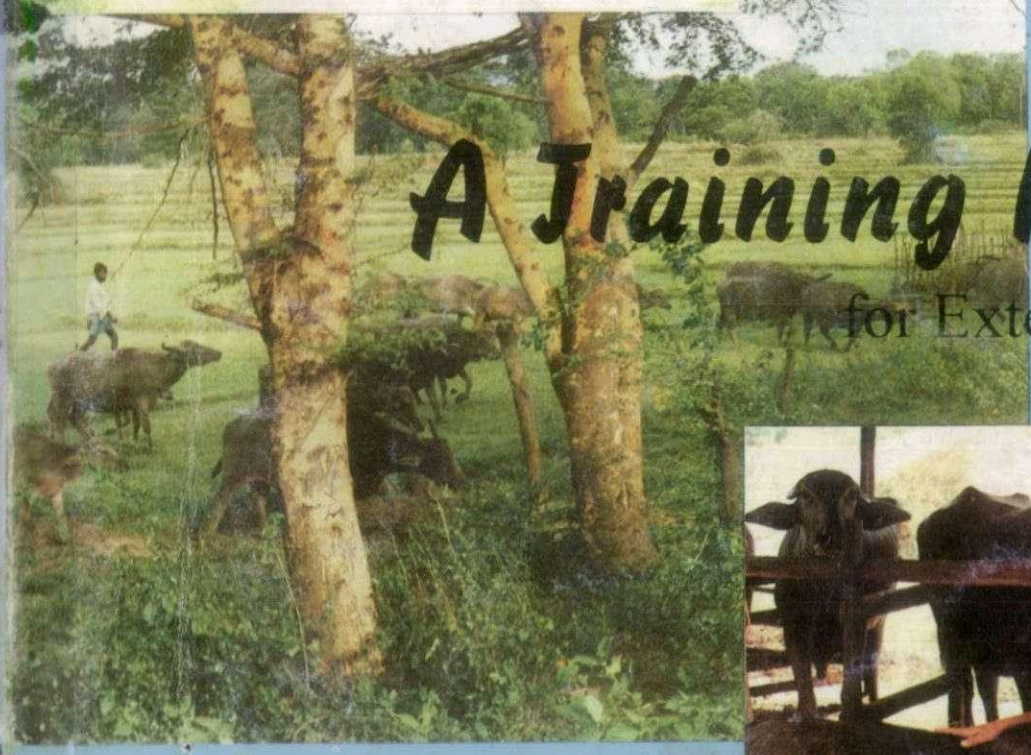
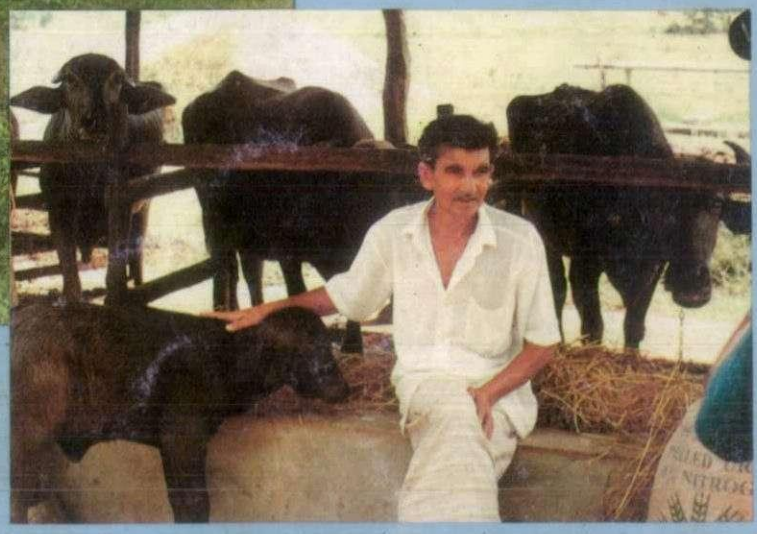


Cattle and Buffalo Farming

A Training Manual

for Extension Workers



SAREC/NARESA Buffalo Research
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A Training Mannual for Extension workers

CATTLE AND BUFFALO FARMING

A TRAINING MANUAL

FOR

EXTENSION WORKERS

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PREFACE

In developing countries, livestock will continue to play an important role as a source for income millions of rural farmers. Besides the direct benefits to the farmer, the livestock sector provides several other benefits including employment and income generation, that together make an important contribution to the economic development of the country,. The dairy farmer, in recent times, has had to face many difficulties in maintaining his dairy farming activity as a viable enterprise. The real income from livestock products has gradually declined over the years. The consistent cry of the dairy farmer has been for a higher farm gate price for his milk, which has not received adequate consideration in the past. It is unlikely that milk prices will be increased in the near future, because of globalisation of free trade under GATT and liberalisation of trade within SAARC countries under SAPTA. Hence, the only option left to the livestock farmer is to optimise the utilisation of his limited resources and to maximise the output per unit of farmland.

In this context, genetic upgrading of animals, strategic feeding of livestock with fibrous feed and agro-industrial by-products and the adoption of appropriate management practices appear to be the only course open to him for improving the productive and reproductive efficiency of his farm enterprise. This task invariably depends on the his ability to adopt improved management practices, which in turn depends on the opportunities available to him to improve his knowledge base and his competence in all aspects of livestock farming. The task of educating the farmer lies in the hands of the livestock extension staff of the animal production and health sector.

Our interaction with field staff has revealed that the extension staff lack appropriate training material for this purpose. Therefore, the purpose of preparing this manual is to fill this need.

This training manual is arranged in two parts. Part I sets out the objectives of training and the messages to be transferred to extension staff in 10 training sessions, which cover all aspects of dairy buffalo and cattle farming. Part II provides the background material and technical information to help the trainer to prepare his training material.

We wish to acknowledge the encouragement given to us by Prof. Priyani Soysa, Chairperson of the National Science Foundation (formally, Director General of NARESA), to achieve the primary objective of phase 3 of the SAREC/NARESA Research and Development Programme, which is the dissemination of research information to the end-user. Moreover, we wish to record our appreciation of the contributions made by the subject matter specialists, Dr. M.C.L.de Alwis, Prof. A.N.F.Perera, Dr. (Ms) E.R.K.Perera, Dr. M.N.M.Ibrahim, Dr. N.U.Horadagoda, Dr. M.G.Jeyaruban, Dr. B.M.A.O.Perera and Mr. Premalal, who contributed their knowledge and experience in the preparation of this training manual. We also wish to thank Mr. Janaka Herath for the technical assistance and Mr. T.D. Niroshan for art work provided by them.

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J.A. de S. Siriwardene
D.H.A. Subasinghe

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Instructions to Trainers

This training manual is organised in 2 parts.

Part I Provides instructions to trainers on the training procedure to conduct 10 training sessions covering the following topic, nutrition (Lesson 1 to 5), reproduction (Lesson 6), breeding (Lesson 7), health (Lesson 8), management (Lesson 9) and crop livestock integration (Lesson 10). The instruction note for each session gives,

(a) Lesson objectives
(b) Methods of instructions
(c) Key points on the subject matter to be discussed and impart to the farmers.
(d) Method of evaluation.

Part II Provides material for lesson preparation. The material is presented in 10 chapters. Each chapter provides information on the respective topics to assist the trainer to prepare his or her teaching material.

It is important to note that these lessons have been arranged in a particular order, based on our experience. It is recommended that the trainer should follow this order, to ensure clarity and a sequential approach in conducting the training. However, if the trainer wishes to deal with particular aspects of a lesson, he could pick up the relevant information in preparing the training material. For this reason, repetition of subject material in different chapters has been intentionally introduced for the convenience of the trainer.

Ten information leaflets have already been published by the project for use by farmers. The information presented in these leaflets would be useful to the trainer in preparing his teaching material. These could be obtained from the National Science Foundation at a very nominal price.

After each training session, trainers are advised to conduct an evaluation to assess the success of your training. For that purpose a short questionnaire for each session has been included in each instruction in Part 1, to help the trainer to develop his own questions.

PART 1

TRAINING SESSIONS 1 TO 10

Objectives and Lesson Contents

Instructions to Trainers
on
Procedures to Conduct the training Course

Training Session 1: Basic principles of fibrous feed utilisation by ruminants

1.1 Introduction

Most small holder farmers do not have a clear understanding of the mechanisms by which buffaloes and cattle use fibrous material, such as grass and fodder, as feed. This lack of knowledge most often leads to underfeeding of animals, which results in low production and poor reproductive performance. A common complaint of farmers is that green grass is scarce and that concentrate feed, such as poonac, is too expensive. Even though there are plentiful supplies of fibrous feed such as crop residues (rice straw) and tree fodder (ipil-ipil, glyricidia, and calliandra), they are very seldom used as animal feed. The reason for this is that such material is not readily consumed and their utilization by the animal is poor.

The feeding of concentrate has become uneconomical when considered in relation to existing prices of outputs (i.e. milk and meat). Therefore, in order to reduce feed costs, it is important for small holder farmers to understand the processes of digestion in the ruminant and to learn how to take advantage of the ability of the ruminant to digest and utilise seemingly unacceptable and indigestible coarse fibrous feed. They should learn to use crop residues like rice straw and adopt strategic but low cost feeding systems, utilizing locally available feed resources as far as possible. As fibrous feeds are deficient in some important nutrients, and are also low in palatability (e.g. rice straw), farmers should learn to supplement the deficient nutrients in low quality roughage, through supplementary feeding.

1.2 Objectives of the training session

This is the first of 10 training sessions on cattle and buffalo farming and the primary purpose of this lesson is to lay the foundation for acquiring knowledge on different aspects of management that will be discussed in the next 9 training sessions.

The specific objectives of the lesson are to:

(i) create an understanding of the role of the complex stomach of the ruminant in the digestion of fibrous feeds.

(ii) understand the basic principles of rumen microbial digestion.

(iii) understand the characteristics and limitations of fibrous material as feed.

(iv) create an awareness of the methods that could be adopted to overcome limitations in the use of fibrous feed material.

(v) demonstrate the benefits that can be obtained with the use of fibrous material and non-conventional feed resources as ruminant feed.

1.3 Methods of training

This training session could be conducted as a classroom lecture, with emphasis on discussion. To make the session interesting, use audiovisual aids if available, such as slides and transparencies. If such facilities are not available, prepare posters using the diagrams given in Chapter 1 in Part II of this manual. It is important to conduct the session in a discussion form rather than as a formal class room lecture.

1.4 Messages to be transferred

The lesson is expected to transfer the following messages to the trainees. The subject material for this training session is presented in Chapter 1 of Part II of this training manual.

(a) *The ability of the ruminant to digest fibrous feed:* The differences in the anatomy and functions of the rumen stomach and the simple stomach of the monogastric animal. A brief description of the microbial digestion processes.

(b) *Characteristics of fibrous feed material:* The nature and characteristics of fibrous feeds and the availability, composition and nutritive values. The trainees should have a good understanding of the possibilities of overcoming feeds shortages and deficiencies by adopting management practices utilising the resources available in small holder farms.

(c) *Limitations in use of fibrous feeds:* The reasons why farmers do not use fibrous material in feeding of ruminants. The limiting factors that adversely effect the efficient utilisation of such material.

(d) *Methods of overcoming feed shortages and deficiencies*: A brief description of the available resources are non-conventional feed resources such as crop residues (e.g. rice straw, maize stover, sorghum stover and straw from legume crops like green grass, cowpea, soya bean, etc.) and agro-industrial by-products such as molasses sugar cane bagasse, fruit and cannery waste, waste tea leaves, poultry litter, etc. The physical, chemical and feed supplementation methods that can be used to improve feed intake and quality.

(e) *Feed formulation*: A knowledge of the feeding values of grasses, forage, fibrous feeds (including non-conventional feeds and agro-industrial by-products) should be imparted. Practical training should be provided to enable trainees to acquire competence in the formulation of feed mixtures.

Information on the use of fibrous material as feed for ruminants is given in Chapter 1 of Part II. Use the information provided in Chapter 1 to prepare instruction material.

1.5 Evaluation

Using the questions given below, evaluate the knowledge gained by the trainees during the training session you conducted.

Q.1. How do ruminant digest fibrous feed?

Q.2. What are the problems associated with feeding fibrous feeds?

Q.3. How could you overcome the problems associated with feeding your cattle and buffaloes?

Q.4. How do you improve the digestibility of low quality fibrous feed such as straw?

Q.5. What are the advantages of using of non - conventional feeds, such as straw, tree fodder and urea - molasses - mineral feed supplements?

Training Session 2: Use of Urea-Molasses-Mineral (UMM) multinutrient supplements as ruminant feeding

2.1 Introduction

As discussed in Training Session 1, ruminants can use fibrous feed material in the diet to meet their energy, protein and mineral requirements. Digestion in the rumen takes place through the action of microbes (i.e. bacteria and protozoa) that live in the rumen. To ensure optimum efficiency of microbial digestion of fibrous material, microbes require the presence of adequate levels of nutrients to meet their own nutritional requirements in terms of soluble sugars, nitrogen, vitamins and minerals. However, most fibrous feeds supplied to the animal are of poor quality and deficient in soluble sugars, nitrogen, vitamins and minerals. Hence the microbial digestion process is hindered and this in turn impairs the efficiency of utilisation of fibrous material by the animal. In the Training Session 1, three ways of improving the digestibility of fibrous feeds were briefly discussed. These methods are 1) physical treatment, 2) chemical treatment and 3) supplementation. Under supplementation, four types of feed supplements, namely (a) urea, (b) urea-molasses-mineral (UMM) multinutrient feed supplements, (c) tree fodder and (d) concentrates were listed. In this lesson, the use of UMM multinutrient feed supplements in ruminant feeding will be discussed in detail.

2.2 Objectives of the training session

The objectives of the lesson are to:

(i) Improve the understanding of the rumen microbial digestive processes

(ii) Provide an in-depth understanding of the ways by which poor quality fibrous feeds derail microbial digestive processes and how both microbial activity and utilisation of fibrous feed can be improved.

(iii) Educate the trainees on the use of Urea-Molasses-Mineral Multinutrient feed supplements to improve the efficiency of rumen microbial digestion of low quality fibrous feeds

(iv) Create an awareness of the availability of various forms of UMM multinutrient feed supplements in the market and methods of using these in small holder farms

2.3 Methods of training

A part of training session could be conducted in the form of classroom lecture - discussion with ample use of audiovisual aids, such as poster boards depicting the key information given in Chapter 2 of Part II. It is desirable that the trainees are taken to a location where UMM

multinutrient feed supplements are produced or to show a farm where UMM multinutrient feed supplements are fed along with poor quality roughage.

2.5 Messages to be transferred

This lesson is expected to transfer the following messages to the trainees. The subject material for this training is presented in Chapter 2 of Part II of this training manual. Use that material to prepare your training material.

(a) *Rumen microbial digestion:* Recapitulate the microbial fermentation processes that occur under normal conditions of feeding. Discuss in detail the metabolic processes that occur in microbes to promote growth and multiplication. The effect of churning movements of the rumen musculature on mixing of rumen digesta and the flow of microbes from the rumen/reticulum into the omasum and abomasum and finally into the small intestine. The trainees should understand the role played by by-pass protein and non-protein nitrogen in digestion and metabolism in the ruminant.

(b) *Strategic use of UMM feed supplements:* The basic concept of supplementation of nutrient deficiencies in poor quality feeds, the stimulating effect of balancing nutrient deficiencies on microbial growth and thereby the improvement in the efficiency of utilization of fibrous feeds should be discussed. In this context, the importance of the nutrient composition of various types of feed material, paricularly in relation to the deficiencies and extent of imbalances that exist in nutrients should be explained.

(c) The importance of maintaining the stability of the rumen environment, particularly the rumen NH_4-N concentration in the rumen liquor at the optimum level, should be discussed. The methods of feeding UMMB under different feeding management systems and the limits of use should be clearly explained.

(d) The composition of UMM formulations, the methods of production and also the precautions to be taken in mixing, packaging and storing UUM supplements should be taught.

(e) Trainees should be made aware of the possible dangers in feeding UMMB above the recommended levels. They should be aware of the reasons why caution should be exercised in feeding UMMB to ruminants under the age of 6 months.

(f) Information of the sources of supply and the cost effectiveness of feeding UMMB should be provided.

2.5 Evaluation

Using the questionnaire given below evaluate the extent of knowledge gained from the training session you conducted.

Q.1. How do ruminants digest the fibrous feed that they ingest?

Q.2. How do microbes obtain their nutrient requirements?

Q.3. What are the major nutrient requirements of microbes?

Q.4. What are the methods of supplementation available to supply deficient nutrients to rumen microbes?

Q.5. What is the composition of UMM preparations available in the market and from where you could purchase these?

Training Session 3: Use of tree fodder in ruminant feeding

3.1 Introduction

As described in Training Session 1, ruminants use fibrous feed (grass, fodder, tree loppings, rice straw etc.) as feed to meet their energy, protein, vitamin and mineral requirements. We also discussed problems of ruminant feeding and mentioned that the use of tree fodder is one of the ways of overcoming the limitations faced by the small holder farmers in providing feed to their stock.

3.2 Objectives of the training session

The objectives of the training session are to:

(i) Provide information on the nutritive value of the different varieties of tree fodder, commonly found in the country, that could be used as animal feed.

(ii) Discuss the advantages of feeding tree fodder and also the limitations.

(iii) Provide information on the methods of using tree fodder as a supplementary feed for cattle and buffaloes.

3.3 Method of Training

This training session could be conducted as a class room lecture-discussion, using audiovisual aids such as poster boards etc. If a suitable demonstration farm is available, the class room lecture- discussion should be followed by a field visit.

3.4 Messages to be transferred

It is expected that the following messages will be transferred to the trainees. The subject material for this training session is presented in Chapter 3 of Part II of this training manual. Use that material to prepare your training material.

(a) Tree Fodder Varieties: Fodder trees are commonly found in many home gardens, in scrub land, around human dwellings and in communal lands. They can also be cultivated in integrated small farms to serve as useful multipurpose trees. These trees are generally grown as shade trees and they have the advantage in that they are drought resistant.

Fodder trees can be categorized as naturally growing or cultivated varieties. The table below gives a list of both categories that can be used in feeding of ruminants.

Natural growing	Cultivated
Jak	Gliricidia
Neem (Kohomba)	Dadap
Gansooriya	Calliandra
Tamarind (Siyabala)	Ipil-ipil
Maila	Desmodium
Palm	Flemingia
Weera	Sesbania
Wild Sunflower (Eramadu)	Albizia
Keppettiya	Accasia
Bo	
Nuga	
Murunga	
Kathurumurunga	

The method of cultivating these fodder trees in a home garden will be discussed in Training Session 10.

