productivity requirement

- Growth is the increase in protein over its loss in the animal body. It occurs by increases in cell numbers, the cell size, or both.
- Growth requires energy, protein, minerals, and vitamins.
- Young animals require more protein to build muscle and grow.
- Monogastric animals also need certain amino acids for proper growth.
- Young animals also need calcium and phosphorus, salt, or a normal sodium

level, any mineral that may be deficient in the area the animal lives.

- Iodine and Selenium require special consideration as Iodine deficiency in the foetus prevents thyroxine from being produced, causing goiters as shown in Figure 7-1 and eventual death in new-borns while Selenium deficiency may cause white muscle disease in new-borns.



Figure 8.2: Iodine deficiency in kids

- Vitamins are also required by growing animals.
- Vitamin A is usually the only vitamin commonly fed to ruminants.
- Energy is required to sustain growth, metabolic rate, and activities.
- Energy can be supplied by feeding corn, barley or wheat
- Having satisfied maintenance, additional nutrients are used for production processes.
- Efficiency varies between the nutrient and the particular productive process.
- John Hammond introduced the concept of metabolic priorities operating during the time of feed shortages.
- It is now accepted that neural tissue has the first call on nutrients, lymphatic and immune system, viscera, bone, muscle and finally fats.
- Foetal development is maintained at the expense of lactation.
- However, during the period of shortage, animals use the body reserves to support milk synthesis.

8.7 Fattening requirement:

- Before marketing, market targeted animals are primed to fetch a better price and ensure better meat quality.
- The process is done by maximizing the storing of surplus feed energy as fat.
- It is the result of excess energy from carbohydrates, fats, or protein beyond the maintenance requirements.
- This improves the quality of the carcass at slaughter.
- Tabulate nutrients required for fattening and average daily gains.

8.8 Reproduction requirement:

- Two categories of requirements namely:
 - Gamete production Figure 8-2and
 - Foetal growth in the uterus.
- Foetus requirements are much greater in the last trimester of pregnancy.
- Nutrition of the female must not be inadequate during pregnancy.

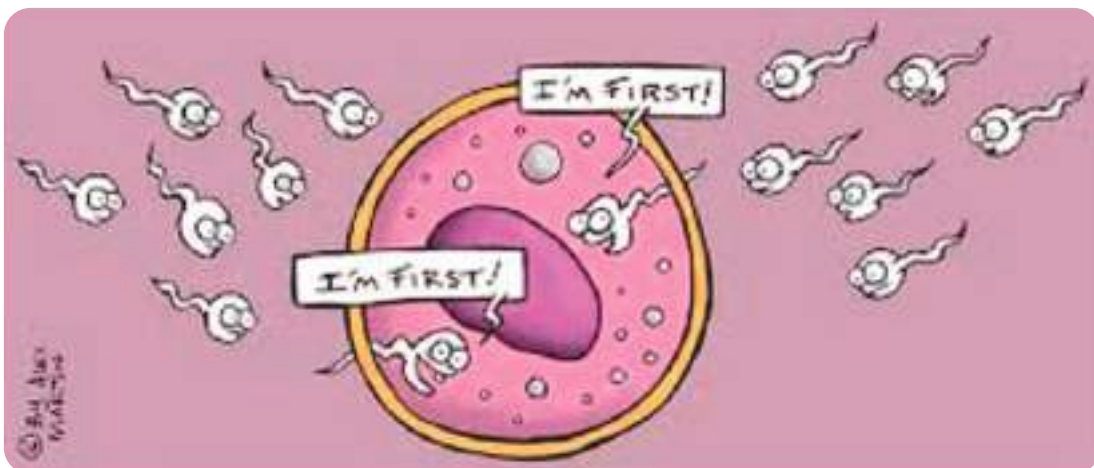


Figure 8.3: Sperm and Ovum development need a good supply of nutrients

8.9 Milk production requirement

- Requires considerable protein, minerals, vitamins, and energy.
- The need for protein is greater because milk contains more than 3% protein.
- Calcium and phosphorus are the two most important minerals needed for lactation.
- If absent may result in decreased lactation, disease or even death.
- Energy is the most vital requirement for the production of large quantities of milk.
- High producing dairy goats may need up to four times the energy of non-lactating goats of the same size.