(b) *Feeding values of tree fodder varieties:* The feeding or nutritive value of tree fodder varies with the stage of harvesting of the plant. Tree fodder is high in protein (12-25%), in lignin (6-18%) and also in dry matter (35-75%). The crude protein, crude fibre, ether extract (fat), lignin and dry matter contents of tree fodder are given in the Chapter 13. Tree fodder also contains some substances that could be toxic to animals, if consumed in excess of tolerable amounts. Further, feeding excessive amounts could cause bloat (excessive gas production in the rumen). Therefore, it is recommended that when tree fodder is fed to animals, the quantity must not exceed 1/3 of the total forage ration.

(c) *Methods of feeding tree fodder:* Tree fodder could be used as a regular feed supplement to animals whose basal diet consists of poor quality grass and/or straw which are poor in soluble carbohydrates, nitrogen and minerals.

Guidelines for feeding of tree fodder to different types of dairy cows and buffaloes are given in Chapter 3 and also in Chapter 10 of Part II of this manual.

3.5 Evaluation

Using the questionnaire given below evaluate the extent of knowledge gained by the trainees from the training session you conducted.

Q.1. List a few varieties of fodder trees found in home gardens and the vicinity of small farms.

Q.2. Tree fodder is rich in one of the most important nutrient for ruminant. Name the nutrient.

Q.3. Tree fodder could be used as a feed supplement to cattle and buffaloes. What is the recommended level of feeding tree fodder to ruminants.

Q.4. What will happen if you feed tree fodder in excessive amounts to ruminants?

Training Session 4: Guidelines for feed formulation

4.1 Introduction

Feed costs account for 40 - 80 percent of the cost of production of milk depending on the feed resource base and the type of management system. One way of increasing the gross margin of agricultural produce is by reducing the cost of production.

There is evidence to show that in most instances, cattle and buffaloes are either underfed or overfed when viewed in terms of their production potential. In the former situation, animals will lose body weight and produce or reproduce at a level of efficiency below their potential capability, thus bringing about economic losses to the farm operation. On the other hand, in situations where animals are overfed, losses are incurred, because the feed that is consumed over and above the production requirements, does not result in an incremental increase of milk production and reproductive capacity. Excessive feeding of animals above their production potential will in no way increase productivity. The excess nutrients are either converted to body fat or are lost through the excretory processes. Apart from these two extreme situations, most diets of animals are not balanced in terms of the carbohydrate : protein (including non - protein nitrogen) : mineral ratios, required for optimal utilization of nutrients. Such situations lead to economic losses, as the animal will produce below their potential capacity. In the Training Session 1, it was shown that in general, the basal diet of ruminants is deficient in soluble sugars, proteins and minerals and therefore results in poor utilization of fibrous feed by ruminants. The inclusion of concentrate feed in the diet is one of the conventional ways of overcoming deficiencies, particularly in the feeding of high producing dairy cows and buffaloes.

4.2 Objectives of the training session

The objectives of this training are to:

(i) Create an understanding of the role and economics of concentrates feeding

(ii) Create an understanding of the basic principles of ration formulation

(iii) Provide information on nutrient contents of different feed materials and nutrient requirements of dairy animals in relation to body weight and level of production

(iv) Educate the trainee on the practical application of scientific feeding methods so as to enhance the efficiency of production and reproduction, and optimize the income generation

4.3 Method of training

The session should be conducted in two parts. During the first part, basic principles and information on the nutritive values of different feed material should be conveyed in lecture-discussion form. This should be followed by a practical training session on feed formulation, using the instructions given in Chapter 4 of Part II.

4.4 Messages to be transferred

It is expected that the following information will be transferred to the trainees.

(a) Information on nutritive value of feedstuffs and the physiological functions of different nutrients in feeds.

(b) Practical guidelines for feeding of animals in different physiological states

The subject material for this training session is presented in Chapter 4 of Part II of this training manual. Use this material to prepare your training material.

4.5 Evaluation

Q.1. What are the units of measurement of energy and protein?

Q.2. What do you understand by the term nutritive value of a feed

Q.3. What are the major nutrient components of feedstuffs?

Q.4. What is the minimum level of roughage that must be included in the daily ration?

Q.5. What is the difference between roughage and concentrate?

Training session 5: Body condition scoring system for assessing the nutritional status of buffaloes and cattle

5.1 Introduction

Dairy cattle and buffaloes must be maintained at an optimum level of nutrition to ensure optimum production and high economic returns. Empirical evidence shows that in most instances, animals are either underfed or overfed, due to the ignorance of the farmer to provide the correct feed to meet their nutritional requirements. This is an outcome of inability of the farmer to assess the nutritional needs of his animals and the lack of appreciation of the need to change the level of nutrition to suit the nutritional status of animals. The basic problem is that farmers are not aware of a practical and simple method to assess the nutritional status of animals. This training session introduces a very practical method to assess the body condition score (BCS) of ruminants, which is a measure of the nutritional status, particularly of dairy animals.

5.2 Objectives of the training session

The objectives of this lesson are to:

(i) Educate trainees on the value of maintaining dairy animals in optimum body condition.

(ii) Introduce the trainees to the simple method of assessing the nutritional status of animals.

(iii) Develop skills of trainees to assess the body condition of animals using the body condition scoring system.

5.3 Method of training

This training session is to be conducted in 2 parts. During first part, conduct a lecture - discussion session on the use of body condition scoring system to assess the nutritional status of animals. Use audiovisuals, such as poster boards in the lecture-discussion session. During the second part, conduct a practical session to develop hands-on experience on the use of body condition scoring system on dairy animals.

5.4 Messages to be transferred

It is expected that the following messages will be transferred to the trainees.

(a) The nutritional status of an animal is reflected externally by the body condition. Well-fed animals are fatter than poorly fed animals, which may be thin or emaciated.

(b) selected body regions of the animals. It has been shown that the fat cover of a normal healthy animal is directly related to its nutritional status. Feeding an animal on a high plane of nutrition will result in the deposition of a thick fat layer between the skin and muscle or bone tissues, and a low plane of nutrition will result in the loss of fat between tissues.

(c) The body condition of animals could be estimated using a numerical scale, which ranges from 1 (emaciated animal) to 5 (obese animals).

(d) The body condition is assessed by inspection and palpation of several locations on the body of the animal and a value is assigned on the scale, which reflects the body condition score of the animal. A practical guide on how to make an assessment, and examples of different body condition scores are given for both buffaloes and cattle in tables 1 and 2 of Chapter 5 of Part II.

(e) The optimum body condition of an animal ranges between 3 and 4. The BCS at calving should be 3+ or 4, and following calving, it generally drops but will regain its body condition within 3 to 4 weeks. Poor nutrition lengthens the period taken to regain its condition and the animal will not commence postpartum estrous activity until it regains its body condition to 3 or 3+. Maintaining animals above a score of 4 would not give any financial benefits.

The subject material for this training session is presented in Chapter 5 of Part II of this training manual. Use that material to prepare your training material.

5.5 Evaluation

Using the questionnaire given below, evaluate the extent of knowledge gained by the trainees from the training session you conducted.

Q.1. Why are poorly fed animals thinner and well fed animals fatter?

Q.2. What are the areas one should palpate and/or observe for determining the body condition score?

Q.3. What is the best body condition score for a healthy and fertile cow?

Q.4. Why is a body condition score above 4 is uneconomical?

Q.5. What are the body condition scores desirable for the following physiological states:

(a) a cow at calving.

(b) a cow at 4 weeks postpartum.

Training Session 6: Reproduction in Cattle and Buffaloes

6.1 Introduction

The efficiency of reproduction plays an important role in determining the efficiency of small holder farms and therefore it has an impact on the economic returns. Although, cattle and buffaloes have the potential to attain early sexual maturity and give birth to a calf at an age of less than 24 to 30 months, animals in small holdings very rarely achieve this target. This stems from 2 major factors. First, it is due to the poor genetic potential of animals for desirable characters, such as growth rate. Secondly, it is due to under-nutrition during the prepubertal period. Once the animal gives birth to calf, she should resume oestrous activity within 45 to 60 days following calving and become pregnant within 90 days after calving. This allows the cow to calve down once every year. This is most often not the case and cows take a very long time, sometimes as long as 3 to 4 months to resume oestrous activity and thus require 3 to 4 services for conception. The delay in the onset of oestrous following calving is primarily due to poor nutrition, while other factors such as free suckling by calves, peripartal diseases and the age of the cow also play a role. The delay in getting a cow to conceive following the onset of oestrus activity is primarily due to problems of poor heat detection, the delay in getting cows in oestrus served at the right time and problems associated with the quality of the semen and the competence of the technician.

6.2 Objectives of the training session

The objectives of the training session are to:

(i) Provide information on the sexual cycle of cattle and buffaloes, so as to improve the capability of farmers in managing animals to achieve optimal reproductive efficiency, by ensuring (a) early puberty (b) early first calving and (c) the birth of a calf every year.

(ii) Create an awareness of the importance of heat detection and mating the cow at the right time.

(iii) Create an understanding of the factors that effect reproductive efficiency

(iv) Explain the value of keeping record of reproductive events in herd management

(v) Explain the impact of proper reproductive management on economic returns

6.3 Method of Training

This training session should be conducted in the classroom in a lecture/discussion form with ample use of audiovisual aids such as posters, pictures and charts. As most trainees will have

a fair knowledge of some of the aspects of reproductive events, such as detecting oestrus, handling parturition, etc., the training session must be conducted in the form of a discussion, with the active participation of trainees.

6.4 Messages to be transferred

It is expected that the following messages will be transferred to the trainees.

(a) Factors that influence the development of sexual maturity and steps to be taken to ensure the early attainment of maturity. The economics benefits of reducing the age at first calving.

(b) The phases of the sexual cycle, the duration of the oestrus period, heat detection, the optimum time for mating and insemination and the procedures to follow to ensure a successful conception.

(c) The role of the endocrine system of the animal in reproduction and the changes that are brought about by the influence of hormones, with special reference to the onset of oestrus, ovulation, maturation and fertilization.

The subject material for this training session is presented in Chapter 6 of Part II of this training manual. Use that material to prepare your training material.

6.5 Evaluation

Using the questionnaire given below evaluate the extent of knowledge gained by the participants from training session you conducted.

Q.1. What is the length of estrous cycle of (a) cattle and (b) buffaloes?

Q.2. What is the average duration of oestrus and best time for service to achieve the highest conception rates?

Q.3. What are the ways of achieving early puberty in cattle and buffaloes?

Q.4. What are the ways of getting a calf every year?

Q.5. What are the records that must maintained with regard to reproduction of the cow?

Training Session 7: Breeding of cattle and buffaloes in small holder farms

7.1 Introduction

The cattle and buffalo populations have remained in isolation for centuries and never been subjected to selection for production characteristics. For generations, indigenous cattle and buffaloes have been selected the ability to survive. These animals are hardy, able to withstand harsh, tropical climatic conditions and are resistant to many tropical diseases, but their productivity is low. Sri Lanka carries a higher animal population density (number of animals / sq. kilometre) than most of other Asian countries. Though, Sri Lanka has a fairly high animal density, scattered across 600,000 small holdings (approximately), it is able to produce only 20% of market share of the milk requirement. Small holder farmers are compelled to rear more animals than their resource base can support (e.g. labour, pasture grounds, space etc.) so as to produce a sufficient quantity of milk to obtain a cash imcome. As more and more land is brought under cultivation and for human settlements, the small holder cattle and buffalo farmers are compelled to reduce the herd size and adopt new management practices. In this context, farmers have to be well informed of the principles to be applied to select the right type of bulls or semen for mating their animals.

7.2 Objectives of the training session

The objectives of the training session are to:

(i) Educate the trainee on the value of genetic upgrading of their stock.

(ii) Educate the trainee on how to select the best breed type of bull or semen to serve a cow.

7.3 Method of training

The training should be conducted in the classroom in the form of a lecture/discussion. Visual aids will be useful to ensure a good understanding of the information provided.

7.4 Messages to be transferred

It is expected that the following messages will be transferred to the trainees.

(a) The suitable type of breed for upgrading cattle and buffaloes will depend very much on the agro-climatic conditions, management system and the purpose for which animals are reared. For this purpose the Ministry of Livestock Development has issued guidelines for upgrading of cattle and buffaloes in the different parts of the country.

(b) In order to achieve the best results, the trainees must be provided information to put into practice the following:

(1) Always adhere to the breeding recommendations applicable to different agro-climatic zones. Failure to do so with result in producing a genotype or animal which will not be able to thrive under the management conditions adopted in that region and

(2) Maintain appropriate records of reproductive data: calving dates, service dates and type and identity of bull or semen used. This will enable the veterinarian and the AI technician to decide on the type of semen to use and the expected performance of the progeny.

(3) Practice a selection programme along with genetic upgrading. All the progenies produced from AI cannot perform to the same standard expected for the genotype. There is tremendous variation in birth weights, growth rates and milk production levels. Only those animals that record higher birth weights, higher pre-pubertal growth rates and higher milk production should be retained. Replace the poor milking animals with heifers with a higher production potential, obtained by upgrading through AI or natural mating.

(4) Calculation of estimated breeding value. The selection of the type of semen or bull to be used for mating a cow must be done on a sound scientific basis. The recommended method of doing this is on the basis of the estimated breeding value of the dam (cow) and the sire (bull or semen). The farmer must use semen or a bull that has higher estimated breeding value than his cow.

The subject material for this training session is presented in Chapter 7 of Part II of this training manual. Use that material to prepare your training material.

7.5 Evaluation

Using the questionnaire given below, evaluate the knowledge gained by the participants from the training session you conducted.

Q.1. Name the agro-ecological zone to which your area belongs.

Q.2. What are the suitable breed types of semen or bulls recommended for (a) cattle and (b) buffaloes in your area?

Q.3. Once you decide on the breed type, what other criteria would you consider in selecting a particular bull or semen to serve animals in your area?

Q.4. What records do you need to maintain for your herd?

Q.5. What criteria will you use in selecting animals for replacement of the old animals?

Training Session 8: Health and Diseases of Cattle and Buffaloes

8.1 Introduction

The health or disease status has a direct influence on growth, productivity, reproduction and even the very life of the animal and thereby the profitability of the farm operation. For optimum economic returns from the farm operation, animals must be maintained in prime health. The popular saying that "prevention is better than cure " is true for humans as well as for animals. Therefore, the farmer must adopt appropriate disease prevention and control measures, and also seek veterinary assistance promptly if a disease condition is suspected in his farm.

8.2 Objectives of the training session

The objectives of the lesson are to:

(i) Create an awareness on the common disease conditions that may occur in farms.

(ii) Educate the trainee on the value of adhering to appropriate preventive health care programmes that are recommended and promote their adoption in farms

8.3 Method of training

The training session is to be conducted in the classroom in a lecture-discussion form with the use of appropriate audiovisuals such as posters and charts.

8.4 Messages to be transferred

It is expected that the following messages will be transferred to the trainees.

(a) Diseases caused by a wide variety of organisms including bacteria, virus, protozoa and ectoparasites.

(b) Information on the important endemic bacterial and viral diseases prevalent in the country, morbidity and mortality in animals and the resultant economic losses to the small farmer as well as to the dairy industry

(c) The procedures that should be applied so as to effectively control and prevent the incidence of diseases.

(d) The common gastrointestinal parasites, such as round worms, tape worms and flukes.

(e) The methods recommended for their effective control

(f) Other disease conditions such as mastitis, navel and joint ill in calves, respiratory infections and tick borne diseases and prophylactic measures that should be adopted.

The subject material for this training session is presented in Chapter 8 of Part II of this training manual. Use that material to prepare your training material.

8.8 Evaluation

Using the questions given below, evaluate knowledge gained by participants from the training session you conducted.

Q.1. What are the diseases that are considered as endemic in the country?

Q.2. How do you prevent the occurrence of endemic diseases?

Q.3. What are the common parasitic diseases found in farms and how would you prevent their occurrence in farms?

Q.4. List the recommended vaccination programmes for your area.

Q.5. How do you prevent incidences of mastitis in a herd?

Training session 9: Management of buffaloes and cattle

9.1 Introduction

Thus far, we have discussed different aspects of farm activities: nutrition and feeding, reproduction, breeding and health aspect of cattle and buffaloes. In order to achieve optimal efficiency of the small holder operation, all aspects that have already been discussed must be put into practice at the farm, in managing calves, juveniles and mature cows.

9.2 Objectives of the training session

The objectives of the lesson is to learn how to introduce the management packages including those relating to feeding, reproduction and health care to farmers to enable them to integrate these packages in the management of:

(i) new born calves

(ii) juveniles from birth to weaning

(iii) juveniles from weaning to puberty

(iv) pregnant heifer/cows

(v) parturient cows

(vi) post-partum cows

9.3 Method of training

The training session is to be conducted in the classroom in the form of a lecture/discussion with ample use of audio-visual aids. As this is the final stage of training programme, the trainer could adopt more participatory approach in conducting the training.

9.4 Messages to be transferred

It is expected that the following messages will be transferred to the trainees.

(a) In order to achieve the desired level of efficiency in management, the trainee should be aware that the farmer has to depend heavily on the proper utilisation of his farm resources, such as pasture, fodder, crop residues and farm labour. The trainee must realise that the farmer should pay attention to (i) animal handling and management,

(ii) feeding and nutrition, (iii) reproductive management and health care and (iv) body temperature regulation, particularly with regard to buffaloes.

(b) The care of the new born calf, the importance of feeding colostrum within few hours of birth and take the necessary precautions to prevent infection of the naval cord at birth.

(c) The feeding of milk to the calf from day 7 to weaning age.

(d) The feeding of the growing calf from weaning to puberty

(e) Management of adult animal, pregnant heifers and cows, parturient cows and postpartum cows, with special reference to feeding and reproductive management.

The subject material for this training session is presented in Chapter 9 of Part II of this training manual. Use that material to prepare your training material.

9.5 Evaluation

Using the following questionnaire, evaluate the extent of knowledge gained by the trainees from the training session that you have conducted.

Q.1. What is the importance of first milk (colostrum) to the new born calf?

Q.2. If zero suckling is practised, how much milk should be given to the calf daily?

Q.3. List the prophylactic vaccination procedures recommended for growing animals?

Q.4. How much grass/fodder and concentrate must be given to a cow weighing 300 kg and giving 8 litres of milk a day?

Q.5. If you desire to get a calf every year, how would you manage your postpartum cow?

Training session 10: Crop livestock integration for maximizing income generation in small holder farms

10.1 Introduction

Crop livestock integration refers to the complementary use of crop and livestock farming to maximize the output from a land holding unit. This has become the inevitable choice for small holder farmers operating at near substance level. Though the value of crop livestock integration has been emphasized over the last few years, very few farmers in fact practice true integration of livestock with crops.

Almost all livestock farmers are also crop farmers. They consider crop farming as the primary occupation, even though in many instances, livestock may bring a higher income than crops to the farmer. Unfortunately, many farmers do not get the maximum benefits from their resources they have at their disposal (crop residues and animal excreta). They pay very little attention to ways and means of optimizing the use of the available resources, such as land and labour for income generating activities.

10.2 Objectives of the training session

The objectives of the final lesson are to:

(i) Explain the advantages of integrating crops and livestock activities, by recycling animal excreta as organic manure and crop residues as animal feed.

(ii) Promote the use of the limited land available to farmers to obtain the maximum output, by incorporating fodder grasses and fodder trees, which would perform multiple functions besides providing feed to animals.

(iii) Explain the benefits of adopting more scientific management practices in animal rearing, such as appropriate housing, feeding, reproduction, breeding and health care management.

(iv) Explain the importance keeping records of important events, which would be useful in making management decisions and monitoring the efficiency of the operation.

10.3 Method of training

This training session is ideally conducted in a real life situation, in a crop livestock integrated farm. In many areas, you will be able locate a farm that adopts a few of the appropriate management practices which are outlined in Chapter 10 of Part II. If such a facility is not available, conduct the session in the form of a classroom lecture/discussion, with ample use of audiovisuals.

10.4 Messages to be transferred

It is expected that the following messages will be transferred to the trainees.

(a) *The need for intensification of farm management systems:* Small holder farmers should understand that they can overcome constraints faced by them in rearing animals by (i) more efficient utilization of the farm land, (ii) the judicious use of locally available non-conventional feed resources, (iii) overcoming nutritional deficiencies with the use of appropriate low cost technologies, (iv) integration of livestock with crops and (v) making better use of idle or surplus family labour.

(b) *The value of green forage and tree fodder:* Pasture grasses, fodder grasses and fodder trees could be early established within the farmer's homestead. A variety of green forage species are available, such as tree fodder rich in proteins and soluble sugars, that could be used as a supplementary feed for cattle and buffaloes. The fodder trees could be grown along boundary fences, as internal hedges or hedgerows, and as cultivated plots around the shed. (See Chapter 10 of Part II for detailed information).

(c) *Housing for cattle and buffaloes:* Housing is an essential component of an intensively managed dairy farm. Good housing not only improves the hygienic status but also helps the farmers to save labour and use this in many other farm activities. The importance of siting the cattle shed in the correct location and the adoption of hygienic practices must be emphasized.

(d) *Adoption of appropriate livestock management practices:* The application of practices such as, (i) good handling and feeding management procedures, (ii) methods for achieving optimum reproductive and productive efficiency, (iii) hygienic milking techniques and (iv) prevention of the incidence of disease

The subject material for this section is provided in Chapter 10 of Part II of this training manual. Use the material presented in Chapter 10 to prepare your training material.

10.5 Evaluation

Using the questionnaire given below evaluate the extent of knowledge gained by the participants from the training session you conducted.

Q.1. What is the value of tree fodder and crop residues in managing your farm?

Q.2. What is the tree fodder variety or varieties recommended for your area and in what locations in your homestead you would grow them?

Q.3. What is the optimum cutting frequency of the tree fodder variety you have chosen to establish in your farm and how would you fertilize the plants?

Q.4. Why do you need a properly designed house for your animals?

Q.5. What are the 3 methods of milking practised by farmers. Of the 3 methods what is the most recommended method?

Q.6. What are the ways if recycling animal and crop by - products or waste to maximize farm resource use?

PART 2

CHAPTERS 1 to 10

Resource Material for Trainers

Chapter 1: Basic principles of fibrous feed utilisation by ruminants

1.1 Introduction

Sri Lanka has an abundance of green forage in addition to other fibrous feed material, that can be used to advantage in feeding of ruminant animals. In order to develop feeding systems using fibrous feeds, it is necessary to have an understanding of the role of the fore-stomachs of the ruminant and the symbiotic relationship between the rumen micro-organisms and the ruminant animal. In this process, it is important to relate information on the nutritional characteristics and limitations of fibrous feeds to the nutrient requirements of the animal, so as to be able to correct the deficiencies in the composition and availability of nutrients in fibrous feeds.

1.2 Ruminant stomach

Ruminants, like buffaloes and cattle possess a specialized digestive system that differs significantly from that of monogastric animals. They are therefore able to utilize fibrous material which monogastric animals cannot use as feed. The stomach of the ruminant is made up of four compartments, the fore stomach (the rumen, reticulum and omasum) and the abomasum (the true stomach). A schematic diagram of the ruminant digestive system is shown in Fig. 1.1

In the ruminant, the digestion of fibrous material takes place in the fore stomachs, particularly in the rumen and reticulum. Digestion occurs through a microbial fermentation process. The ruminant is thus able to utilize roughage material, such as grass, leaves of trees, fodder and even crop residues and convert these into products such as,.milk and meat, which are important items of food for man. However, the full potential of the ruminant to convert fibrous material as feed has thus far not been fully exploited by farmers in Sri Lanka.

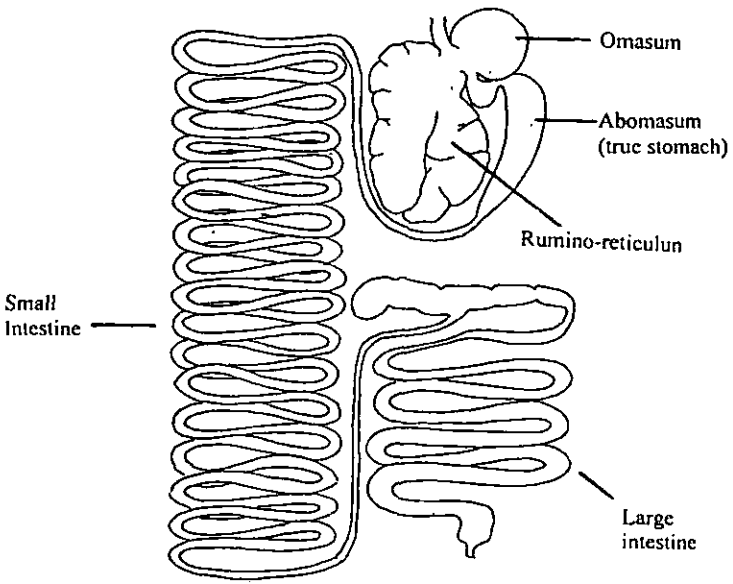


Figure 1.1 Schematic diagram of the digestive system of ruminants

The digestion of fibrous feeds begins is the rumino-reticulum through the mediation of microbes (bacteria, protozoa and fungi), which are normal inhabitants of the three fore stomachs. Microbial digestion commences in the rumen and continues in the reticulum and later in the omasum, finally ending in the abomasum and intestine. The difference in the process of digestion in the fore stomachs is that digestion occurs by the action of microbial enzymes, while in the abomasum and intestines this occurs by the action of digestive enzymes. Microbial enzymes also have the ability to utilize non-protein nitrogen, like urea to synthesize bacterial protein.

1.3 Characteristics of fibrous feed material

Fibrous feed material are those that are not digested in the monogastric animal. They contain high fibre due to the presence of ligno-cellulose material in cell walls. Low quality grasses and crop residues contain low (2 - 10%) crude protein and high (65 - 75%) cell wall fibre. There are four main categories of fibrous feed in tropical countries.

(a) Natural pasture and fodder which provides the bulk of the feed

(b) Fibrous residues from crops grown for human food, like straw and stover from cereal crops such as rice, sorghum, millet and maize.

(c) New feed resources from crops like sugar cane (molasses and sugar cane tops) and multipurpose trees.

(d) Other industrial by-products and residues like canary wastes, brewery wastes and spent tea leaves.

Fibrous crop residues constitute a large potential resource, which has not been extensively used by farmers as feed, because they are not palatable and not readily accepted by ruminants. They contain high levels of coarse fibre that is not easily digested by animals, maintained under traditional feeding systems. However, scientists have recently shown that these materials have a high potential value as feed, when given with supplementary feeds that are able to balance the nutrients deficient in fibrous feeds. The ruminant, given the optimum rumen environmental conditions are able to digest fibrous feeds and release large quantities of nutrients which the animal can use.

1.4 Basic principles of ruminant nutrition

The digestion of fibrous feed is carried out by microbes that normally inhabit the rumen. The microbial population is made up of several types of organisms. The efficiency of digestion in the rumen depends on the level of activity of these microbes, which in turn depends on the rate of microbial growth, the density and the composition of the microbial population. The feed consumed therefore has to provide the nutrient requirements of the microbes in terms of volatile fatty acids, ammonia, minerals and other co-factors. Since growth and activity of rumen microbes depend on the availability of nutrients required by these microbes, the diet should provide a balanced nutrient environment in the rumen, which will cater both to the needs of the microbes and the animal. Such an environment will greatly

enhance the breakdown of fibrous feeds.

When fibrous feeds are consumed, it first goes into the rumen, where it is broken down by the micro-organisms through a fermentation process. The breakdown products are volatile fatty acids (VFA), rumen ammonia (NH_3), methane, carbon dioxide and minerals (Fig 1.2).

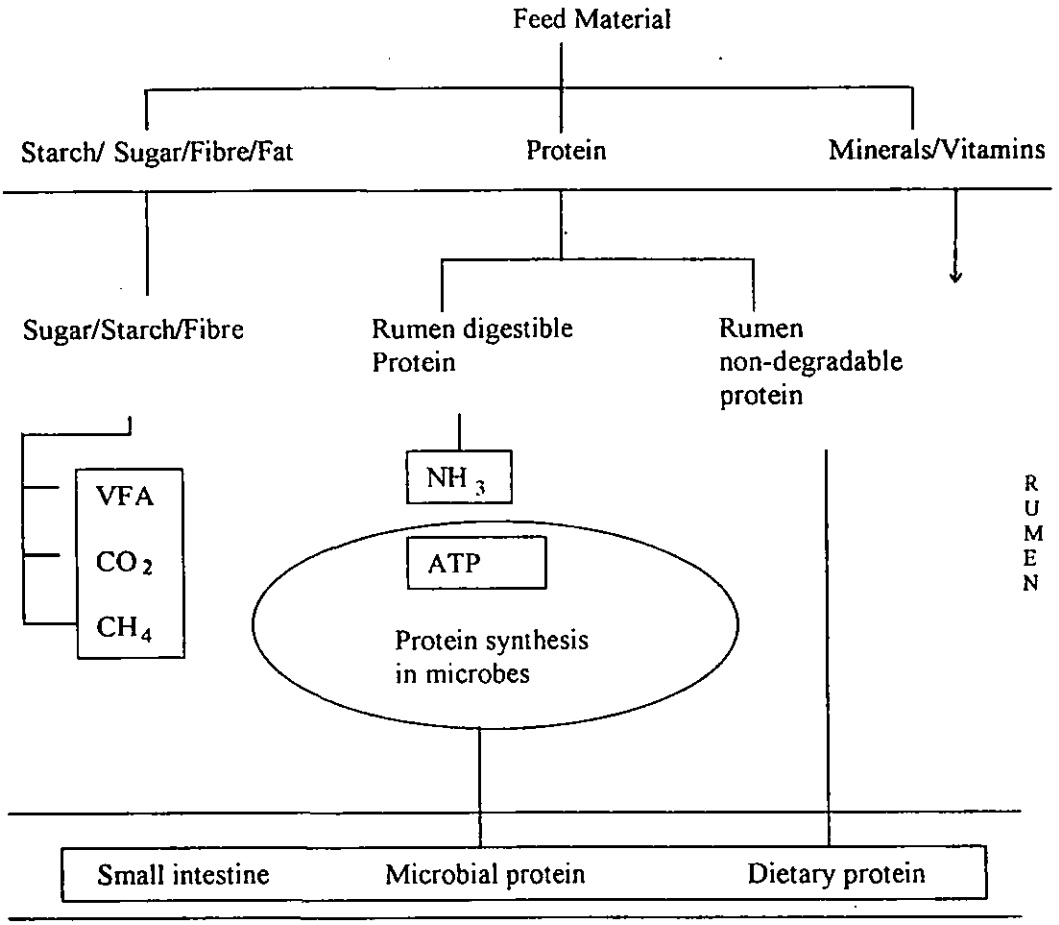


Fig. 1.2 Utilisation of rumen breakdown products in bacterial protein synthesis

The volatile fatty acids, ammonia and minerals are utilised by microbes to produce microbial protein, for growth and multiplication (Fig. 1.2). When these microbes eventually pass down into the intestine, they are themselves digested by enzymes into amino acids, soluble carbohydrates, minerals and vitamins. The rumen non-degradable protein that flow into the small intestine is digested along with the microbial proteins. Thus the animal receives protein from two sources, from the feed (rumen non-degradable or by-pass protein) and from the microbes, the latter being the major source. The absorption of end products of digestion takes place through the rumen wall as well as through the intestinal wall.

For optimum digestion, the microbes require a rumen environment that provides a balanced supply of nutrients (ammonia, VFA, soluble sugars and minerals) and an optimum pH (6.9). The rumen ammonia concentration plays a critical role. The effect of rumen ammonia concentration on intake and the digestibility of fibrous feed is depicted in Fig. 1.3. As shown in the figure, the optimum concentration of rumen ammonia nitrogen is in the range of 180-200 mg/litre of rumen fluid. If the rumen ammonia nitrogen concentration is lower than the

optimum, the population of n.. ..oes will decline and the rate of digestion will slow down resulting slower rate of passage of ingested material from the rumen. A lower concentration of rumen ammonia concentration usually occurs due to ingestion of poor quality fibrous feed, which is low in digestible proteins. In contrast, supplementation of low quality fibrous feed with feeds that are rich in protein, such as concentrates or feed supplements, soluble sugars and minerals, will help to maintain the rumen ammonia nitrogen concentration at the optimum level, thereby increasing bacterial multiplication and digestion of fibrous feed. When the microbial growth and population are high, the rate of fermentation is high and the feed consumed disappears faster from the rumen, creating more room, allowing the animal to eat more feed. The animal thus benefits in two ways. It obtains more nutrients, firstly through more efficient fermentation of the feed and secondly, by increasing the amount of feed consumed.

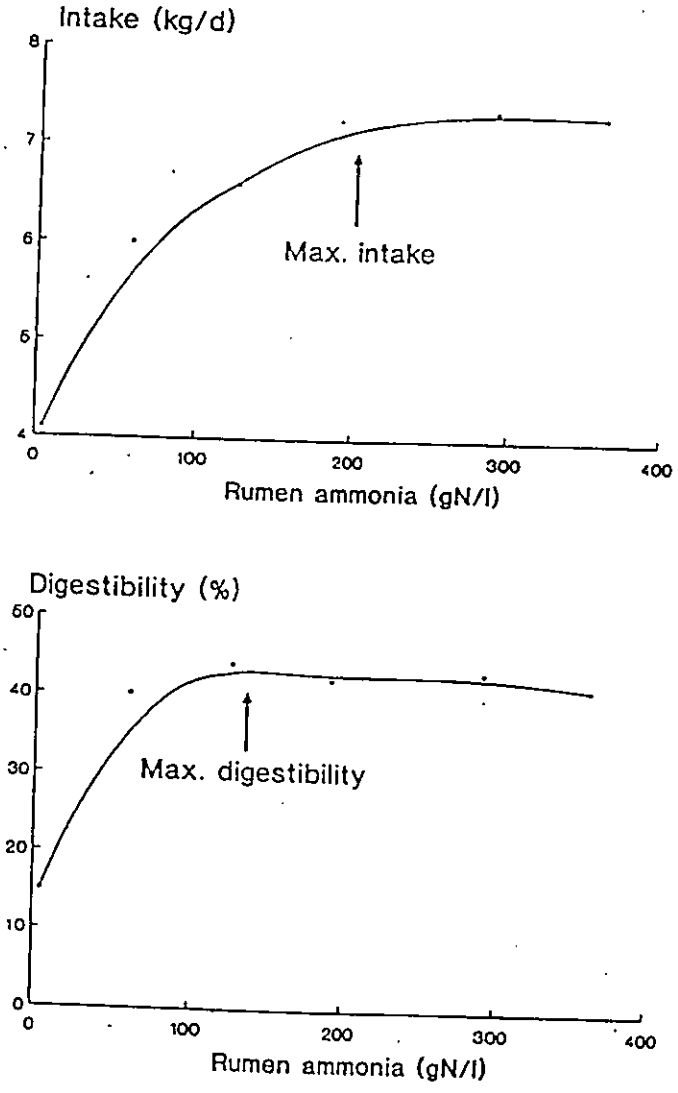


Fig. 1.3 **The effect of ammonia concentration in rumen liquor on the intake and digestibility of fibrous feed** (Perdok, et al. 1988).

1.5 Seasonal variation in availability and quality of fibrous feed to ruminants

The major sources of nutrients for ruminants as stated above are fibrous feed such as natural grass and fodder. The production and quality of pasture and fodder during the different seasons of year are primarily dependent on bimodal rainfall pattern during the Yala and Maha seasons. As a consequence, during the dry months, that is during June to September/ October and again during February to April, the amount of green grass available in communal grazing lands as well as from other sources, fall short of the requirements of animals in production (Fig. 1.4). Most often the fodder that is available is of poor quality and as a result farmers face the problem of providing feed of good quality to meet the requirements of the animals.

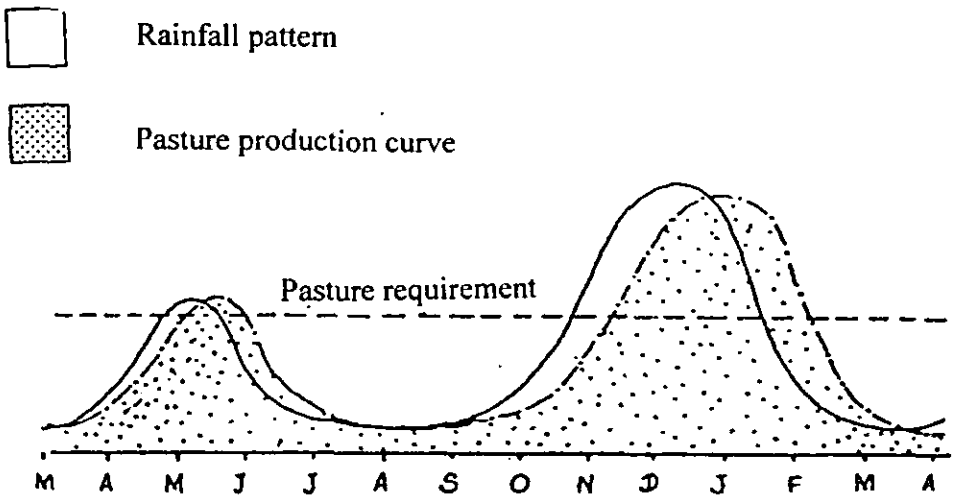


Fig. 1 4. The relationship between the year round pasture availability and the pasture requirement and the influence of the rainfall pattern

Further, during the periods of rain, although there is plenty of forage available, the nutrient intake from forage alone cannot satisfy the total maintenance and production requirements of high producing animals. At other times, under very wet conditions, when the moisture content of forage is high, the intake of dry matter may be inadequate and some nutrients such as carbohydrates and minerals may become deficient. The supplementation of the ration with concentrates or other supplementation will in these circumstances become necessary.