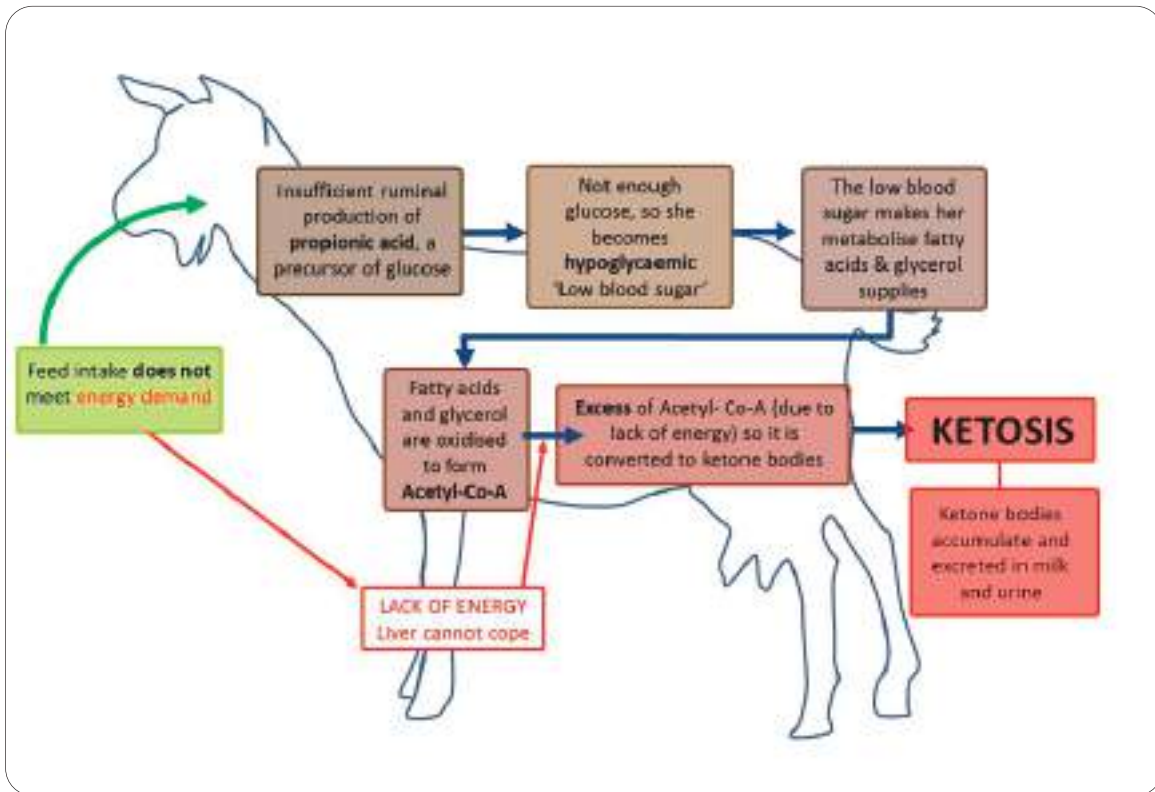


Figure 8.4: Nutrient requirement for milk production in goats

Protein and energy requirement at different production stages

Table 8.3

Goats	Percent Protein (CP)	Percent Energy (TDN)
Bucks	11	60
Dry Doe	10	55
Late Gestation	11	60
Lactation		
Avg. Milk	11	60
High Milk	14	65
Weanling	14	68
Yearlings	12	65

Nutritional content of various feedstuffs commonly fed to sheep and goats.

Table 8.4

Feed Stuff	Percent Protein (CP)	Percent Energy (TDN)
Mature Pasture	8	50
Clover Pasture	25	69
Orchard grass Pasture	18	65
Browse	16	72
Soybean Meal	44	88
Complete Pellets	12	78
Barley Grain	13.5	84
Corn Grain	8	89
Poor Hay	3.6	50
Grass Hay	10	58
Mixed Hay	8	50
Legume Hay	18	62

8.10 Ration formulation

- It is defined as the utilisation of knowledge about nutrients, feedstuffs, and animals in the development of **nutritionally adequate ration** that will be consumed in **sufficient quantities** to provide the **level of production** desired at a **reasonable cost**.
- Important terms in this definition are:
 - Nutrients composition
 - Feedstuffs
 - Balanced diet
 - Palatability and acceptability
 - Production levels
 - Least-cost but high producing.
- The following information is required from feed analysis for successful ration formulation.
 - Nutritional requirements for different species of animals and which feedstuffs are preferred.
 - The quantities of these specific nutrients in the feeds available
 - The efficiency of utilisation of available resources
 - Different types of feedstuff
 - Anti-nutritional factors
 - Industrial and agricultural waste can introduce contaminants.

8.10.1 Principles of formulating rations

- The formulation of feeds at the farm level is very important to the farmer.
- The process reduces the amount of money to be spent on feed.
- Mixing of different ingredients to produce a feed with a balanced nutrient profile to meet the specific demand of a goat at a specific growth stage is vital.
 - Manual and computer-based methods of feed formulation.
 - Pearson square method.
- For this training, we will focus on the **Pearson square method** of feed formulation
- Pearson square method is a useful tool when blending two ingredients based on nutrients.
- Used if there are two ingredients or several ingredients pre-mixed into two components.
- It used to determine the proportions of each of the ingredients in the diet
- Is used as a starting point in the study of feed formulation. You can compute the proper mix of ingredients to attain a certain amount of crude protein (CP).

8.10.2 Guidelines to Ration Formulation Techniques

- One should remember that:
 - Animals have a daily requirement (quantity/day) for energy and nutrients.
 - Animals can eat only a limited quantity per day.
- NRC recommendations are determined from feed intakes of animals of certain weights at various physiological states i.e. maintenance, growth, gestation or lactation.
- Therefore, if animals are consuming 5 kg/day all of their energy, protein and mineral requirements must be packaged in this quantity.
- For example, a 50 kg growing goat is expected to eat 2.6 kg/day and this quantity must provide her with 352 g protein.
- Thus, each kg of diet must provide: $352 \text{ g protein} / 2.6 \text{ kg diet} = 135 \text{ g protein/kg diet}$.
- Priority for balancing:
 - Energy
 - Protein
 - Minerals (Ca & P)

8.10.3 How do we go about balancing a diet?

- Let us use a simple example to illustrate the thought process.
- We want to formulate a 13% crude protein diet for lactating does (30 kg) using a rainy season cut-veld grass hay and a protein/mineral/vitamin supplement.
- The hay contains 9% crude protein and the commercial supplement contains 45% crude protein.
- We want to make 100 kg of this diet and we assume the protein/mineral/ vitamin will meet all other nutrient requirements for the does if mixed with the hay to make a 13% crude protein diet.
- One very basic technique for ration balancing, that some of you may be familiar with is the Pearson square. While the method has technical limitations as to the complexity of the diets you can formulate with it, it does provide a basic framework to understand the techniques used for more complex diets. We set up the square as follows, subtracting on the diagonal.
- A second example is as follows in Figure 8-5;
- If one has maize with 9 percent crude protein and soya cake with 44 percent crude protein.
- Considering that maize has 9 % CP while soya 44% CP or crude protein, in a growers ration you need a 16 % crude protein mix, so, how many parts of corn and soya should be in the mix to attain 16% crude protein.