During the dry periods, the feed consumed is insufficient and poor in quality and therefore cannot supply the requirements of nutrients to the animal to produce milk or maintain the expected growth rate. Generally, the shortfall is overcome by supplementation of the feed with concentrates, such as rice bran and coconut poonac. However, the high cost of these inputs discourage farmers from feeding concentrates to their animals.

1.6 Non conventional fibrous feeds and other feed resources

Generally, there is a plentiful supply of non-conventional fibrous material available around farmers' homesteads that could be easily used as feed for cattle and buffaloes. These materials can be classified as 1) agricultural crop residues and 2) agro-industrial by-products.

(a) Crop residues: There are at times plentiful supplies of crop residues available in and around the rural households. Almost all of these materials are at present unutilised. Examples of commonly available crop residues are:

- cereal straw from crops like rice, millet and kurakkan
- stover from crops like maize and sorghum
- plant residues from legume crops like green gram, cowpea, ground nut and soya bean
- other crop residues like sugar cane tops, sweet potato vines and manioc leaves

(b) Agro-industrial by-products: Most of the agro-industries produce substantial quantities of by- products, which could be easily used as animal feed supplements. Unfortunately very little is used. Examples of commonly available by-products are,

- sugar cane bagasse
- fruit and canary waste
- waste tea leaves
- poultry litter

1.7 Problems associated with the use of fibrous feed

The nutritive value of fibrous feeds and limitations of use as feed for ruminants are given in the table below.

Fibrous feed	DM%	CP%	Fat%	Crude fibre%	Dig. %	Limitations of use
Rice straw	93	5	1 - 2	36	30	Low CP, Oxalic acid
Pulse straw	89	15	2-3	36	57	High lignin
Cereal straws	85-92	5-9	2-4	36-48	47-62	Low CP, Coarseness
Banana Pseudostems	12-18	5-8	1-2	25	63	High water, tannin
Manioc leaves	27	15-20	5-8	15-20	57-62	HCN content
Sweet potatoes vines	20	10-14	3-5	35-38	48-58	
Sugarcane tops.	35-40	4-8	2-3	30-38	38-48	High silica and low palatable
Bagasse	88-92	2-4	1-2	45-49	25-34	High lignin; low digestibility, low CP
Spent tea leaves	87	14-17	4-6	22-26	-	High tannin
Poultry litter	90	20-24	1-2	20-40	25-32	High silica, dusty
Palm press fibre	90-94	3-5	1-2	40-46	27-32	High lignin; low CP; low digestibility
Canary waste	10-18	5-8	1-3	18-24	54-62	High perishability, high moisture, low storage quality

DM - dry matter; CP - crude protein; C. fib.- crude fiber; Dig.% - Digestibility percentage.

In general, farmers do not consider fibrous materials as suitable for use as feed, because they are not eaten readily by animals. This is due to low palatability and low digestibility. The low digestibility is due to the high fibre content (more than 18%), low essential nutrients such as soluble sugars and proteins, minerals and vitamins and in some instances due to the presence of "anti-nutritive" factors.

1.8 Methods of overcoming the problems associated with the use of fibrous feed

There are a number of simple methods available to increase the palatability and the digestibility fibrous feeds. These are:

(a) Physical treatment: Physical treatment methods alter the physical nature of the material, e.g. particle size, length, moisture content, but not the chemical nature. Chopping, grinding and soaking the material in water are the common methods used.

(b) Chemical treatment: One or a combination of chemicals can be used in different ways. In these methods, structural changes of the fibrous material take place, due to chemical reactions. The commonly used chemicals are caustic soda, caustic potash, urea and wood ash.

(c) Supplementation: In this method, the nutrients that are deficient in fibrous feeds are provided through other feed sources. For this purpose, concentrate feeds, mineral mixtures, urea, and tree fodder are generally used. Supplementation with cheap and readily available resources is the most convenient, economic and efficient method that can be practised by farmers.

1.9 Practical guidelines for use of rice straw as ruminant feed

Collection and storage of rice straw: Rice straw is a seasonally available feed resource. In certain areas of Sri Lanka, straw is produced twice a year. Straw must be collected as soon as possible after the rice is threshed, properly dried before storing, to preserve the keeping quality and stored in a manner that will protect it from rain or dampness. Wet straw allows moulds to develop and soon becomes unsuitable for livestock feeding. Mouldy straw is unacceptable to ruminants and if consumed, it may lead to certain metabolic disorders or toxicities due to presence of mycotoxins. Well-dried straw when suitably stored can be kept for nearly 2 years without deterioration of its original nutritive value or acceptance by the animal. Well-dried straw can be made into square bales or loosely stacked in a hay barn or similar structure. Straw must be stored in a manner that will allow proper cross-ventilation, or heaped on a rock or on woody platform as in the "Kolaya" method. When stored unprotected, in the open, precautions must be taken to prevent termite damage, by stacking on an elevated base.

1.10 Methods of treatment of straws and stover

(a) Physical treatment

Rice and other cereal straws should be chopped into 8-10 cm lengths, before feeding. Stover which are thicker and coarser, need to be chopped into lengths of 4-6 cm. Chopping alone

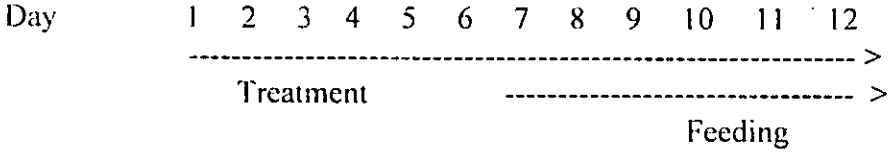
will not improve the intake because of the coarse nature of the material. Therefore, it is important to improve the texture by soaking the chopped material in water for 6-8 hours before feeding. This will not only improve the palatability but also remove certain detrimental water soluble compounds (oxalic acid in rice straw). One disadvantage is that along with the detrimental substances some of the water soluble nutrients, (sugars and proteins) may also be lost.

Method of treatment: Weigh the daily requirement of fibrous feed and spread the material evenly on a clean cemented floor or on a plastic sheet. Sprinkle water on the feed, using a watering can or a large tin with a perforated base. The amount of water to be used is 1 bottle (750 cc) for every kg of fibrous feed. While sprinkling water, turn the fibrous feed many times over to ensure proper wetting of the material. After wetting, cover with a polythene sheet and allow sufficient time for absorption of water into the feed material. This takes about 6-8 hours, depending on the type of material. The feed for the morning ration can be prepared the previous evening and that for the evening ration in the morning of same day. This method of treatment will improve the feed intake by 30-40 %.

(b) Chemical treatment

This can be done with caustic soda (NaOH), caustic potash (KOH), burnt lime (CaO) or urea [$(NH_2)_2CO$]. The cheapest, least hazardous and most convenient method is treatment with urea- ammonia. This method was popularised some years ago in Sri Lanka, but did not find acceptance by farmers because of practical difficulties in adopting this method in small farms. Today, in many developing countries, this method is widely used to improve fibrous feeds. The chemical generally used is fertiliser grade urea.

Method of treatment: Chopped straw or stover (straw may be used without chopping) is spread on a cemented floor or on a polythene sheet. Sprinkle 4% urea solution using a watering can or a tin with a perforated base. Four percent urea solution is made by dissolving 40g of urea in 1 litre of water. For treatment the ratio of straw : water should be 1:1. After treatment, the treated straw must be covered with a polythene sheet to prevent the escape of ammonia gas that is formed from urea. Another convenient method of preventing the loss of ammonia, is to pack the treated straw into polysack bags and tying the open ends. The bags should be covered with a large polythene sheet and stored for 7 days to allow time for the urea to react with the straw. The straw that is treated on day 1, will therefore be ready for feeding only on day 7. The straw that is required for feeding on day 8 and thereafter should be treated daily starting from day 2. The following time schedule should be followed in preparation of treated straw;



After 7 days of storage, open the polythene cover to expose the quantity of straw required for the day. Prior to feeding, allow the treated straw to remain exposed for 0.5 - 1 hr to facilitate the liberation of excess free ammonia. Urea treated straw must be introduced to animals gradually, offering 10% of the total feed and daily increasing the amount offered so

as to allow time for the animal to adapt to the new feed over a period of 7 to 10 days.

It is important to remember the following points:

- Collect and properly store an adequate quantity of straw for drought feeding.
- Treat straw daily to meet one days' requirement.
- Do not feed refusals on the next day.
- Do not exceed the concentration of urea solution more than 4%.
- Do not feed treated straw as soon as the polythene covering is opened. Animals may refuse to eat.
- Continue feeding of treated straw until grass becomes available and withdraw the feeding of treated straw gradually as grass becomes available.
- When feeding urea treated straw, it is important to provide a readily available energy feed like concentrates. This should form at least 10% of the total basal ration (100g of concentrate per kg of dry straw). For cows producing above 2-3 lit/d, a supplementary feed must be given at the rate of 2 kg for maintenance plus 1 kg of concentrate for every 2 litres of milk. But as concentrates are expensive, fresh grass rich in soluble sugars could be given with urea treated straw whenever possible in order to reduce the feed costs. The alternative is to feed supplements such as molasses when urea treated straw is fed.

(c) Supplementation

This method will help to provide nutrients that are deficient in rice straw and stover. Supplementation will improve the quality of the ration in the following manner.

i) By optimizing the rumen nutrient balance by providing the limiting nutrients such as ammonia nitrogen, soluble sugars and minerals, to improve digestibility (***catalytic effect***)

ii) By providing deficient nutrients to balance the low quality feed (***supplementary effect***)

Supplements do not change the structure of the fibrous feed, but facilitates its utilization. Supplementation is an easier method for the farmer to practice than chemical treatment. Moreover, the feed can be harvested and offered to the animal on the same day. The type of supplement to be fed will depend on the nutrients that are deficient in the basal feed.

Type of supplements:

1. Urea to provide rumen ammonia nitrogen
2. Urea-molasses-mineral multinutrient (UMMM) mixture to supplement rumen ammonia nitrogen, soluble sugars and minerals
3. Concentrates to supplement proteins, carbohydrates and minerals
4. Tree fodder to provide deficient proteins and soluble sugars

(i) Supplementation of urea: Urea could also be used as a supplement for fibrous feed.

This could be done through sprinkling urea solution on fibrous feeds or incorporating urea in the concentrate feed mixture. Urea supplementation has proved to be equally effective as urea treatment when fed with fibrous feed, but the level of urea used must not exceed more than 1.0-1.5% of the total feed on dry matter basis. This could be achieved by sprinkling 1 to 1.5% urea solution (10-15 g of urea desolved in 1 litre of water) at the rate of 1 litre per 1 kg of straw. Urea sprinkled straw could be fed after 2-3 hours of sprinkling. One must make sure, as with the feeding of urea treated straw, that a source of readily available energy, such as molasses must be given, and that urea supplemented straw must be gradually introduced to the animal.

It is important to remember that urea, if given in excess could lead to toxicity. In the event that excess urea is consumed, the animal will exhibit symptoms of ammonia toxicity such as purple or blue colouration of the mucous membrane of the mouth, muzzle and eyes. In such a situation, administer 1-1.5 litres of vinegar orally and summon a veterinary surgeon.

(ii) Urea-Molasses-Mineral Multinutrient mixture: Urea- molasses-mineral multinutrient (UMMM) mixtures provide complete supplementation of nitrogen, energy and minerals. This is widely used in many countries and is becoming popular in Sri Lanka. Details of UMMM and its use are provided in Chapter 2. This is made by mixing molasses (35-45%, rice bran (30-40%), urea (10-12%) and minerals (3-5%). The exact composition of the UMM multinueient mixture and the form (bricks or flakes) could be varied to suit the feeding practices under different production systems.

(iii) Concentrate feeding: This is the most common method of supplementation. At the present time, this has become an uneconomical to practice due to the high price of concentrates in relation to the low price received by the farmer for milk. Although commercial concentrate feeds are readily available in the market place, farmers often prepare concentrate mixtures using commonly available ingredients, such as coconut poonac and rice bran. Even when mixed on farm, concentrates are the most expensive feed available for milk production. As a general rule, 1 kg of concentrate is given for maintenance and thereafter, an additional 1kg is provided for every 2 litres of milk produced.

(iv) Feeding of tree fodder: Feeding of tree fodder is an another economical and sustainable method of supplementation. The farmer does not have to invest or spend money to obtain this valuable supplement. This is either generally freely available or can be easily cultivated in homesteads along fences. Tree fodder can be either legumes or non-legumes. The common tree fodder species that can be used are Vetahiriya (gliricidia), Erabadu (erythrina), Ipil-ipil (leucaena), Calliandra, Murunga (drum sticks), Thiththa Sooriya (wild sunflower), Mulberry, Maila, Gansooriya, Wehimara (raintree), Kos (jak), Kapok, Wada (shoe flower) and Kohomba (neem). These have certain limitations when used as feed that are specific to each variety. They are high in lignin and some contain chemical substances that may be toxic to animals, when consumed in excess. Therefore, the use of tree fodder as the sole feed should be limited. If judiciously used as supplements, they can contribute tremendously to the nutrition of the animal. More details are given in Chapter 3.

Generally, tree fodder can be satisfactorily included at a level of between 30-40% in the diet. In certain areas, 2-3 litres of milk per day is obtained by feeding a combination of grass and tree fodder, without resorting to concentrate feeding.

1.11 Cost comparison of different methods of supplementation

(a) Cost of feeding a cow with urea treated straw

Straw is assumed to be cost free
Cost of urea = Rs. 15.00 per kg
Cost of polythene per day = Rs. 1.26
Requirement of urea for 1 ton of straw = 40kg
Cost of urea to treat a ton of straw = Rs.15.00 x 40 (Rs. 600.00)
The daily rice straw requirement of a cow = 3.5% of body weight
Total weight of straw for a 300 kg cow (3.5x 3) = 10.5 kg straw/day
No. of days to consumes 1 ton of straw (1000/10.5) = 95 days
Feeding cost/day (600.00/95)= Rs. 6.30
Total cost including cost of polythene = Rs.7.56 (6.30 + 1.26)

(b) Cost of feeding a cow with urea sprinkled straw

The cost of feeding 10.5 kg of urea sprinkled straw per day is Rs. 6.30, as the cost of polythene (Rs. 1.26/day) could be deducted from the estimate given in (a) above (Rs. 7.56)

(c) Cost of feeding a cow with urea-molasses-mineral mixture and rice straw.

For a lactating cow consuming the following feed, give the amounts of UMMM shown alongside.

(a) Good quality forage = 0.5kg of UMM/day
(b) Medium quality forage and straw = 0.8 kg/day
(c) Poor quality forage and straw or mature grass = 1.0 kg/day

Cost of 1 kg of UMM = Rs. 8.00

Cost of UMMM per day for each of the above feeding systems:

(a) 0.5 x 8 = Rs. 4.00
(b) 0.8 x 8 = Rs. 6.40
(c) 1.0 x 8 = Rs. 8.00

Note: Feeding of UMM supplements would be sufficient to meet the nutritional requirements of a cow giving less than 5 litres of milk per day. In the case of cows that produce more than 5 litres per day, UMM feed supplement could replace 30-40% of the quantity of concentrates provided on the basis of level of production.

This chapter was prepared by Drs. A.N.F. Perera, H. Abeygunawardena and J.A. de S. Siriwardene for the SAREC/NSF (NARESA) Buffalo Research and Development Programme.

Chapter 2: Use of urea-molasses-mineral multinutrient (UMMM) supplements in ruminant feeding

2.1 Introduction

As discussed in Chapter 1, buffaloes and cattle require good quality forage in sufficient quantities as well as concentrate feeds rich proteins, soluble sugars and minerals, to enable them to express their full potential to grow, reproduce and produce milk.

Dairy buffaloes and cattle in Sri Lanka have traditionally been reared on natural pasture and tree fodder available in the locality. The quality of the grass and fodder species varies widely from season to season depending largely on the rainfall pattern. During dry periods, both the quality and quantity of the forage available for use by farmers decline. In such situations, the immediate effect that is evident is a decline in milk yield and loss of body condition. Farmers with good milking animals have, under such circumstances, learnt to supplement the available forage with a mixture of coconut poonac and rice bran to prevent a decline in milk yield. But generally, concentrate feeds are fed in limited quantities, because of the high cost. Under normal conditions, if the feed offered to animals is inadequate, the nutrient requirements of animals in terms of protein, energy, minerals and vitamins will not be met. This will result in a decline in milk yield, body condition and fertility.

These limitations could be overcome by adopting more strategic and economic feeding regimes utilising low cost feed resources such as crop residues (e.g. rice straw) and agro-industrial by products (e.g. molasses in combination with urea). In order to understand how these products could be used in ruminant feeding, a good understanding of ruminant digestive processes is necessary.

2.2 Rumen environment and microbial digestive processes

As discussed in Chapter 1, one of the factors that influence microbial activity in the rumen is rumen ammonia nitrogen concentration. The optimum concentration of rumen ammonia nitrogen for maximum microbial digestion and maximum feed intake in dairy animals, is between 180-200 mg/litre of rumen fluid. When the animal eats more of poor quality pasture, which is particularly low in rumen degradable proteins and soluble sugars, the rumen ammonia nitrogen concentration becomes sub-optimal and as a result, the microbial population and microbial activity declines. When this happens, digestion slows down and the feed remains for longer periods in the rumen. But if the nutrients that are deficient in the feed are supplied through feed supplements, such as UMMM, rumen microbial growth and activity is enhanced. The rate of microbial fermentation of fibrous feed then increases and the feed consumed disappears faster from the rumen, creating more room to allow the animal to eat more feed. The animal benefits in two ways. It obtains more nutrients, firstly through increased microbial digestion of the feed and secondly, by the increase in the amount of feed consumed. Therefore, provision of nitrogen in the form of urea and soluble sugars utilising crop residues and agro-industrial by products, such as rice bran and molasses offers a unique way of enhancing the efficiency of microbial digestion in the complex stomach of ruminants.

Scientists working in the SAREC/NARESA Buffalo Research and Development Programme have developed methods for using these crop residues as ruminant feed in combination with a low cost urea-molasses-mineral multinutrient (UMMM) feed supplement, to improve the digestibility and intake of the crop residues.

2.3 UMMM feed supplements in ruminant feeding

The complex stomach of the ruminant provides the right environment to utilise coarse fibrous material that monogastric animals are not able to utilise. The digestion of fibrous material occurs in the rumen through a microbial digestion process. Ruminants thus have the ability to utilise fibrous materials, such as, native grass, leaves of trees, fodder and crop residues and convert these into products such as milk and meat. However, it is well known that the full potential of the ruminant to utilise this type of feed is generally not exploited to the fullest extent by farmers. The reason for this is that the efficient utilisation of fibrous feeds depends on the provision of a balanced nutrient environment in the rumen. The use of UMMM feed supplements provides a means of correcting the imbalances in the feed available under traditional management systems. The most limiting nutrients in fibrous feeds are protein and readily fermentable carbohydrate, both of which are required for optimum microbial activity in the rumen. These two limiting nutrients and other essential trace minerals are provided, through urea (nitrogen), molasses (soluble sugars) and minerals, which are the main ingredients used in the preparation of UMMM feed supplements. The composition of UMMM feed mixture is given in Table 2.1 below.