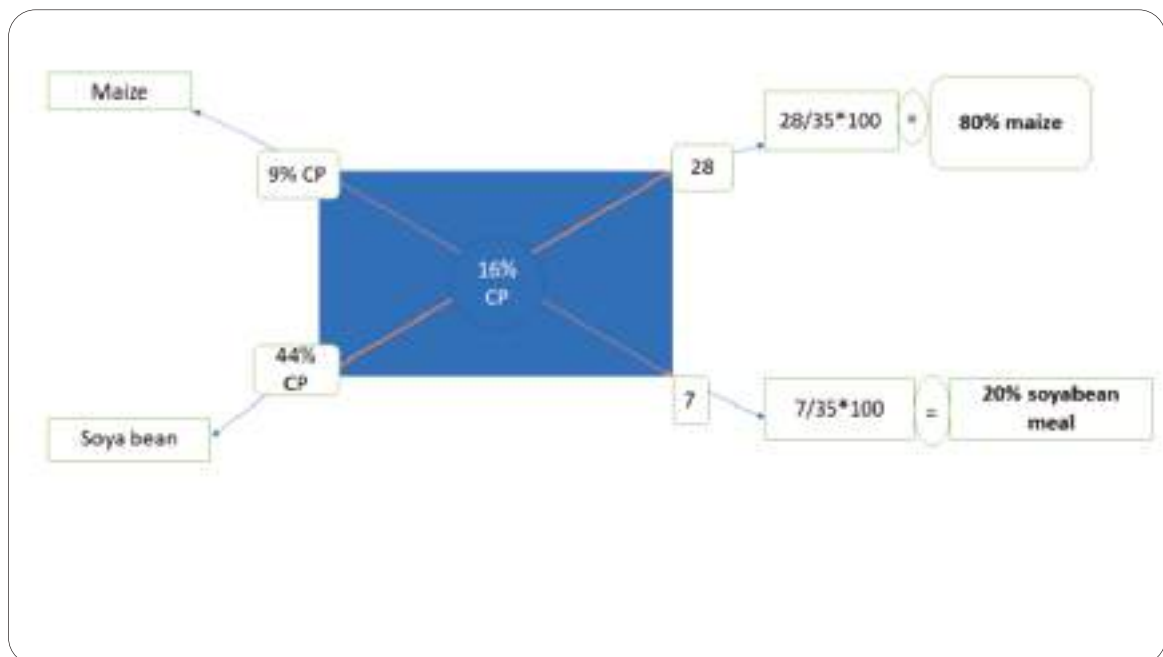


Figure 8.5: Practical example of the Pearson square method in feed formulation

- The 28 parts are attained by subtracting 16 CP with the CP of the soya which is 44.
- The 7 parts are attained by subtracting the 16 CP with the CP of corn which is 9.
- 35 is obtained by adding the 28 parts to 9 parts.
- Following the formula, we attained 80% parts corn and 20 % parts soya. So, if we want a 50 kg feed with 16% crude protein:
 - $50 \text{ kg} \times 80\% = 4000/100 = 40 \text{ kg maize}$
 - $50 \text{ kg} \times 20\% = 1000/100 = 10 \text{ kg soya cake}$
 - total of 50 kg of feeds with 16% CP

After mixing these two ingredients one can now add mineral and vitamin premix to ensure that all nutrients are available in the ration

Some points to remember

- Think about the sense of what you are doing as you formulate rations. Can an animal eat that much feed? If a ruminant, is there enough fiber?
- Animals eat pounds (kg), not percentages. Check that you have met absolute requirements by weight before expressing the final ration in fractional terms.
- There is almost never a single, perfect answer to a ration balancing problem.

8.11 Activity

1. Draw a table listing the common feedstuffs for goats in your area during the wet and dry season. Include their nutrients contents.
2. Why are goats thin during dry season?
3. What are the implications of adequate goat nutrition in two seasons?

9.1 Objective

1. To train learners to feed all classes of goats.
2. To know which classes of goats are more vulnerable to nutrient deficiencies.
3. To introduce learners to the methods of feeding goats.

9.2 Outcomes

1. Learners should be able to feed goats properly.
2. Learners should be able to identify the effects of feed shortages on production.
3. Learners to make their balanced diets using locally available feedstuffs

9.3 What is feeding?

- Offering feed to animals is the process of feeding an animal. Goats can forage from pastures and rangelands or feed on total mixed rations.
- Eighty percent of nutrients required by a goat should come from pastures or rangelands.
- The most consistent sign of protein deficiency in lactating animals is poor weight gain or slow growth in kids particularly twins or triplets.
- Protein supplements such as browse legumes, forage legumes, oilseed cakes, cowpea, velvet bean, lablab, synthetic, animal protein sources and non-protein nitrogen such as urea are critical in the provision of amino acids for muscle growth.
- Protein should be supplied to meet but not to greatly exceed the animal's protein requirement requirements.
- Excess protein supply results in increased feed costs and higher rates of diseases such as heat stress and pizzle rot.
- Non-protein nitrogen is an inexpensive way to increase the protein concentration of rations and the most common NPN source is urea but should be used with care.
- It is normally used in urea treatment of poor-quality hay and stover or urea molasses lick.