Table 2.1 Composition of UMMM feed supplements

Ingredient	Proportion
Urea	10-12% (should not exceed 12%)
Molasses	30-45% (may vary with the quality of molasses)
Rice polish	30-50% (used as source of energy and as a filler)
Mineral mixture	03-05% (to supplement mineral deficiencies)
Fish meal	05-10% (optional; may need only for high producing animals)

Note: For UMMM blocks cement is used at 10-12% replacing rice polish. Also note that the composition of UMMM preparations may vary with the type of production system.

Urea (the fertiliser grade is satisfactory) is converted in the rumen into ammonia, which then is used by microbes for their growth and multiplication. Molasses (which is a by-product from the sugar industry) provides rapidly fermentable energy which microbes use along with ammonia for cell growth and multiplication. Molasses also improves the palatability and thus increases the intake of low quality fibrous feeds. Furthermore, molasses is rich in minerals like sulphur and these provide additional benefits. The UMM mixture can also be enriched by addition of minerals such as calcium, phosphorus, cobalt, copper, zinc, magnesium and selenium.

Research work carried out by scientists working in the SAREC/NARESA Buffalo Research and Development Programme has shown that UMM feed supplements can be used in the

feeding dairy buffaloes and cattle in any part of the country, at a relatively low cost. It helps to improve the digestibility of low quality fibrous feed and thus overcome nutritional limitations.

UMM feed supplement production equipment and UMMB feeding at Girandurukotte Mahaweli Livestock Farm

The SAREC/NARESA Buffalo Research and Development Programme has set up three units to produce UMM feed supplements at (1) the Mahaweli Livestock Farm at Girandurukotte, (2) the Mahaweli Niraviya Livestock Farm at Thambuttegama and (3) the NLDB Horakelle Farm. In addition, UMM feed supplements will also be available through co-operative societies and private sector manufacturers very soon. These feed supplements will be available in two forms: as a brick (UMMB) and in the form of granules (UMMG).

2.4 Methods of using UMM feed supplements for optimum benefits

UMM feed supplements are produced in two forms to suit different management systems.

(1) To obtain maximum benefits from UMM feeding, animals should have access to UMM as a lick to consume at will. The animal will consume sufficient UMM to satisfy its limiting nutrient requirements, to maintain the optimum level of ammonia in the rumen, which is between 180 and 200 mg/l of rumen fluid. If the use of the UMM block is not convenient to the farmer, he could use the granular form or a portion of the block, which can be crushed and mixed into the concentrate feed or poonac. UMM supplements should not be fed in excess of 1000 g per animal per day. UMM could be fed to animals in divided portions (2 to 3 times) during the day to suit the convenience of the farmer.

(2) The maximum benefits of feeding UMM supplement can only be obtained if the animal has free access to the UMM feed throughout the day, to ensure the maintenance of optimum rumen conditions that will promote continuous microbial activity. When sufficient good quality feed is available to the animal, the voluntary intake of UMM will decline. Thus when UMM is available as a block, the animals will regulate the intake depending on the quality of the feed offered.

UMM feed formulations can be used in two ways:

1. For cows yielding less than 5 litres of milk per day, up to 1 kg can be fed in place of costly concentrates, together with forage and/or crop residues.

2. For cows yielding more than 5 litres per day, 1 kg of UMM can be fed as a supplement, to replace 30-50 percent of concentrate feed in the daily ration.

In both of the above situations, rumen digestion of fibrous feed is enhanced as described earlier and the intake of fibrous feed will increase. Therefore, it is important to remember that animals must be offered more than the usual intake of fibrous feed to obtain optimum benefits from UMM feeding. Remember that UMM is not a replacement for fibrous feeds.

Recommendations for feeding UMMB

1. The recommended level of feeding UMM feed supplement is between 0.75 and 1 kg. Do not feed in excess of 1 kg per animal per day.

2. If the block form (UMMB) is used, it should be placed in a wooden box and kept in a suitable place where the animal has easy access to lick when required. If the animal starts to bite or eat the UMMB, remove it for a few hours and replace it again. Ensure that the animal does not consume more than 1 kg/day.

3. If the granular form (UMMG) or chopped UMMB is used, give up to 1 kg/day in divided quantities at milking time, mixed with concentrates.

4. Whatever the form of UMM feed supplement that is used, provide more than adequate quantities of fibrous feed and water. Ensure that fibrous feed is available at all times in the feed trough or in the grazing area and the animal has easy access to water.

Some important points to remember on the use of UMM supplements

1. UMM feed supplements should not be given to animals below 3 months of age.

2. UMM should be introduced gradually to allow time for adaptation to the new feed. Animals may sometimes not consume UMMB when first introduced. Give time to the animal to start licking the block.

3. When UMM feed supplements are given to animals they must be provided water *ad-libitum* (animals must have access to water at all times).

4. UMM feed supplements, whether as UMMB or UMMG, must be protected from rain, dust, dung and urine.

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Chapter 3: Use of tree fodder in livestock feeding

3.1 Introduction

Ruminants are able to use fibrous material (grass, tree leaves, rice straw etc.) as feed to meet their energy, protein, vitamins and mineral requirements. They need to consume adequate quantities of grass and other feed material to produce efficiently and optimally. But in most smallholder farms, the feed is insufficient and moreover, most of the feed material offered is poor in quality and deficient in soluble carbohydrates, nitrogen and minerals. Generally, farmers do not seem to use this abundant feed resource that is freely available, in the vicinity of the farm. In most parts of the country, (particularly in the dry zone, mid country and low country wet zone) tree fodder like Gliricidia and Leucaena are grown along fences. However, this valuable resource is most often wasted, perhaps due to the lack of knowledge on their value in ruminant feeding.

Information on ways and means of overcoming the feed shortages and deficiencies has been included in Chapter 1 on Fibrous feeds and their utilisation. One of the ways of overcoming feed deficiencies is to use tree fodder to supplement deficiencies of soluble carbohydrates and nitrogen. This chapter provides information on the different types of tree fodder, the methods of cultivation, management, the nutritive values and feeding methods.

3.2 What is tree fodder?

This is the green forage biomass obtained from trees or shrubs. This includes leaves, twigs and the edible parts and barks of certain plant species. They are dicots and are usually perennials. By virtue of the extensive deep rooting system, they can withstand drought conditions and provide quality green fodder during dry periods. Fodder trees are found growing naturally, but they can also be cultivated. Generally, they are not grown as a fodder resource, but for other purposes such as live fencing, shade, supports etc. However, the green biomass is available for livestock feeding. A list of fodder trees recommended for various agro-ecological zones is given in Table 3.1.

3.3 Advantages of feeding tree fodder

Tree fodder can provide the bulk of the feed during the dry season, when pasture or fodder grasses are scarce. They are rich in protein, soluble sugar (some varieties) and minerals. The high crude protein and soluble mineral contents can supplement deficiencies in the roughage feed offered to animals. Therefore, they play an important role as a valuable supplementary feed. During drought periods, when the sole source of roughage is crop residues (e.g. rice straw) or low quality mature grass, the use of tree fodder as feed will improve the digestibility and nutritive value of the daily ration and therefore help to sustain production. Tree fodder can totally replace the concentrate feed at low levels of production.

When good quality tree fodder is included in the ration, about 1/3 of the diet can be fed along with good quality grasses. In such instances, 4-5 litres of milk can be easily obtained

without feeding any concentrates. For cows with higher levels of production (>4-5 l/day), tree fodder given at the rate at 1/3 of the fibrous diet can partially replace (30-50 %) of the concentrate feed. In both situations, the cost of production could be reduced substantially.

3.3 Methods of cultivating fodder trees in the home garden

Fodder trees grow naturally and they can also be cultivated. Detailed instructions for this purpose are given in Chapter 2. They are climate specific. Natural fodder trees grow in home gardens, scrub jungles and waste lands. These are Kos (jak), Kohomba (Neem), Gansuriya, Siyambala (Tamarind), Maila (Bahema), Erabadu (Erythrina), Palu, Weera etc. Some species are planted on the fences or for shade and some to support vines like pepper etc. They are also grown as hedge rows e.g. Gliricidia, Erythrina, Leucaena (Ipil ipil), Sesbania etc. Common fodder tree species recommended for different agro-ecological zones and the yields are summarised in Table 3.1.

Table 3.1 Species of fodder trees recommended and expected yields

Fodder tree species	Recommended zone	Defoliation frequency (months)	Fresh leaf yield (Av) Kg/tree/yr
Gliricidia	MC,DZ,Co,LC,WZ	3 - 4	7- 10
Leucaena (Ipil Ipil)	MC, DZ, Co, LCWZ	3 - 4	5 - 6
Erythrina (dadap)	HC, MC, DZ	3 - 4	5 - 7
Albizia	MC, DZ, Co, LCWZ	3 - 5	4 - 6

Mid country = MC, Hill country = HC, Dry zone = DZ,
Low Country Wet Zone = LCWZ, Coconut Triangle = Co

Forage production could be easily incorporated into an integrated cropping system in farmers homesteads, through cultivation of fodder, grasses and tree fodder in the manner illustrated in Fig. 10.1 of Chapter 10.

(a) Along boundary fences: Fodder trees could be established and maintained as a live fences. Live fences reduce the cost of fence maintenance, particularly the replacement cost of fence posts. The planting material is inexpensive and available locally. Fodder trees in fences are commonly planted at a spacing of 0.5-1.0 m (2 or 3 ft) and harvested at a height of 1.0-2.5m (3.5 - 8 ft) above ground at 3 month intervals. In general, 100 trees would provide enough fodder for two milking cows throughout the year. This is perhaps one of the most widespread uses for tree fodder, in small home garden systems. Live fences of Leucaena (Fig 3.1) around one acre of land can produce enough fodder to satisfy 30% of the intake of the roughage needs of a cow throughout the year.

(b) As hedgerows: Hedgerow inter-cropping in a home garden is a practice where perennial

tree legumes or shrubs are grown together with vegetables and pasture crops. The recommended tree (shrub) species suitable for internal hedges are Gliricidia, Leucaena, Caliandra, Flemingia, Sesbania spp., Acasia and Erythrina. The trees are planted in wide rows and vegetables, cereal crops like maize or sorghum and pasture spp. are grown in the inter-spaces or alleys between the rows as shown in Fig. 10.2 in Chapter 10. During the cropping season, the trees are pruned and the prunings are used as mulch for crops, to improve the organic status and to provide nitrogen to the soil. Hedges should be placed along the contour of the land or in an East-West direction to allow maximum sunlight for the crops. However, when planting hedgerows, the slope of the land is the main factor that must be considered particularly in steep/sloping lands. It is always better to plant the hedgerows along the contour to prevent soil erosion. If hedges are placed along the slope, taking into consideration the direction of the path of the sun, then strips of short grass (e.g. Guinea, Setaria, Savandara) should be grown along the contour. See diagram below (Figs. 10.2, a and b) in Chapter 10.

Fig. 3.1 Fodder trees along boundary fences

The choice of tree species for hedgerow planting is extremely important and this to a large extent will determine the success or failure of the system. There are several attributes that should be considered when selecting a tree species. In most areas, row spacing between trees range from 2 to 7 m, while a spacing of 4-6 m is commonly used. However, the spacing may be varied according to the slope of the land. Spacing of trees within rows should be as close as possible. Experience with species such as Leucaena, Gliricidia and Sesbania indicate that trees should be spaced 30 cm (1ft) apart or as near as possible to form a solid hedge along the row. This helps a favourable leaf to stem production ratio, provide a more effective

barrier to soil movement in sloping lands and create a better micro-environment for crop growth. Hedge rows or alley cropping is recommended for flat land as it helps to improve the productivity of the system.

3.4 Management of fodder trees

Good management of the forage plants throughout the entire year is essential. Harvesting practices, fertiliser application, weed control and careful management will ensure maximum forage production in the system.

Cutting frequency (cutting interval) and cutting height (cutting intensity): Harvesting management is a very important factor that influences the productivity of tree fodder grasses. Severe pruning or harvesting causes adverse effects on subsequent growth. Re-growth is generally faster during wet season, allowing more frequent harvests. It is more advantageous to harvest before the re-growth becomes mature, as the nutritive value is higher at this stage.

	Cutting frequency in days	Cutting height
Tree fodder in the main fence	75-90	4 -5 ft
Tree fodder in the internal hedges	45-60	2 ft

Lopping of branches must be done with a sharp knife or a sharp trimmer. Further, frequent pruning at a lower height than that recommended should be avoided as it would minimise the shading effect of the hedgerows and also reduce the effectiveness of biomass production and nutrient recycling.

Fertiliser application: It is important to remember that soil nutrients are constantly removed either directly through crops like pasture and fodder, vegetables and fruits and indirectly through milk and other animal products. Hence it is vital that nutrients extracted from the soil should be replaced so as to bring about a soil nutrient balance. This could be done either through the application of (i) organic manure or (ii) artificial fertiliser. For more details refer Chapter 10.

3.5 Feeding value of tree fodder

The feeding value of tree fodder varies with the species, stage of harvest and parts of the plant used. The nutritive values of the common varieties are given in Tables 3.2 (a-d).

Table 3.2(a) Leguminous tree fodder varieties commonly found in the home garden

Tree fodder varieties	CP %	CF %	Fat %	Lignin %	Dry matter digestibility %
Gliricidia	24	16	4	7	64
Leucaena (ipil-ipil)	18	14	4	6	61
Sesbania spp.	20	25	3	12	54
Erythrina	26	27	5	14	62

Though these varieties are commonly found in most home gardens, very little use is made of these as ruminant feed. As shown in the Tables 3.2 (a-d), these varieties are rich in crude proteins and therefore offer a cheap and efficient way of supplementing the nitrogen requirement of the animal, particularly in situations where the animals are fed low quality fibrous feed.

Table 3.2(b) Non-leguminous species available in the home garden

Varieties of tree fodder	**CP %**	**CF %**	**Fat %**	**Lignin %**	**Dry matter digestibility %**
Jak leaves	14	20	4	12	48
Kapok leaves	14	19	7	12	52
Gansuriya leaves	16	20	4	8	58

Non-leguminous tree fodder varieties are moderately rich in crude protein. As such, they could be included in the ruminant diet, in situations where grass is in short supply and the feed is of poor quality.

Table 3.2(c) Tree fodder varieties found naturally in the environment

Tree fodder varieties	**CP %**	**CF %**	**Fat %**	**Lignin %**	**Dry matter digestibility %**
Margosa (Neem)	16	26	5	13	52
Tamarind	23	19	3	16	47
Maila	16	24	6	12	54
Wild sunflower	23	13	5	7	59

Wild sunflower which is commonly found in the mid and hill country areas is a very rich source of crude protein. Because of the lack of knowledge of its value as a good ruminant feed, it remains unutilised. The other varieties are predominately found in dry zone areas, as they are resistant to drought. In the dry zone areas, where the dry period extends over 6 to 7 months, tree loppings from these species could be incorporated into the diet to maintain the body condition and the production levels of animals.

Table 3.2(d) Introduced species used as tree fodder

Tree fodder varieties	CP %	CF %	Fat %	Lignin %	Dry matter digestibility %
Calliandra	26	24	6	14	52
Flemengia	24	26	5	18	50
Acacia Spp.	18	15	3	15	50
Albizia	21	17	5	16	36

CP= crude protein; CF= crude fibre;

The above species were introduced into the country several years ago. They are rich in crude protein and can easily be grown, in home gardens. They offer a very economic way of supplying protein requirement of animals.

3.6 Method of feeding tree fodder to cows and buffaloes

Tree fodder could be used as a regular feed supplement to animals whose basal diet is grass and/or straw, which in most instances is poor in soluble carbohydrates, nitrogen and minerals. As shown in Table 3.2, tree fodder is rich in soluble sugars, protein and minerals However there are a few limitations in feeding tree fodder, but this could be overcome by adhering to practices such as.

(i) Mixing tree fodder with grass or straw, to overcome possible rejection by animals when they are given alone

(ii) By blending several varieties of tree fodder, to improve the rate of utilisation of feed. When blended diets are given, the feed must be mixed thoroughly to prevent selective feeding by the animal. Further, chopping could be done to enhance intake and also to prevent wastage of feed material.

(iii) By avoid excessive feeding. Tree fodder should not exceed more than one third of the total fibrous diet. Excessive feeding can cause bloat and toxic manifestations may appear, as some plants contain toxic substances.

The quantity of tree fodder that could be used as a feed supplement will vary with the quantity of grass and/or straw given to the animal. Table 3.3 below provides guidelines for feeding of different breeds of cows and buffaloes. In general, the fresh grass requirement of an animal is equivalent to 10% of the body weight on wet weight basis. For example, a cow weighing 100 kg would require 10 kg of grass. On dry matter basis, this is about 3% of the body weight. Therefore the straw intake of a 100 kg cow will not exceed 3 kg. Tree fodder could replace one third by weight of the fresh grass (i.e. grass to tree fodder ratio is 2:1). Tree fodder could replace one third of the straw in diets of an animal maintained on straw alone, (i.e. straw to tree fodder ratio is 1:2). For animals maintained on mixed diets of grass and straw, tree fodder could replace half of the forage diet (i.e. grass and straw mixture to tree fodder ratio is 1:1). For your convenience, grass and/or straw and tree fodder requirements of different types of cows and buffaloes are given in the Table 3.3.

Table 3.3 Use of Tree Fodder in combination with grass and/or straw

Type of cow/buffalo	Composition of diet and the quantity of tree fodder to be used in kg
1. Zebu cow a) Body weight: 150 kg Milk yield : 3 litres/day	Grass alone : 15 Straw alone : 4.5 Grass + tree fodder: 10 + 5 Straw + tree fodder : 3 + 6 Grass +straw + tree fodder : 6 + 1.5 + 6
b) Body weight: 200 kg Milk yield : 6 litres/day	Grass alone : 20 Straw alone : 6 Grass + tree fodder: 13.5 + 6.5 Straw + tree fodder : 4 + 8 Grass +straw + tree fodder : 8 + 1.5 + 6
2. Temperate/cross bred cow a) Body weight : 200 kg Milk yield : 3 litres/day	Grass alone : 20 Straw alone : 6 Grass + tree fodder : 13 + 7 Straw + tree fodder : 4 + 8 Grass +straw + tree fodder : 8 + 2 + 8
b) Body weight : 300 kg Milk yield : 8 litres/day	Grass alone : 30 Straw alone : 9 Grass + tree fodder : 19.5 + 10.5 Straw + tree fodder : 6 + 12 Grass +straw + tree fodder : 12 + 3 + 12
3. Buffalo cow a) Body weight : 150 kg Milk yield : 3 litres/day	Grass alone : 15 Straw alone : 4.5 Grass + tree fodder : 10 + 5 Straw + tree fodder : 3 + 6 Grass +straw + tree fodder : 6 + 1.5 + 6
b) Body weight : 300 kg Milk yield : 8 litres/day	Grass alone : 30 Straw alone : 9 Grass + tree fodder : 19.5 + 10.5 Straw + tree fodder : 6 + 12 Grass +straw + tree fodder : 12 + 3 + 12

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Chapter 4: Ration Formulation - Principles and Practices

4.1 Introduction

Humans obtain their daily nutrient requirements from the food they eat, and similarly animals obtain their nutrients from the feed they consume. Nutrients required by animals are energy, protein, water, minerals and vitamins. All these are important to keep the animals healthy. These nutrients can be supplied by feeding roughage (grass, legumes, tree leaves, straw) or concentrates (coconut poonac, rice bran). The energy and protein in the feed are not completely digested and the undigested fraction passes out in the dung. The amount of available energy in the feed is called the Total Digestible Nutrients (TDN) and the amount of available protein is called Digestible Crude Protein (DCP). To simplify matters, the nutrient requirements of animals are also presented here in terms of TDN and DCP. The animal has a limited intake capacity, and for this reason the TDN and DCP required by the animal should be contained in a ration that is not in excess of the intake capacity of the animal.

Most small holder farmers do not adequately feed their animals. As a result the productivity is below the potential of the animal and the milk yields are low. Fibrous feeds are generally deficient in the some of the nutrients and are also not easily digested. This problem is more acute during the dry season and animals that are fed on poor quality feed develop nutritional deficiencies.

Water, energy, protein and minerals must be provided in adequate, balanced amounts if optimum results are to be achieved. The requirements of the animal for these nutrients depend on whether the animal is;

Idling (maintenance requirements)
Growing (growth requirement)
Pregnant
Producing milk
Working

Nutrient requirements are to be used as a guide in establishing a feeding regime and not as absolutes. They do not replace the expertise of the farmer in matching the nutrient intakes to the performance of their animals. Nutrient requirements can be used as a starting point when formulating a diet and also to estimate the feed requirements for any period of time. The first requirement for balancing a diet is to establish guidelines as to how much of each of the various nutrients is needed to supply nourishment to an animal in amounts that will meet its requirements for maintenance, growth, production and reproduction. In order to feed the animal according to its requirement, one should know:

Nutrients required by the animal
Nutrient content in feeds
Amount that can be eaten

4.2 Nutritive value of feedstuffs

The biological value of a feedstuff is determined by the:

Dry matter content
Protein content
Energy content
Digestibility
Amount and kind of minerals
Amount and kind of vitamins

4.3 Intake of dry matter

The amount of nutrition that an animal receives depends on 2 factors:

(a) the amount of nutrients in the feed
(b) the quantity of feed that the animal will eat

It is relatively easy to measure the quality of the feed offered, but difficult to assess how much of it an animal will eat, particularly if the animal is roaming at will and grazing or browsing. One of the most important skills in animal husbandry is to persuade livestock to meet their nutritional needs by eating more of cheap, low quality feeds than expensive ones. To do this, one should have an idea of the consumption of different forms of feed, even though it may be impossible to know exactly how much an animal eats. Animals have two sets of competing feelings about feed;

(i) the desire to start eating (appetite) and
(ii) the decision that enough has been eaten (satiety)

In general, how much a cow will eat depends on its body weight, the milk yield and the type and quality of feed. A higher intake of concentrates will lower the consumption of roughage, if the roughage is of high quality. If the quality of the roughage is average or low, concentrates may slightly increase the intake of the roughage. In order to prevent disorders in the functioning of the rumen, it is advisable to ensure that at least 1/3rd of the total DM in the daily ration is made up of roughage.

4.4 Protein

- The protein requirements of cows and the protein content of a feedstuff are expressed in g of crude protein (g CP) or in g of digestible crude protein (g DCP).
- The protein requirements of cows can only be met from the nitrogenous compounds in the feed (true protein and non-protein nitrogen).
- A shortfall in proteinous compounds in the feed cannot be compensated for by substitution of carbohydrates (CHO) or other substances.

4.5 Energy

- Energy is supplied by the organic matter in the ration; CHO, protein and fats
- The cow only uses protein to supply energy when there is not enough CHO and fat in the ration to meet the requirements OR when more protein is fed than needed.
- 'Protein for energy' should be avoided because protein is usually expensive.
- The amount of energy a cow needs and the amount of energy that a feedstuff supplies can be expressed in several ways. For simplicity the oldest and the most common system, namely the Total Digestible Nutrient (TDN) system is used.
- In the TDN system: 1 kg of CHO is assumed to liberate 4000 kcal of energy. The same applies to 1 kg of digestible crude protein. As fat is rich in energy, 1 kg of digestible crude fat liberates 9000 kcal of energy

The nutritive value of a feed is usually assessed by the amounts of nutrients it contains. Feeds can be generally classified as roughage and concentrates. Roughages include grasses (natural, improved), creepers (climbers), legumes (siratro, centrosema), leguminous (glyricidia, ipil ipil) and non-leguminous (jak, mango) trees and shrubs, agricultural (straws, stover) and agro-industrial by-products (soya hulls, bagasse). Concentrates include coconut poonac, rice bran/polish etc. Rather elaborate information on the nutritive values of locally available feedstuff in Sri Lanka is given in Ibrahim (1988, a & b).

4.6 What are concentrate feeds?

These are feeds rich in available nutrients such as energy, protein, minerals and vitamins that are essential to the animal. Examples of commonly used concentrates are coconut poonac, rice polish, soyabean meal, gingelly poonac or a mixture of these ingredients. It is important to remember that concentrate feedstuffs that are by-products of industrial processes such as rice bran can vary in quality. For instance, the TDN value of rice bran can vary from 40% to 60% depending on the type of milling process employed. The variation in quality is a function of the efficiency of separation of the hulls from the rice polish.

Concentrate feeds are generally relatively expensive and the extent of their use should be determined on the basis of the cost effectiveness of the level of inclusion in feeds. In formulating rations, adequate consideration should be given to the efficiency of conversion of feed to the product, be it weight gain or milk.

4.7 Nutritive values of common feedstuffs

A knowledge of the nutritive values of different feeds is essential in feed formulation. The nutritive value can be expressed in terms of TDN ands DCP. Table 4.1 gives the feeding values of several selected feed ingredients that are freely available and generally utilized in ration formulation.

Table 4.1 Nutritive value of selected feeds (g/kg/fresh weight)

Feedstuff			DM	TDN	DCP
Grass:	Guinea -	Before flowering	210	116	19
		After flowering	301	105	09
	Napier grass		156	81	20
	Signal grass -	Before flowering	195	113	18
		After flowering	228	114	11
	Natural grass -	From road side	250	100	25
		From paddy field	180	88	18
Legumes:		Gliricidia	226	142	50
		Ipil ipil	227	154	50
		Erythrina	237	119	64
		Wild sunflower	153	81	30
		Albizia	353	124	56
Tree leaves and shrubs		Jak leaves	314	151	28
		Girapala	250	165	31
		Madu-wal	300	146	25
Straw		Rice straw	900	300	0
		Rice stubble	850	315	0
		Ground nut straw	900	531	54
		Maize stover	903	447	29
Concentrates		Coconut poonac	923	683	148
		Rice bran	902	343	72
		Dairy mix.(Prima)	940	620	124
		Urea molasses multinutrient	900	764	46
		block	894	733	72
		Rice polish			

4.8 Feeding requirements of animals in different physiological states

The dam's milk provides all the nutrients necessary for the new born calf. The fore-milk or colostrum contains in addition, protective agents called antibodies that provides protection against diseases causing organisms. The value of colostrum is discussed in Chapter 9.

4.9 How to estimate the nutritive requirements of an animal

The nutritive requirements of animals vary with the physiological status. The body weight,

milk yield and pregnancy status has a bearing on the nutritive requirements. The daily requirement can be expressed in terms of the total digestible nutrients (TDN) and the digestible crude protein (DCP). These requirements must be provided to ensure optimum production from the animal. The requirements of TDN and DCP of animals can be obtained from published Feeding Tables. A standard table giving the TDN and DCP requirements of a buffalo cow weighing 350 kg with milk fat varying from 4 to 8% is given in Table 4.2

Table 4.2 Daily nutrient requirements (g TDN & g DCP) of a lactating buffalo cow weighing 350 kg (for maintenance, growth, milk production and gestation)

Milk yield (l/d)	Milk with 4.0 % fat		Milk with 6.0 % fat		Milk with 8.0 % fat	
	TDN	DCP	TDN	DCP	TDN	DCP
1	4710	565	4800	580	4900	600
2	5050	625	5230	655	5430	690
3	5390	685	5660	730	5960	780
4	5730	745	6090	805	6490	870
5	6070	805	6520	880	7020	960
6	6410	865	6950	955	7550	1050
7	6750	925	7380	1030	8080	1140
8	7090	985	7810	1105	8610	1230
9	7430	1045	8240	1180	9140	1320
10	7770	1105	8670	1255	9670	1410

The guidelines for feeding calves and heifers up to maturity are detailed in Table 4.3. For simplicity, the rations provided are based on grass and concentrates. Nevertheless in reality, the options that the farmer has in choosing from among the various feed resources that are available at farm level may be more extensive. In formulating rations for lactating cows, the nutrient requirements for maintenance and milk, both in terms of the yield and milk fat content have to be taken into consideration.

4.10 Feed formulation

In formulating feeds, a knowledge of the nutritive value of feedstuffs available to the farmer and the nutritive requirements of the animal are necessary. The objective in feed formulation is to match the requirements of the animal with the nutrient content of the formulated ration, keeping in mind the cost of the feed. The information provided in Tables 4.1 and 4.2 will be useful for this purpose. The method of calculation and the steps involved in the formulation of a feed ration is shown in Boxes 4.1 and 4.2 in page 57.

Table 4.3 Examples of practical rations

Milk (litres)	Hay	Concentrate
Feeding of calf from day 04th to 4 weeks		
2.0 - 2.5	Small amount of hay or good quality fresh grass	Small amount of calf feed or prepared Concentrate feed
Feeding of calf from 1st month to 2nd month		
1.5 - 2.0	250 g of hay or 500 g fresh grass + 250 g legume leaves	200 g of a calf feed or prepared concentrate feed
Feeding of calf from 2nd month to end of 3rd month		
0.50 - 0.75	750 g of hay or 1.25 kg fresh grass + 600 g legume leaves	350 g of a calf feed or prepared concentrate mixture
Feeding of calf from 4th month to end of 6th month		
	6 kg of fresh grass	1 kg of a cattle feed mix + 10 g of mineral mixture
or	6 kg of fresh grass + 4 kg of legume leaves	0.5 kg of concentrate mix + 10 g of mineral mixture
Feeding from 7th month to end of 09th month		
	11 kg of fresh grass	1 kg of a cattle feed mix + 10 g of mineral mixture
or	10 kg of fresh grass + 6 kg of legume leaves	0.5 kg of concentrate mix + 10 g of mineral mixture
Feeding from 10th month to end of 12th month		
	16 kg of fresh grass	1 kg of a cattle feed mix + 10 g of mineral mixture
Feeding from 13th month to end of 15th month		
	18 kg of fresh grass	1 kg of a cattle feed mix + 30 g of mineral mixture
or	15 kg of fresh grass + 9 kg of legume leaves	0.5 kg of concentrate mix + 30 g of mineral mixture
Feeding from 15th month to end of 18th month		
	21 kg of fresh grass	1 kg of a cattle feed mix + 30 g of mineral mixture
or	18 kg of fresh grass + 11 kg of legume leaves	0.5 kg of concentrate mix + 30 g of mineral mixture
Feeding from 19th month to end of 21st month		
	25 kg of fresh grass	1 kg of a cattle feed mix + 30 g of mineral mixture
or	22 kg of fresh grass + 12 kg legume leaves	0.5 kg of concentrate mix + 30 g of mineral mixture
Feeding from 22 month to end of 24th month		
	30 kg of fresh grass	1 kg of a cattle feed mix + 30 g of mineral mixture
or	25 kg of fresh grass + 15 kg legume leaves	0.5 kg of concentrate mix + 30 g of mineral mixture
Feeding from 25 month to end of 30th month		
	35 kg of fresh grass	1 kg of a cattle feed mix + 30 g of mineral mixture
or	28 kg of fresh grass + 16 kg legume leaves	0.5 kg of concentrate mix + 30 g of mineral mixture

Box 4.1 Adjustment factors for different body weights and fat contents.

Adjustment for different body weights:
For every 50 kg difference in body weight, add or subtract 300 g TDN and 25 g DCP

Adjustment for fat content in milk:
For every 1% increase in fat content provide an additional 50 g TDN and 8 g DCP for every litre of milk produced.

Box 4.2 Calculation of a ration for a lactating cow

Assume that a pregnant buffalo cow weighing 400 kg produces 5 litres of milk per day with 7 % fat. If the farmer has access to guinea grass (1 month old), gliricidia, coconut poonac and urea molasses lick block, prepare a suitable ration to meet the daily nutrient requirements of the animal following the steps given below.

Step 1 Determine the TDN and DCP requirements of the cow from Table 4.2.

A 350 kg cow producing 5 L of milk with 6% fat requires	6520 g TDN	880 g DCP
plus a requirement for the balance 50 kg body weight	+300	+25
plus a requirement for 1% fat (50x5 TDN & 8x5 DCP)	+250	+40
Total requirement for 400 kg cow		
Producing 5 L milk and 7% fat	**7070 g TDN**	**945 g DCP**

Step 2 Determine the nutritive value of the available feeds from Table 4.1.

	g. TDN	g. DCP
Guinea grass	116	19
Gliricidia	142	50
Coconut poonac	683	148
Urea molasses multinutrient mixture	764	46

Step 3 Ration formulation

Now select the appropriate combination of feed materials to match the nutrient requirements of the animal as given above. In feeding of ruminant, there is a limit to the intake of roughage feeds. The maximum intake that can be expected of a cow weighing 400 kg. is 12 kg of dry matter or about 60 kg fresh grass, if we assume that the dry matter content of grass is 20%.

Now calculate how much a cow weighing 400 kg and producing 5 l of milk containing 7% fat would receive, if she consumes good quality grass (Guinea grass, before flowering, with 116 g TDN and 19 g DCP) at maximum level of intake (3% body weight on dry matter basis). This will amount to 6960 g TDN (60 x 116) and 1140 g DCP (60 x 19). At this level of consumption, the cow will receive the total TDN and DCP requirements. Unfortunately, under normal conditions, cows neither receive good quality grass nor the optimum level of intake. Moreover, when poor quality roughage is fed the intake is low, because of low palatability and digestibility. Thus, as discussed elsewhere (Chapter 1) supplementation with concentrates (e.g. coconut poonac, rice polish), tree fodder (Gliricidia, ipil-ipil) urea-molasses-multinutrient feed mixtures, separately or in combination is necessary. In such circumstances the feed ration has to be balanced with supplements in a manner that will make it cost effective. One such example is given below.

.....continuation of Box 4.2

Assume that you are using 50 kg of young Guinea grass (before flowering) and 3 kg of Glyricidia. The total TDN and DCP that could be obtained is given below.

	Dry matter Intake (kg)	TDN (g)	DCP (g)
50 kg guinea grass grazed or cut and fed, will provide	10.5	5800	950
3 kg gliricidia will provide	0.7	426	150
Nutrients supplied by grass and gliricidia	**11.2**	**6226**	**1100**

From the above table it is clear that there is a deficiency of TDN in the above ration. Therefore *a third feed resource has to be included in the ration to overcome the TDN deficiency of 844 g (7070-6226). Because of the space limitation in the rumen, this has to be a concentrate like coconut poonac or urea molasses multinutrient mixture (UMM). So the farmer has two options.*

- *the DCP requirement is satisfied by feeding grass and gliricidia*

Step 4.:

In order to bridge the 844 g deficiency in TDN he could feed;

(a) 844/683 = 1.24 kg of coconut poonac at a cost of Rs. 17.36 (@Rs. 14/kg) or

(b) 844/764 = 1.10 kg of UMM at a cost of Rs. 7.04 (Rs. 32 for a 5 kg block)

Note that there is a Rs. 10 difference between options (a) and (b) above.

The farmer has a choice between the following two rations:

	Ration A (kg)	**Ration B** (kg)
Guinea grass	50	50
Gliricidia	03	3
Coconut poonac	1.24	
Urea-molasses-multinutrient Mixture		1.1

The ultimate choice will obviously be based on economic considerations, which in this case is the ration B, which includes UMM. One should also remember that UMM contains mineral elements such as calcium and phosphorus which are equally important nutrients as TDN and DCP.

This information leaflet is prepared by Drs. M.N.M. Ibrahim, H. Abeygunawardena and D.H.A. Subasinghe for SAREC/NSF (NARESA) Water Buffalo Information Dissemination

Chapter 5: Body condition scoring system for assessing the nutritional status of buffaloes and cattle

5.1 The Importance of Nutrition for Animal Production

Buffaloes and cattle, like all other animals, require energy, protein, fat, minerals and vitamins for optimal growth, body maintenance, work, reproduction and production of milk. They obtain their nutrient requirements through the feed (e.g. grass, tree fodder, poonac, rice bran, mineral mixtures, etc) directly, or indirectly by utilising the products of rumen microbial digestion of feed.

Buffaloes in Sri Lanka are primarily reared for milk, the other products being draught and milk. Animals in smallholder farms are generally underfed and therefore, their productive and reproductive efficiency is low. This situation has arisen due to several factors, such as (1) the limitation in the availability of grazing grounds, (2) the fluctuation in the quality and quantity of green feed available, due to the seasonal variation in rainfall, (3) the high cost of concentrate feeds, such as coconut poonac and rice bran, (4) the lack of a proper understanding of the value of alternative low-cost feed resources, such as tree fodder and rice straw and (5) most importantly, the inability of the farmer to assess the nutritional status of his animals. We have already discussed the first four aspects Chapters 1, 2, 3 and 4. The inability of the farmer to assess the nutritional needs of his animals is due to the lack of appreciation of the need to change the level of nutrition to suit the nutrition status of the animals. In this Chapter, we present a very simple and practical method of estimating the nutritional status of buffaloes and cattle, which can be used by farmers.

5.2 Practical guidelines to assess the nutritional status of animals

As mentioned earlier, the lack of a simple, rapid and practicable method for determining the nutritional status of animals has made it difficult for veterinarians, extension workers and farmers to determine the nutritional adequacy of the diet and therefore to provide the appropriate level of nutrition to cattle and buffaloes. Recently, scientists have developed a simple numerical scale, which brings out the relationship between body muscle mass and fat cover and the nutritional status of animals. This method is called the BODY CONDITION SCORING SYSTEM. This is based on the finding that the variation of body condition score (BCS) reflects the nutritional status of animals. The body condition of the animal has a bearing on the efficiency of production, reproduction and the health of the animal. The BCS therefore gives a more precise assessment of the changes in nutritional status and health of the animal than body weight, as the latter can be affected by genotype and factors such as rumen fill and stage of pregnancy.