- However, it should be noted that whenever one is feeding NPN, sufficient amounts of highly fermentable energy component should be supplied.
- Cereal grain and urea result in the decrease in pH in the rumen which is good in lowering the ability of ruminal urease enzyme to ferment urea. This results in a slower release of or breakdown of ammonia and carbon dioxide.
- Once this metabolic pathway is slowed, there is an increased efficient protein synthesis by rumen microbes.
- Poor quality roughage results in higher rumen pH and enhanced urea activity thus reducing the efficiency of microbial protein synthesis thus promoting urea or ammonia toxicity.
- Non-protein nitrogen is best used in goats with BSC of 2.5 or better on a scale of 1 to 5.

9.4 Why do we feed goats?

- Goats are fed to keep them healthy and to stimulate productivity.
- To achieve two kidding annually, goats are supposed to be maintained in a good body condition score of between 3 and 4.
- Body condition score is an effective tool for managing both individual goats.
- A low BCS of an individual animal may be indicative of a disease or poor access to feed.
- A trend of low BCS may be indicative of inadequate feed quantity, quality or management-related diseases such as internal parasites
- If one records a low BCS in the herd that should be a trigger for investigating management disease or introducing supplementary feeding.
- The majority of high BCS may indicate the need to reduce supplementary feeding.
- Ideally, BCS should be between 2.5 to 3 depending on the animal's stage in the reproductive and production cycle.
- The whole body to be manually explored and palpated every 3 weeks to determine the BCS of the animal as a management tool.
- Put table of body condition scores according to animal status of production.
- Table 8-1, shows different production parameter.

Parameter	Expected performance
Age at puberty (Months)	4 -12
Oestrus duration (hours)	12 -72
Oestrus cycle (days)	18 -23
Gestation (days)	145 -155
Average birth weight	Breed dependent
Dairy	2.5 -4.5
Meat	2.5 – 6.5

9.5 Which types of feeds?

- Goats are ruminants and should be fed on high roughage diets.
- There is no need to allow goats to compete with a human being for food.
- Crude protein quantity is more important than quality hence all forages with approximately higher than 7% crude protein is a good feed.
- Goats can derive nutritional value from numerous feeds.
- However, feeds used are limited by:
 - Fat content
 - Palatability
 - Moisture content
 - Anti-nutritional factors
- Goat feeds are analysed for three most important components namely crude protein (CP), neutral detergent fibre (NDF), and acid detergent fibre (ADF).
- Neutral detergent fibre is negatively correlated with intake, the higher its content the low the intake.
- Acid detergent fibre is negatively correlated with digestibility, as the ADF content increases digestibility is reduced.
- Goats should get 80 to 90 percent of feed supply from natural pastures, shrubs and hay.
- In communal areas we recommend feeding goats with grass hay, shrubs, acacia, monkey bread pods, *Dichrostachscinera* pods and leaves, browse legumes such as *Leucaenaspp*, *Acacia spp*, *Calliandraspp* and many other forage legumes as protein supplements.
- Feeds that should be fed to animals should be guided by the intended use of the animals and stage of production as shown in Figure 9-1

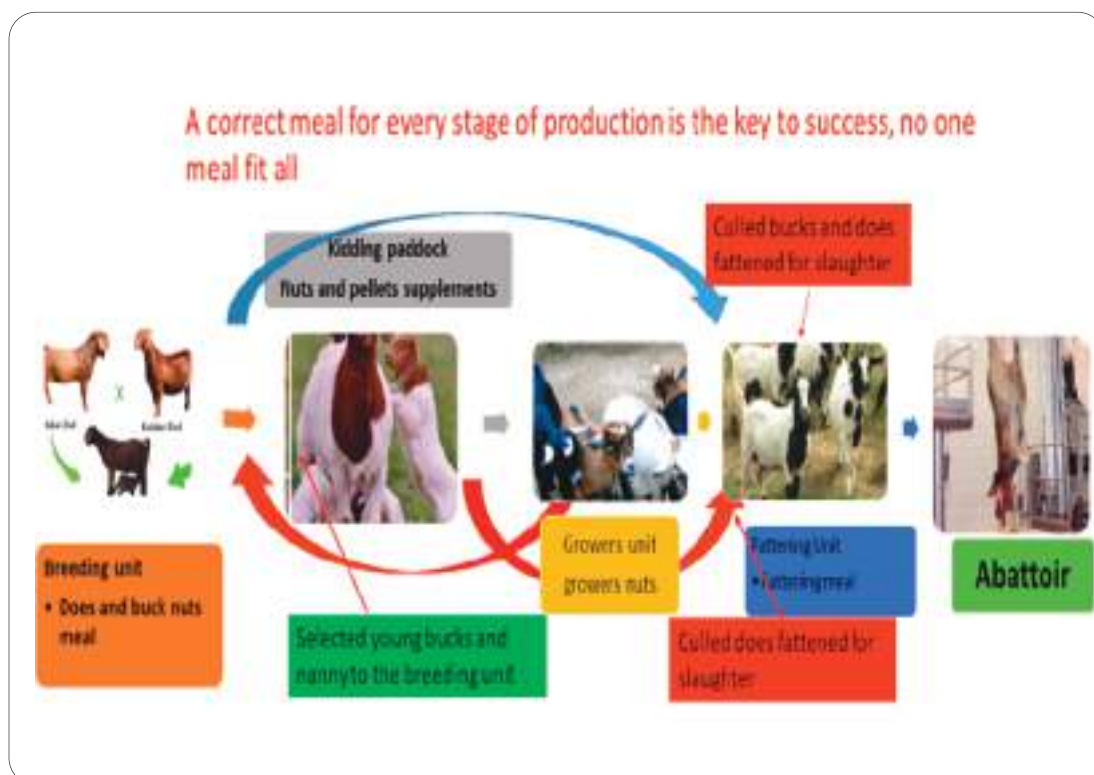


Figure 9.1: Goat farm units and feeding regimes

9.5.1 Conventional feeds

- They are feeds that are commercially formulated.
- These are balanced diets specially formulated for a specific group of goats.
- Conventional feeds can be found in different categories such as creep feed, buck and doe meal, and lactating doe meal, goat nuts and pellets.