This information will be very valuable to veterinarians, extension workers and farmers, as there is a need for a means of assessing the nutritional status of animals. Farmers particularly will find this method very useful, as a guide in feeding and management of buffaloes and cattle, so as to

obtain optimum growth, reproduction and production. This will also allow farmers to obtain the best economic returns from their buffalo and/or dairy cattle herds.

5.3 Body Condition Scoring System

The scale ranges from one to five. It is based on the visual observation and palpation of two or more of the following four points on the animal (*Plates* 5.1a and 5.1b).

Plate 5.1(a) Posterior view of cow showing the area on either side of the tail head and rectum

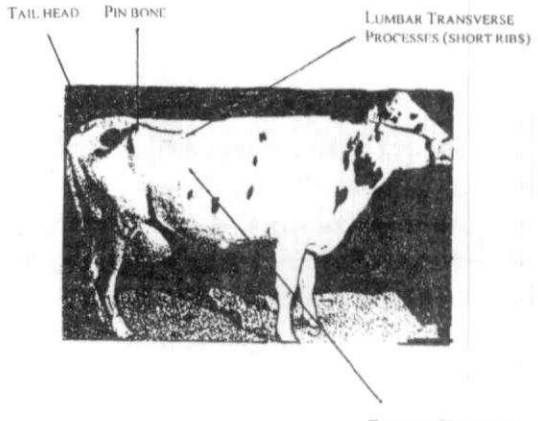


Plate 5.1(b) Lateral view of cow showing thoracic vertebrae, lumbar transverse process and tuber coxa (pin bone)

Plates 5.1(a & b) Palpable features of a cow presented by the frontal and lateral view of cattle

1. The area on either side of the tail-head and rectum
2. The pin bones (Tuber coxae)
3. The bones on the spine (Thoracic vertebrae)
4. The short ribs (Lumbar transverse processes)

The appearance and the palpable features of these areas reflect the degree of accumulation and mobilisation of body nutritional reserves, mostly body fat. This is directly related to the nutritional status of the animal, which depends on feed intake and utilisation.

The procedure for determining the condition score is as follows:

1. Note the appearance of the area on either side of the tail-head and rectum. Are there deep cavities or is the area well filled?
2. Palpate the pin bones. Are the borders sharp or rounded?
3. Note the appearance of the bones on the spine. Are they individually visible or covered by muscle and fat?
4. Palpate the ends of the short ribs as shown in (Fig. 5.1b) Are they sharp and covered only by skin, or rounded and covered by fat under the skin?

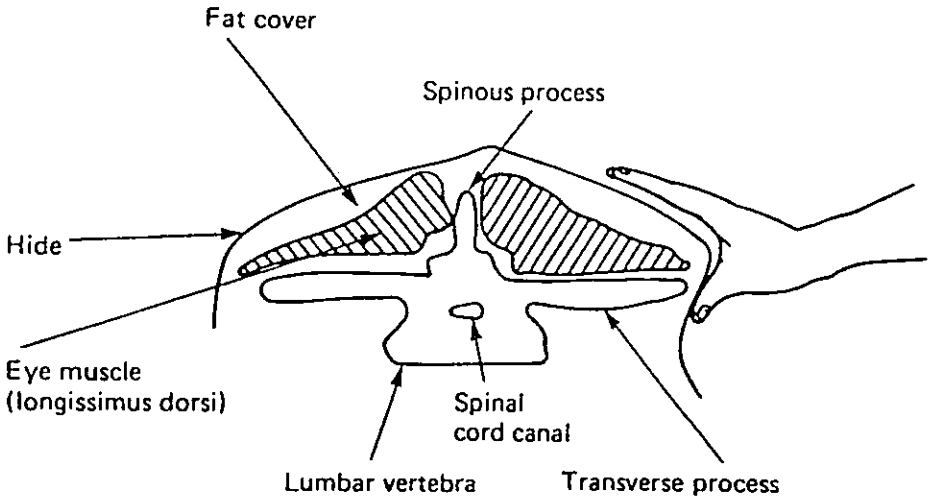


Fig 5.1 Technique of body condition scoring over the lumbar vertebrae.

Body condition scoring systems have been developed for both buffaloes and cattle. Table 5.1 shows the criteria for assessing the body condition of buffaloes and Table 5.2 shows the criteria for cattle.

5.4 What is the optimum condition score?

1. It is recommended that animals should have a condition score of above 3 at calving. This can be achieved by drying off the animal two months before the next expected calving date and providing adequate feed during these two months. This will ensure that sufficient body reserves will be available for milk production after calving.

2. After calving animals usually lose body condition during the first month or two. Adequate feeding will ensure that the condition score does not go below 2, and that the animal begins to improve in 1-2 months after calving. This will ensure efficient and economical milk production and early commencement of sexual cycles.

3. The optimum condition score for dairy cows is between 3 and 4 as shown in the graph below (Plate 5.4). Maintaining the animal at a body condition score of 4 or above is not advantageous in terms of production or reproductive performance.

Table 1 : The Body Condition Scale for Buffaloes

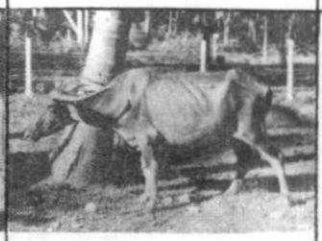
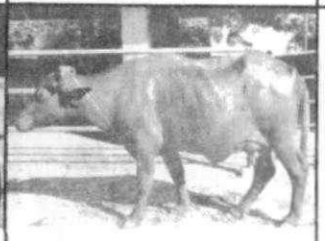
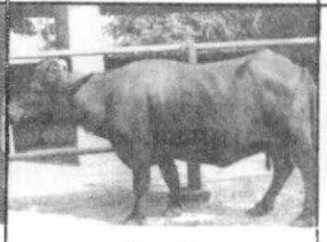
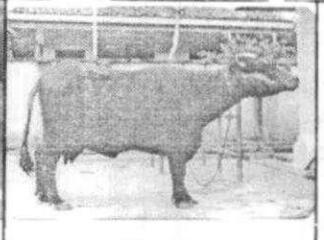
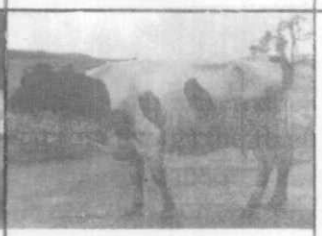
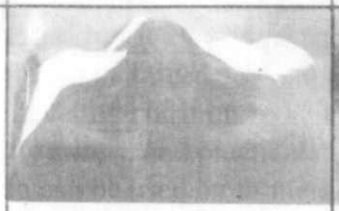
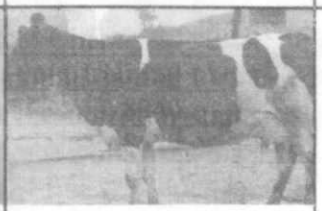
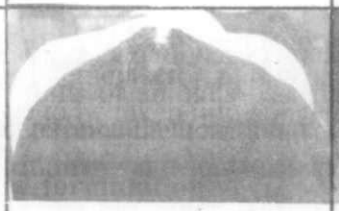
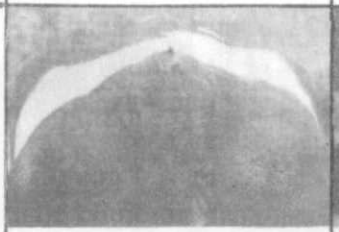
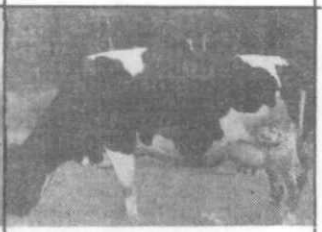
Score	Posterior View	Lateral View	Visual and Palpable Features
1	 Plate 3a	 Plate 3b	An emaciated animal. Cavities on either side of the tail-head are very pronounced; borders of pin bones very sharp; individual bones of spine and their borders are visible, ends of short ribs are very pronounced and can be easily palpated; no fat layer under the skin.
2	 Plate 4a	 Plate 4b	A thin animal. Cavities are less pronounced; borders of the pin bones are sharp; individual bones of spine are less visible; ends of short ribs less sharp but can be palpated; thin layer of fat under the skin.
3	 Plate 5a	 Plate 5b	A lean and healthy animal. Cavities are not present; borders of pin bones are rounded; individual bones of spine are not visible and muscles are detectable over the bones; ends of short ribs can still be palpated with firm pressure; a medium layer of fat under the skin.
4	 Plate 6a	 Plate 6b	A fat animal. Cavities are filled out; borders of pin bones are rounded; individual bones of spine are not visible and there is muscularity over the bones; ends of short ribs can only be palpated with strong pressure as they are covered with a thick layer of fat under the skin.
5	 Plate 7a	 Plate7b	An obese animal. Buffaloes or cattle of this condition are usually not found in village farms. Cavities are not present; borders of pin bones are very rounded; individual bones of spine are not visible and there is abundant muscle and fat over the bones; ends of short ribs are not palpable as they are covered with a very thick layer of fat.

Table 2 : The Body Condition Scale for Cattle

Score	Posterior View	Lateral View	Visual and Palpable Features
1	 Plate 8a	 Plate 8b	An emaciated animal. Cavities on either side of the tail-head are very pronounced; borders of pin bones very sharp; individual bones of spine and their borders are visible, ends of short ribs are very pronounced and can be easily palpated; no fat layer under the skin.
2	 Plate 9a	 Plate 9b	An emaciated animal. Cavities on either side of the tail-head are very pronounced; borders of pin bones very sharp; individual bones of spine and their borders are visible, ends of short ribs are very pronounced and can be easily palpated; no fat layer under the skin.
3	 Plate 10a	 Plate 10b	A lean and healthy animal. Cavities are not present; borders of pin bones are rounded; individual bones of spine are not visible and muscles are detectable over the bones; ends of short ribs can still be palpated with firm pressure; a medium layer of fat under the skin.
4	 Plate 11a	 Plate 11b	A fat animal. Cavities are filled out; borders of pin bones are rounded; individual bones of spine are not visible and there is muscularity over the bones; ends of short ribs can only be palpated with strong pressure as they are covered with a thick layer of fat under the skin.
5	 Plate 12a	 Plate 12b	An obese animal. Buffaloes or cattle of this condition are usually not found in village farms. Cavities are not present; borders of pin bones are very rounded; individual bones of spine are not visible and there is abundant muscle and fat over the bones; ends of short ribs are not palpable as they are covered with a very thick layer of fat.

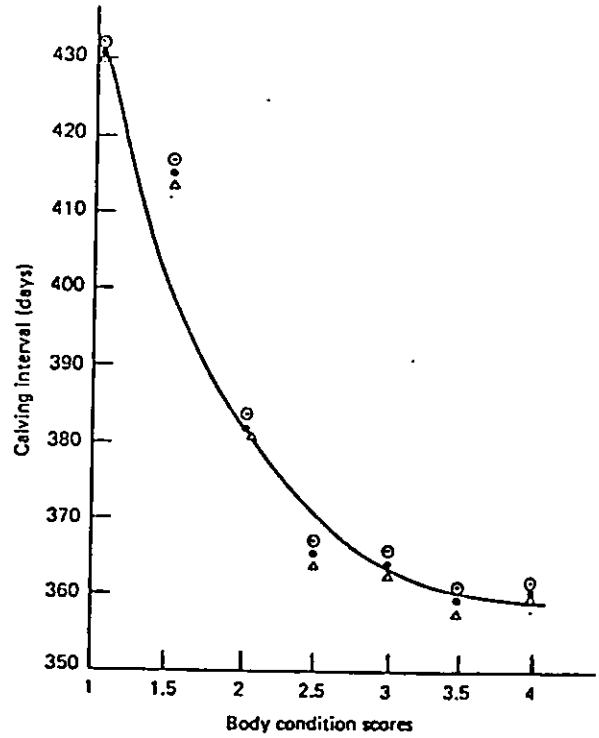


Fig 5.4 Relationship between body condition score and fertility

As shown in the graph, maintaining an animal at a body condition of 4 would not result in any improvement in the calving interval of 365 days, which is the optimum one could achieve. On the other hand, feeding animals to maintain a BCS of above 3.5 or 4 would show diminishing returns to any incremental increase of feed intake (mainly concentrates), until it reaches the maximum potential. But this level of feeding is not economically advantageous. Therefore, to achieve economic production, avoid under-feeding as well as over-feeding if animals or above is not advantageous in terms of production or reproductive performance.

This Chapter was prepared by Drs. B.M.A.O. Perera, H. Abeygunawardena and J.A de S.Siriwardene for the SAREC/NARESA Water Buffalo Information Dissemination Programme

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Chapter 6: Reproduction in cattle and buffaloes

Both buffaloes and cattle have the potential to (1) reach sexual maturity within 24 months of age, (2) give birth to a healthy calf within 36 months and (3) thereafter to produce a calf every year. The attainment of these goals will result in optimum productivity in terms of calves and milk over the lifetime of an individual breeding female. This process is however influenced by genotype (genetic make up of animal), feeding, management and climatic conditions. Scientists have found that in most farms in Sri Lanka, sexual maturity is delayed until 30 to 36 months of age and the first calving usually occurs when animals are more than 40-48 months of age. The inter-calving interval is also longer than the ideal interval of 12 months, sometimes as long as 24 months. This would result in a direct economic loss to the farmer, as the cow would produce fewer calves and therefore fewer lactations during its lifetime.

This chapter will deal with reproductive management of cattle and buffaloes for optimum reproductive efficiency.

6.1 Sexual cycle of buffaloes and cattle

Heifers after puberty and adult non-pregnant cows (buffalo and cattle) become sexually active during the oestrous period (or heat period) that occurs at approximately 21 day intervals. Oestrus is a part of the sexual cycle that occurs in sequence in 4 phases as shown in Fig. 6.1, and is the only externally visible phase. The heat period usually lasts about 18 hours, but it can be much shorter, about 2 hours or as long as 30 hours. During this period, males as well as other females will show interest in, and attempt to mount females in heat.

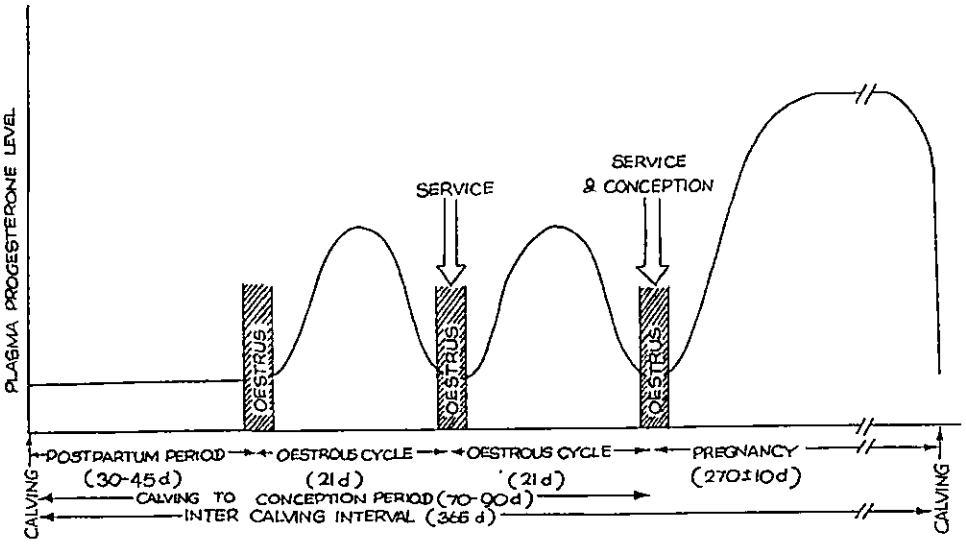

Fig. 6.1 Sexual cycle of a cow - parturition, postpartum period, oestrous cycle, conception and pregnancy.

The female can get pregnant only if she is mated during or soon after the period of heat. As shown in Fig. 6.2, sperms are deposited in the anterior vagina in the case of natural service or deposited in the anterior cervix or in the uterus in the case of artificial insemination.

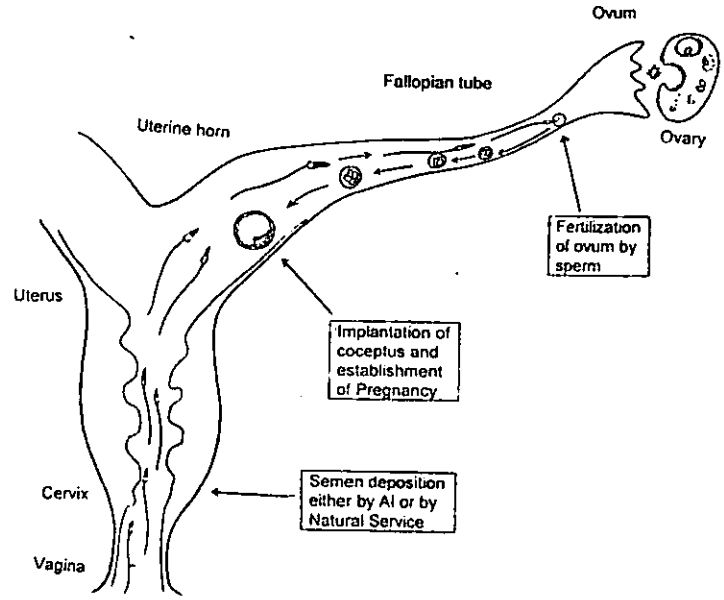

Fig. 6.2 Schematic diagram of the reproductive tract of cattle and events from semen deposition to conception

The sperms swim up along the reproductive tract, aided by uterine contractions to meet the ovum that is released from the ovary. The sperms from the male need to spend a minimum of 6 hours in the female reproductive tract, before it acquires the capability to fertilise the ovum. The sperms can survive up to 24 hours in the female tract and the ovum can remain alive for 12 hours after ovulation. On the other hand, ovulation or shedding of the ovum from the ovary occurs about 12 hours after the end of oestrus. Therefore, to obtain maximum fertilisation rates, cows should be served within 12-18 hours after first detection of heat as depicted in Fig. 6.2. Once the animal becomes pregnant, pregnancy lasts for 270 to 280 days in cattle and 300-330 days in buffaloes.

6.2 Heat signs in buffaloes and cattle

The changes that take place during the heat period are brought about by the hormone, oestrogen. The heat signs, shown in Fig. 6.3 are, (1) secretion of clear, glassy, stringy mucus from the vulva, (2) swelling and reddening of the vulva, (3) relaxation of pelvic ligaments, (4) restlessness and/or bellowing, (5) decreased appetite, (6) a drop in milk yield and (7) the desire to interact with other animals, particularly males.