9.5.2 Non-conventional feeds

- On-farm formulated or blended feeds using various feed ingredients that are locally produced.
- Examples of protein supplements under non-conventional feed are browse legumes, forage legumes and oilseeds such as sunflower seed, cowpea, velvet bean and other legume plant seeds and bush/shrub meals.
- Examples of energy sources are all cereals, hays, crop residues and *Cactus cladodes (dorofiya) pads*.

9.5.2.1 Feeding different classes of goats

- Goats are most productive when fed a balanced diet according to their nutrient demands.

- Hence feed meant for different classes of goats should have different energy and protein levels.
- Breeding females have different nutrient requirements as the stage of production changes.
- Maintenance, gestation and lactation are all stages of production with a different nutrient requirement, hence meeting these requirements is important for efficient production.
- From a practical stand point, body condition scoring should be done every three weeks.
- Body condition score is an important and cost-effective management tool.
- It guides the farmer as to when to start supplementing and when to reduce supplements.
- When formulating diets farmers should take the guidelines as given in Table 8-2

Rations for feeding 30kg does at various production stages in kgs per day

Table 9.2

Ingredient	Maintenance		Gestation		lactation	
	A	B	A	B	A	B
Legume hay	0.9	-	1.25	-	1.170	-
Good quality Grass hay	-	0.75	-	1	-	0.9
Cereal grain	-	0.15	-	0,225	0.18	0.18
Oilseed cake	-	-	-	-	-	0.18

9.5.3 Bucks

- A buck is the most important animal on the farm.
- Bucks should be fed properly with the correct amount of protein per day.
- Good quality hay with crude protein greater than 12 percent is ideal.
- Supplementing them during the dry season with a ration with 16 percent crude protein as with does in the gestation stage will enable them to maintain good health and productivity.
- Body condition scoring should be regularly done and maintain your buck condition score between 3 and 4 all the time.
- Above or below that score will affect the libido and sperm quality and may predispose your buck to ill health.

9.5.4 Does

- Tropical and subtropical goats are unaffected by seasonal variation and can breed throughout the year.

- The breeding cycle begins again as kids begin to mount other kids in just seven days.
- With proper nutrition and maintaining the animal on BCS of above 2.5, does can rebreed within few days postpartum.
- Goats should be offered free choice good quality hay supplement and should consume at least 2.5 to 3% of their body weight.
- Does fed for maintenance may not be supplemented as rangelands and pastures supply adequate nutrients.
- The prime objective is to maintain weight and health and to replenish any losses experienced during lactation.
- Supplementary feeding maybe necessary under drought situation, cold weather and dry seasons associated with feed scarcity.

9.5.5 Breeding females

- During breeding, the practice of flushing females has been used with great success.
- Flushing involves increasing nutrition, particularly energy just before and during the early breeding season.
- The process increases the ovulation rate thus kidding rate
- Three factors affect the response to flushing which are:
 - Age of does,
 - A body condition score of does and
 - Time of the year.
- Mature does in marginal body condition of 2.5 usually respond best to flushing.
- Does in BCS 1 is too thin and flushing will not achieve increased ovulation rate, the does will be in no condition to have normal reproduction cycles.
- Flushing can be done by providing lush pastures or by supplementation with approximately 140 g to 450 g of 12 to 16 % crude protein total mixed ration/head/day.
- Hyper nutrition can begin some three weeks before the males are introduced and continued for an additional three weeks into the breeding season.
- Benefits of flushing are:
 - Increased body condition,
 - Increase ovulation rate,
 - Increase in the number of kids born
 - Increase in number of females cycling early in the breeding season resulting in a greater proportion of females that conceive at the start of the breeding season
- Does should be fed to maintain a BCS of 2.5 to 3 during early gestation.

REMEMBER to do a BCS every three weeks and any observed change please act immediately!!!!

9.5.6 Pregnant does

9.5.6.1 Early to mid-gestation

- Early gestation is the time for partial foetal and placental development.
- Nutrition is very important for adequate development of foetus.
- If the ration is lacking in energy, protein and certain mineral, placental development may be poor resulting in poor foetal growth.
- Poor foetal growth is associated with a reduction in kid survival rate at birth.
- Adequate nutrition is required for proper attachment of the embryo to the uterus.
- The gestation period of does is between 145 to 155 days depending on breed.
- From a practical standpoint we recommend 450 grams to be offered to does of good quality browse legume or forage legume hay.
- During this phase does should be supplemented with gestation ration (Table 8-2.)
- It can be made with an energy source of sorghum or maize bran, and a protein source of cowpea hay or grain, velvet bean or browse legume hay.
- The diet should have approximately 16% crude protein
- Mid-term stress abortion can occur as a result of energy deficiency.
- This is more common in goats under range feeding programme or communal rangeland during the dry season.
- Stress effects are common in goats on rangelands particularly after a weather change, predator attack or a decreased feed intake.
- In Zimbabwe, this is common in October due to early or beginning of the rainy season which is associated with very cold spell affecting all does with a poor body condition score.

9.5.6.2 Late Gestation

- Nutrition during the last six weeks of gestation is more critical.
- Approximately 70% of foetal growth occurs during the late gestation commonly known as the third trimester.
- Inadequate nutrition results in:
 - Poor colostrum production
 - Low birth weight thus affecting survival rate
 - Low energy reserves in the new-born kids also affecting survival rate
 - Increased death losses especially during cold and extreme weather conditions.

- Please note: Birth weight is a very important factor that influences the new-born's survival rate.
- However, the survival rate is influenced by breed, the number of kids born, the age of dams and the dam's pre-parturient diet.
- In most cases, kids weighing less than 1.5-kilograms birth weight fail to survive resulting in increased death rate during the first 24 hours post-partum.
- Also, overfeeding of energy may cause **obesity** in does and contribute to kidding problems such as **dystocia**.
- Therefore, good nutrition to meet the nutrient demand is the key.
- It should be remembered that more problems are associated with underfeeding than overfeeding during late gestation.
- It is recommended to offer goats some concentrates during late gestation.
- This is recommended because during late gestation the capacity of the rumen is greatly reduced.
- A large uterus filled with many foetuses physically limits the rumen capacity.
- Feeding approximately 150 to 250 g of concentrate per day will be good for the doe and the ration should have approximately 16% crude protein content.
- It is also wise to supplement does with concentrate high in energy so that the animal reduces the use of its body energy reserves.
- Excess use of body fat reserves can result in pregnancy toxemia although goats are slightly resistant to this condition.
- Still birth, pregnancy toxemia and poor milk production are all indicators of feeding an energy-deficient diet in the late gestation.
- A good quality diet should be provided during late gestation to support milk and colostrum production.

9.5.6.3 Lactating does

- Milk production peaks in two to three weeks after parturition and declines rapidly to low levels by the 8th to 10th week after parturition.
- Milk production during the first four weeks is very important for kid growth and survivability.
- If milk production is low, the kids may exhibit a suppressed growth rate during early lactation.
- Underfeeding energy during early and late lactation results in higher than expected death losses in kids especially twins and triplets.
- Very low milk production results in kids that are poorly kept, thin and weak.

9.5.7 Kids

- Are young ones of a goat

9.5.8. Newly born kids

- Newly born kids should get colostrum within 3 hours after birth.
- In the unfortunate event of the death of the does artificial colostrum can be made or frozen colostrum from other does can be fed to the kid using a bottle-feeding method.
- The following recipes shared by a few goat breeders can come in handy when you need to make your own colostrum replacement:-
- Recipe 1:
 - 1 litre of goat/cow's milk
 - 250 ml fresh cream
 - 1 egg yolk from a chicken on your farm.
- Take care in separating the white from the yellow as the egg white cause diarrhea.
- Recipe 2:
 - 1 litre milk
 - 1 egg yolk
 - 1 teaspoon of glucose powder
- Recipe 3
 - Half litre milk
 - Half litre warm water
 - 1 egg yolk
 - 1 teaspoon castor oil
 - 1 teaspoon cod liver oil
- As a guideline feed 4-6 times daily to achieve 10-15% of the kid's body weight per day.
- Some farmers feed the colostrum replacement for 24hours and some do it for 4 days.
- It is also recommended to warm the mix to the goat's body temperature of 38-40 degrees Celsius.
- Also disinfect the tits and bottles thoroughly before after each feed to avoid contamination.
- If you are feeding the mix for more than a day, make fresh mixes each morning.
- Bottle feeding is for orphaned kids on milk replacers or cow milk
- Milk replacers are expensive and labour intensive hence we recommend fostering as the first option of helping an orphaned kid.
- Orphaned kids should be given 10 to 20% of their body weight of colostrum with 3 to 12 hours from birth.

- Creep feeding is a high-quality diet that should be introduced to kids from day 3 of birth.
- Creep feeding is done to:
 - Promote an adequate intake.
 - Provide all essential nutrients for rapid growth.
 - Help kids to get used to eating solids feeds in preparation for weaning
- Creep feed for goats can be made using guidelines give in Table 9-3

An example of creep feed for kids

Table 9.3

Ingredient	% inclusion level
Cereal (Sorghum, Maize, or millet)	33
Cotton seed cake, Soya, Cowpea	10
Molasses	5
Trace mineral salt	0.5
Ammonium chloride	0.5
Limestone flour	1
Browse or forage legume	50
TOTAL	100

9.5.9 Weaners

- Early weaning is carried out at 3 to 4 weeks, but the best results were observed when weaning is done between 8 to 12 weeks old.
- The best is to wean kids when they are weighing between 7 to 11 kg and consuming about 200 grams of creep feed or % of mature body weight
- Remember weaning is a stressful condition hence kids should be accustomed to eating from feed trough and drinking from water trough to avoid major shocks that can lead to death losses.
- If excellent grass hay (12% CP) and browse legumes hay is available, this can be the sole source of feed.
- Depending on when the weaned kids will be marketed, the following diets can be fed to weanlings and grower goats.
- Feeds can be formulated at the farm level using the given guidelines in Table 9-4.

Sample of grower and finisher meal

Table 9.4

Ingredient	% inclusion level	
	Growers meal	Finisher meal
Cereal (Sorghum, Maize, or millet)	35	73.2
Cotton seed cake, Soya, Cowpea	15	-
Molasses	5	5
Trace mineral salt	0.5	0.5
Ammonium chloride	0.5	0.5
Limestone		0.8
Browse or forage legume	40	20
Total	100%	100%

9.6 Activity

1. Farmers should conduct a BSC assessment during training.
2. Farmers to formulate creep, grower, and finisher meal.
3. Farmers to practice weighing goats during training.

10.1 Objective

1. To train farmers on on-farm forage production.
2. To know species of forage and fodder which can be produced at the farm level.
3. To train farmers on forage conservation and the importance of dry season management.

10.2 Outcomes

1. Learners should be able to know forage production at the farm level.
2. Learners should be able to know species of forages suitable in their areas.
3. Learners to know hay and silages making for dry season supplementation.

10.3 Forage and forage quality

- Forages are a major asset or feed input of any livestock operation and the foundation of most rations in a forage-based livestock diet.
- The available nutrients in a forage crop influence individual animal production (e.g., gain per animal), while the amount of forage produced affects production per acre.
- Forages contain a mixture of chemical, physical, and structural characteristics that determine the quality of pasture and the accessibility of nutrients to the target animal.
- The decision of whether to use conserved forage (hay) or to allow livestock to graze—as well as choices related to the purchase and selection of hay—should be based on forage quality.
- Forage quality can be defined in many ways. Forage quality is associated with nutrients, energy, protein, digestibility, fibre, mineral, vitamins, and occasionally animal production.
- For goat production, the ultimate quality test of forage is animal performance.
- In practical terms, forage quality has been referred to as “**milk in the bucket.**” In programs for producers, forage quality has been described

as **“kg on the scale,”** and sometimes livestock reproductive success is incorporated in defining forage quality as **“kids on the ground.”**

- Forage nutritive value typically refers to the concentration of available energy (total digestible nutrients, or TDN) and concentration of crude protein.
- By contrast, forage quality is a broader term that not only includes nutritive value but also forage intake.

10.4 Change in Forage Quality

- Not every plant will have the same nutritive value due to weather conditions and forage stage of maturity.
- The principal factor responsible for declining forage nutritive value are:
 - Stage of growth: growth beyond the first couple of weeks (where protein and digestibility are highest).
 - Deposition of fibrous components at the plant cell level.
 - With advancing maturity: lignin, a component of fibre, is essentially indigestible, acts as a barrier to fibre degradation by rumen microbes.
- If the forage is too mature, fibre is more prevalent in the forage, and digestibility of the forage declines; crude protein (CP) also declines in the forage tissue.
- Additionally, poor storage and harvest conditions lead to sugar losses when forage becomes weathered.
- Forage that is harvested and not properly dried continues to respire, causing soluble sugars to decrease.
- Other factors affecting forage quality are fertilization, season, pre- and post-harvest management, and presence of anti-quality factors.

10.5 Forage conservation

- As explained above the quality and quantity of forage fluctuate between and with the season.
- This affects production hence it is wise for farmers to conserve forage during a period of abundance.
- Zimbabwe experience eight months of dry season associated with very poor-quality forage resulting in performance decline in animals during the eight months.
- There is a great decline in BCS, low milk production, and the death of goats due to protein-energy malnutrition.
- To arrest such challenges farmers must grow fodder in fodder bank and conserve the fodder for dry season supplementation.
- Fodder can be conserved as silage or hay.

10.5.1 Silage

- Silage can be made by preserving green crops or grass with a moisture content of approximately 65 to 75 in an air-tight pit or plastic paper.
- The absence of oxygen promotes the formation of lactic acid which becomes the preservative of the fodder.
- Silage is normally made in February to March period with crops that have reached the milk dough stage.
- Native grass such as thatching grass can be used to make silage.
- Other grasses that can be used in making silage are Bana grass, natural pasture grass, maize and sorghum as well as many forage legumes.
- Cactus can also be used in making silage for dry season feeding of goats.

10.5.2 Hay

- Hay is produced through air drying green fodder or grass.
- Unfortunately, most farmers in Zimbabwe produce hay during the April period and it will be of very poor quality.
- Farmers should have drying shade and make hay during the rainy season by drying the grasses and other fodder under shade.
- Hay that is produced during the rainy season is difficult to dry but will be of good quality with above 7 % crude protein content.
- Hay will be used during the dry season.
- Hay produced from pasture reinforced with forage legume tends to be better quality than hay produced in monoculture pasture or rangeland.

10.6 Non-conventional protein supplements

- To succeed in goat farming, all farmers must formulate their feeds.
- Farmers should identify local resources they can use in diet formulation.
- The use of non-conventional feed resources is gaining popularity the world over.
- Several plants that grow naturally in the rangelands can be used as sources of nutrients.
- For this manual, we will list some of the popularly used protein sources and grass that can be grown in fodder banks for goats feeding.
- Examples of non-conventional protein sources are:
 - Siratro meal
 - Leucena meal
 - Dichrostachys meal
 - *Pilliosmathoningii* meal
 - Acacia meal
 - All other feed stuff not yet commercially used.



Figure 10.1: Alfaalfa *Medicago sativa* forage legume

- Figure 10-1, Figure 10-2 and Figure 10-3 show examples of forage legumes that can be used in goat production by farmers.
- *Trifolium repens* and Alfalfa can be used by farmers from high rainfall zone while Siratro and fine stem can be used in drier areas.
- Other naturally growing weeds such as *Richardia scraba* can be harvested during weeding and used as a winter supplement.
- All these forage plants have crude protein content above 18% and can be used to stimulate growth in kids and lactating does.



Figure 10.2: *Trifolium repens*



Figure 10.3: Siratro (Macroptilium atropurprium) growing at Makoholi Institute for protein supplement

- Siratro can be harvested three times per year: October, March and May.
- The harvested fodder is dried under shade and used as a protein supplement to goats.
- 200 gram per day per lactating doe was sufficient to promote a high growth rate in kids and an increasing kidding rate to over 125%.



Figure 10.4: Browse legume grown for protein supplement

- Figure 10-4 shows an example of browse legumes that can be grown at the farm level.
- These are multipurpose trees with the capacity to fix atmospheric nitrogen and phosphorous in the soil for soil improvement.
- The browse trees such as *Leucaena*, *Acacia*, *Gliricidia*, *Calliandra*, and other species can be grown in an alley with other groups.
- The plants can be harvested three times per.
- They can produce up to five tonnes of biomass hay per year.
- The hay is of good quality with a crude protein content of greater than 220 g /kg and a digestibility coefficient of above 65%.
- Feeding 200 to 300 grams every other day improved goat production.
- Browse legume hay can be mixed with fresh cactus during the period of silage making which was used to feed goats.
- Farmers in a drier area can as well produce high-quality fodder from cactus. Cactus can be feed to goats as a source of carbohydrate and water.



Figure 10.5: Energy and water source cactus *Opuntia ficusindica*



Figure 10.6: Hybrid Bana grass for fodder bank establishment

- Figure 10-6 shows Bana grass commonly used for silage and hay production.
- It can produce a lot of biomass approximately 7 and above tonnes with about 12% CP.
- It can be grown as an intercrop with velvet bean and siratro.
- Table 10-1 shows the type of forage legumes that can be used by goat farmers in different regions according to altitude and rainfall received.
- If these plant species are used soil quality will be improved and the biomass harvested will be good for goat production

Forage legume agronomic requirement

Table 10.1

Species	Soil type	Rainfall (mm)	Altitude (m)	Remarks
1'8&;3!				
53", "%>./0-".6-412/?6\$/"!(\$33*\$^!	3\$+93!	EDP!m!	"!HPP!	T';*Z70/340\$4!\$++&\$%C!K0/%* *-! 3'9'0C!T"9*+8!0\$4'O!A!58!)\$Z"C!
D-B\$60"1-3%094/"1%T(0\$)\$;! 34L%/^!	3\$+93_! 3\$+9L! -%\$L3!	q!HPP!	r"!HPP!	K'0'+*%\$C!T"9*+8!0\$4'O!H!58!)\$Z"C! =//9!0'3*34\$+-'!4/!\$+4)0\$-+/3'C!
D-B\$60"1-3%03/776>"76/2%0]Nb%L!*+'Z34';!34L%/^!	3\$+93!	EPP!Z"! PPP!	q"!APP!	K'0'+*%\$C!T"9*+8!0\$4'O!*3!HZJ!58!)\$Z"C!T&3-'74*B%!'4/!\$+4)0\$-+/3'C!
D-B\$60"1-3%03", "!"#0\$+!34L%/^!	3\$+93_! 3\$+9L! -%\$L3!	EDP!Z"! PPP!	r"!HPP!	[0/&8)4!4/%'0\$+4C!T"9*+8!0\$4'O!H! 58!)\$Z"C!
D-B\$60"1-3%00>"T)0&BBL! 34L%/^!	3\$+93_! 3\$+9L! -%\$L3!	qEDP!	r"!HPP!	K'0'+*%\$!\$+9!0'-4C!T"9*+8!0\$4'O! H!58!)\$Z"C!
T">.6-B\$6, ""L/\$\$.%&0-)'0!	3\$+93_! 3\$+9L! -%\$L3!	q!PPP!	q"!PPP!	K'0'+*%\$!\$+9!4<*+*+8C!T"9*+8! 0\$4'O!HZ!D!58!)\$Z"C!
T">.67-/\$/4, ".674.74.%4,]T*0\$4 0^!	3\$+93_! 3\$+9L! -%\$L3!	EDP!Z"! PPP!	r"!DPP!	K'0'+*%\$!\$+9!4<*+*+8C!T"9*+8! 0\$4'O!EZ!S!58!)\$Z"C!
O%4>"%1"\$%4>6>%4T'8-\$+\$^!	3\$+93_ -%\$L3! 3!	EDP!Z"! PPP!	r"!HPP!	K'0'+*%\$!3)0&B!0!40'C!K%\$+4'9!*+! 0/<3!H!;!\$7\$04C!
	&	&	&	&
B2", ,%, &				
,-0/'0\$3;\$-0&;!JM*%!80\$33`!	3\$+93_! 3\$+9L! -%\$L3!	q"!PPP!	r"!DPP!	K0/340\$4!\$+9!34/%/+*.'0/&3C!63'9! 4/!0*+./0-'!2%*3!0/;!0&+03C!
K"1/>4, &. %7%TQ/07'9/!80\$33`!	T\$+93_! 3\$+9L! -%\$L3!	q"!PPP!	r"!DPP!	V)*e/;\$4/&3C!63'9!4/!0*+./0-! 2%*3!0/;!0&+03C!
K"07"\$4.4.F%\$24670*8)4! 7\$37\$%&;^!	3\$+93_! 3\$+9L! -%\$L3!	q"!PPP!	r"!DPP!	?%\$%!B&+-)!80\$33!/0!0*+./0-*8! 2%*3C!T"9*+8!0\$4'O!"D!58!)\$Z"C!

10.7 Activity

1. Conduct a training workshop on fodder production.
2. Farmers to conserve fodder as silage and hay with the trainer.
3. Demonstrate how these conserved fodders can be used during the dry season.

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