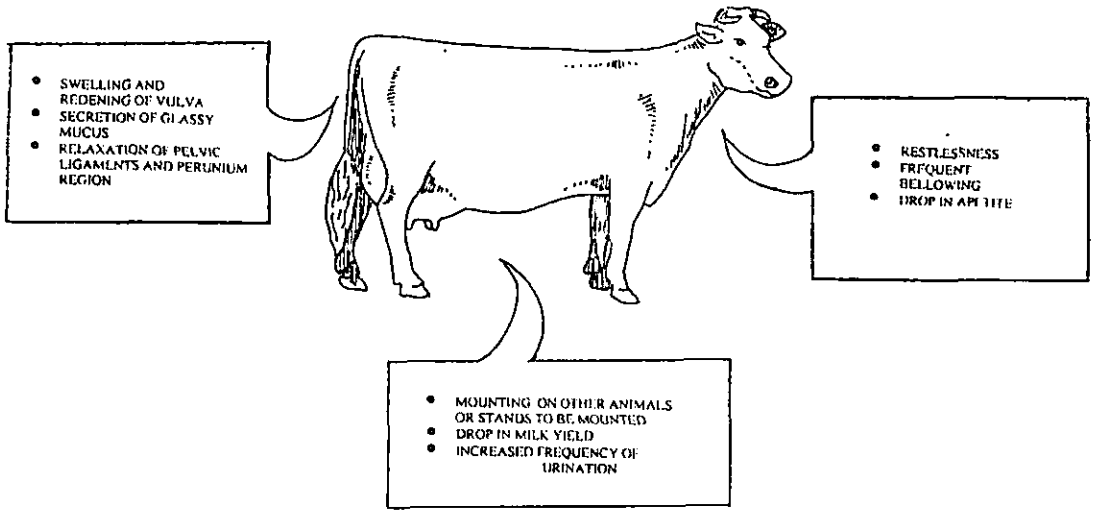

Fig. 6.3 Oestrous signs of cattle and buffaloes

Though cows in heat may show only one or two, or a combination of the above-mentioned signs, the best indication is that a cow in heat will allow a male or another cow to mount her. It is possible to observe this only in free grazing situations but not in animals that are tied in sheds. In such situations, a combination of the other signs must be used as criteria for identification of heat. Cows should be observed at least 3-4 times a day, for at least 15-20 minutes each time.

6.3 Best time for insemination for maximum fertility

As depicted in Fig. 6.4, the best time to inseminate cows to obtain optimum fertility or conception rates is between 6 to 18 hours after the onset of oestrus. Serving either earlier (less than 6 hours) or later (after 18 hours) may result in lower conception rates. The most likely signs before the onset of oestrus (proestrus) and after oestrus are also depicted in Fig. 6.4.

In order to get the animal served at the optimum time, particular attention should be paid to cows that had previously come into heat, irrespective of whether they had been mated or not. Such animals must be observed for a possible return to heat, from the 18th day after the previous heat. If they show heat signs, they must be mated again. In the case of animals that have been previously mated, this usually means that they have not become pregnant. If the animals have not returned to oestrus, it is most likely that they have become pregnant. In order to confirm this, a pregnancy diagnosis must be carried out by a veterinarian after 45 days of last service. In order to determine the expected date of the next heat period, it is important for farmers to keep a record of the dates of the previous heat periods for each cow. A simple format for a record sheet is given at the end of this chapter.

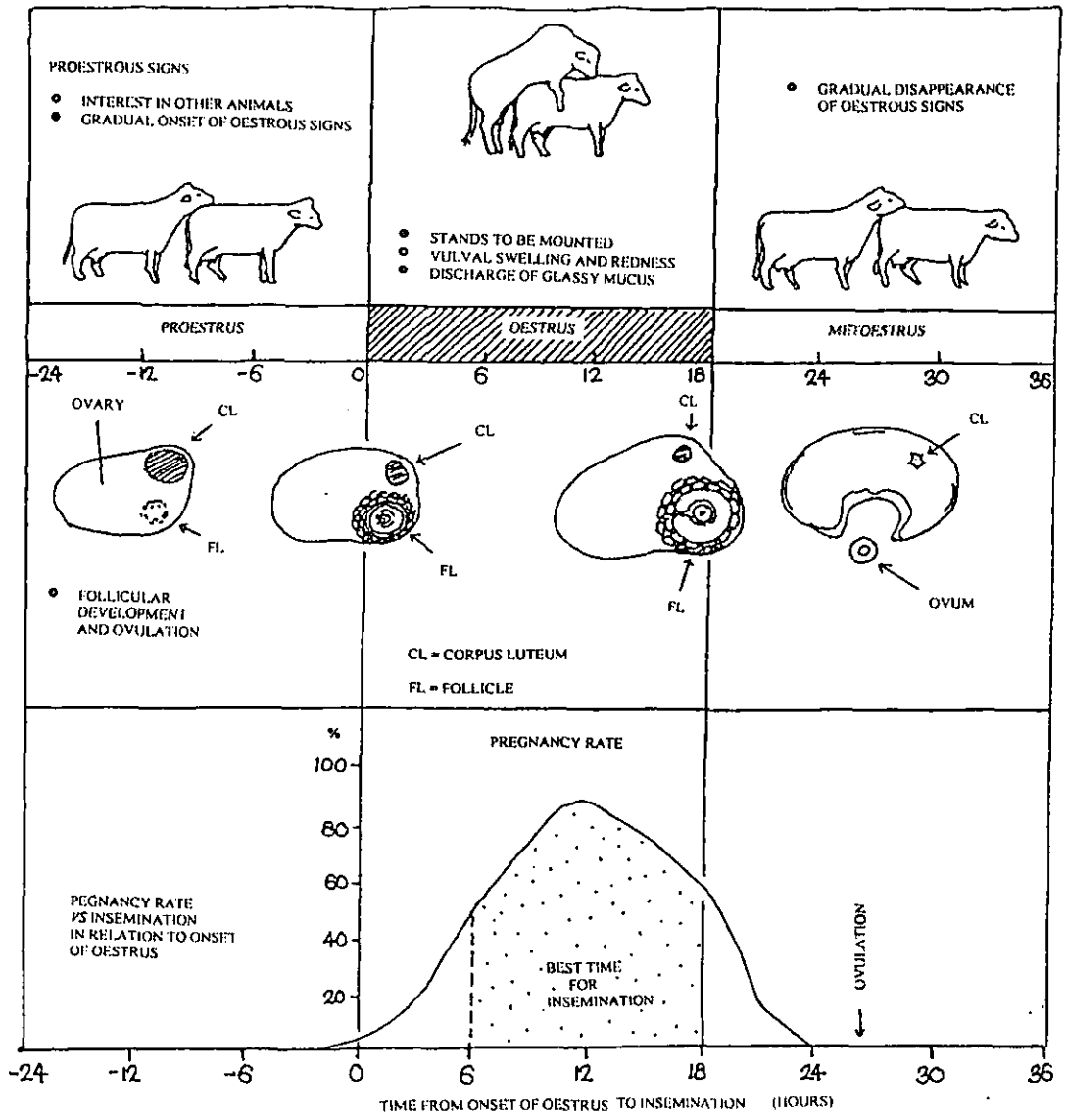

Fig. 6.4 **Schematic diagram to show oestrous signs, follicular development and ovulation and the relationship between time of insemination and pregnancy rate.**

6.5 Practical guidelines for achieving optimum reproductive efficiency

(a) For maximum conception rates:

* Cows detected in heat during the morning (before noon), should be served in the afternoon of the same day.

* Cows first detected to be in heat during the afternoon or evening, should be served on the next morning.

(b) For early sexual maturity or puberty: If a heifer attains puberty (onset of reproductive cycles) at an early age, she can also have her first calf early, and therefore produce more calves during her lifetime. The age at which a heifer reaches puberty is influenced by many factors, including the genetic composition, nutrition and the disease status. The following guidelines will help farmers to ensure that heifers reach sexual maturity at an early age.

1. Obtain a suitable calf to be raised as a replacement heifer. For this purpose, breed the cows with genetically appropriate males or semen (see Chapter 7).
2. Ensure that the calf gets adequate amounts of colostrum within 48 hours of birth.
3. Feed the calf with adequate milk, at least for the first 3 months, at the rate of 10% of the body weight of the calf.
4. De-worm buffalo calves between day 12 and 14, and dairy calves at 1 and 3 months, with suitable anthelmintics (see Chapter 8).
5. Vaccinate calves against HS, BQ and FMD, if these diseases are endemic in your area (see Chapter 8).
6. Provide adequate green grass and tree fodder starting from one month of age. During the dry seasons provide supplementary feed such as commercially available calf starter premix or poonac or good rice polish. For calves above 3 months of age, a supplement such as Urea-Molasses-Mineral (UMM) formulations are available (see Chapter 3).
7. Provide adequate water for drinking, at least three times per day.
8. If possible, allow the growing heifer to interact with other animals, particularly with male animals, from about one year of age.
9. Measure the body weight of animals at monthly interval (e.g. using a weigh band) and try to maintain a growth rate well above 300 grams/day or about 10 kg/month.

Usually a heifer attains puberty as she reaches two thirds the mature body weight of the breed. Thus a fast growth rate during the growing period will ensure that the heifer attains sexual maturity at an early age.

(c) To get the first calf early: Buffalo and dairy heifers are capable of becoming pregnant at the very first heat period. Serving the young heifer as she commences puberty ensures early calving. However, it is important to remember that the heifer is still growing. Pregnant heifers require a high plane of nutrition, for its growth as well as her calf. The following guidelines will help you to manage heifers to ensure early calving:

1. Observe heifers for heat signs regularly according to the guidelines given earlier
2. Mate heifers as soon as they show signs of the first heat (provided body weight is 65% of adult weight has been reached; if not, wait until this weight is reached)
3. Get the heifer served with semen from a bull of a compatible breed with high breeding value (see Chapter 7 for more details)
4. Check the heifers from the 18th days after mating for signs of heat and serve again if necessary
5. Provide adequate nutrition to meet the requirements of the heifer and the growing

foetus. Feeding of fibrous feed *ad libitum* (> 10% of the body weight on wet weight basis) and a suitable concentrate is recommended (see Chapter 1, 2, 3 and 4 for more details).

(d) *To get a calf every year:* In order to ensure that a calf is born every year, as depicted in Fig. 6.5, the cow must become pregnant within 90 days after calving. For the reproductive process to commence after calving, a cow must go through a period of recovery during which the uterus returns to its normal state. The cow should normally resume sexual cyclicity within 30 to 60 days after calving. However, the process of the uterus returning to the normal state can be delayed if the uterus becomes infected after calving. This can happen if the cow has calved in dirty unhygienic surroundings, or if she had an abnormal delivery (such as dystocia, retained placenta or prolapse of the uterus). The commencement of ovarian activity and sexual cycles can get delayed if the cow is not fed well during the period before and after calving, and also if she is suckled by her calf.

Pregnant cows should be dried off two months before the expected calving date. Cows should be dried off 8 months after conception in the case of buffaloes, and 7 months after conception in the case of cattle. Cows should be fed well during the dry period in order to ensure that they accumulate substantial body reserves that will be used to produce milk during early lactation. This will minimise the loss of body weight and condition after calving, and the animals will then be able to resume sexual cycles. Guidelines for assessing the body condition score (BCS) of buffaloes and cattle, and for using this score to ensure adequate feeding for optimum production and reproduction are given in Chapter 6.

In order to get a calf every year the cow must return to heat within 60 days after calving and conceive within 90 days after calving. If the first heat occurs earlier than 45 days after calving, it is advisable to skip this heat and serve the cow at the next (second) heat. Under normal conditions, only about 40-60 percent of cows will become pregnant after the first mating. Therefore, a cow that is mated must be checked for a return to heat from day 18, after the previous service and mated again if heat occurs. If the cow has not returned to heat, it is necessary to have her examined by a veterinarian for pregnancy, about 60 days after service. Time and income may be lost by assuming that the cow is pregnant and finding out much later that she is not.

6.6 When should the farmer seek veterinary assistance ?

In the same way that a motor vehicle needs a regular check-up and servicing, dairy animals need regular veterinary examinations. To maintain farm animals at the optimum level of efficiency, the farmer should consult his veterinary surgeon without delay if:

1. A heifer does not reach puberty by 36-40 months of age

2. A heifer/cow fails to return to heat by 60 days after calving

3. A heifer/cow does not conceive after more than 3 repeated services

4. A heifer/cow has an abnormal vulval discharge, difficult calving, retained placenta or other reproductive disorders.

6.7 Economic impact of good reproductive management

The lactating cow is the income generating machine in the herd. She has a finite life span and productive period. Therefore, the growing animal must reach sexual maturity at earliest possible age, become pregnant, deliver a healthy calf and commence lactation early in life. Any delay in getting the first calf will increase costs in terms of labour, feed and space. Similarly, the cow after parturition, must resume oestrus activity within 30-60 days and become pregnant within 90 days. Any delay in time between calving and the next conception will entail a cost to the farmer in a similar manner as stated earlier. Besides, the cow could produce a fewer number of calves, during its lifetime, and result in a reduction in income to the farmer from the sale of surplus animals. The application of good management practices would help the farmer to achieve all the targets.

The economic benefits are illustrated in the example given below. Assume that the maximum productive life span of a temperate (Bos Taurus) cow is 14 years. Scenario A and B presented below give the likely outcome of the application of proper and poor management practices.

	A (Well managed herd)	B (Poorly managed herd)
Age at calving	2 yrs	3 yrs
Calving interval	1 yrs	1.5 yrs
Number of calving per life time	12	7
Lactation length	300 days	360 days
Average yield/day	6 l	5.5
Total milk yield per lactation	1800 litres	1950 l
Total milk yield per life time of cow	21600 litres	13860 l

Therefore, in an ideally managed herd, a temperate cow will produce 5 more calves and an extra 7740 litres of milk during her productive life. In situations where pharmacological manipulations (e.g. oestrous induction, timed insemination, etc) are carried out to ensure optimum results (e.g. early first calving and a 12 month calving interval, etc.), it has been shown that the cost to benefit ratio is 1:3 or more, indicating that such interventions are economically advantageous to the farmer.

6.8 Importance of record keeping and the events that should be recorded by the farmers

A major drawback in smallholder farms is the absence of records of events taking place in the herd. These records are valuable to the farmer, the veterinary surgeon and livestock development instructor, for identification of any problems that may be present. It is very important that a separate record is maintained for each animal in the herd. For this purpose, an ordinary exercise book is adequate. For each heifer or cow, the following records should be maintained:

Record Sheet for Buffalo/Cattle

Identity (name or number) : .....

Date of birth : ..... Mother's identity : ..... Breed : .....

Father's identity : ..... Breed : .....

Weight at Birth : ..... Date of first heat : .....

Dates of services : ..... Date of first calving : .....

Calving number	Service dates	PD date and result	Calving date
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
.....	.....	.....	.....
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Notes on veterinary examinations and treatments :

Other Notes :

This chapter was prepared by Drs. H. Abeygunawardena, B.M.A.O. Perera and J.A. de S. Siriwardene for the SAREC/NSF (NARESA) Buffalo Research and Development Programme.

Chapter 7: Breeding of buffaloes and cattle

7.1 Introduction

The indigenous buffaloes (Lanka buffalo) and zebu cattle ("batu harak") of Sri Lanka are well adapted to tropical, often harsh climatic conditions and are resistant to many tropical diseases. But they are small in body size and low in milk production compared to their counterparts in the Indian subcontinent and in temperate countries. However, they are highly fertile, provided they are well fed, and they reproduce efficiently even under the harsh climatic conditions. The relatively small body size and low milk production has been the result of inbreeding in closed herds over several centuries and the absence of selection for production traits by man. These animals are predominantly found in the dry and intermediate zones of the country. In the wet zone, however, indigenous cattle have been replaced gradually by more European dairy type animals ("cape" cows). Some cross-breeding of buffaloes with improved dairy types from the Indian sub-continent has also occurred, but on a very limited scale.

In the dry and intermediate zones, the traditional free grazing or tethered grazing systems on communal lands are becoming difficult to maintain, due to competition from land from crop production, human settlements and industries. The traditional roles of livestock farming, which were mainly for draught and meat, have now changed to include milk as the primary commodity. The farmers therefore have to adopt new management practices, restricting animal movement and keeping fewer animals with higher production potential. This necessitates the upgrading of the genetic potential of animals for milk production, the adoption of more intensified rearing methods and the feeding of non-conventional fibrous feeds that are available in the homesteads and in the vicinity.

Genetic upgrading of cattle and buffaloes commenced as far back the 1950's, both through natural breeding and artificial insemination. Unfortunately, there has not been rigorous monitoring and selection of the upgraded populations and most often both the extension worker as well as the farmer fail to adhere to the breeding recommendations issued by the line ministry and related agencies. As a result, the desired benefits of 50 years upgrading efforts have fallen short of expectations. For example, in the wet zone areas, the productivity of European type ("cape" cows) cows has gradually declined and it is conceivable that this is a result of inappropriate breeding practices and nutritional inadequacies in feeding.

7.2 Methods of breed improvement

Buffaloes: As a method of improving the genetic potential for milk production of indigenous buffaloes, crossbreeding with imported river type buffaloes (from India and Pakistan) is feasible through natural breeding and/or artificial insemination (AI).

Cattle: Indigenous as well as "cape" cattle can be improved by crossbreeding with imported tropical breeds (from India, Pakistan and Australia) or temperate breeds (from Europe, America and Canada).

Bulls for natural breeding can be obtained from Government farms managed by the National Livestock Development Board (NLDB) and the Livestock Development Division of the Mahaweli Authority of Sri Lanka (LDD/MASL). Semen for AI is produced in Sri Lanka at three centres (Kundasale, Polonnaruwa and Tinnevely) and is also imported as required. The field AI services are operated under the supervision of your Government Veterinary Surgeon and are available through Government as well as private AI officers.

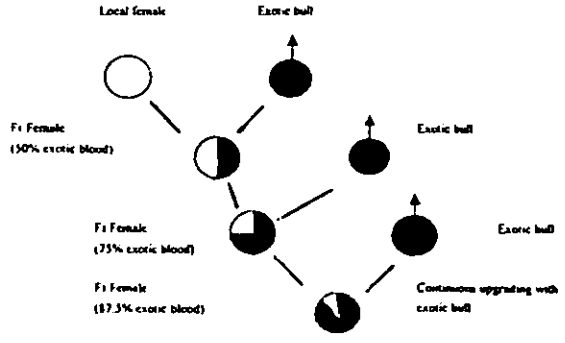
7.3 Importance of selecting the correct type of bull or semen

The selection of the correct type of bull or semen for breeding cows in smallholdings is the most important aspect in the breed improvement programme. The breed type must be able to withstand the climatic and management conditions prevailing in the area. This is because, the calf that is produced through upgrading programmes must be able to survive, grow, produce and reproduce under the climatic conditions and on available feed resources of the particular area. Thus the artificial insemination technician and the farmer must be aware of the principles used in the selection of a bull or semen.

This chapter outlines the recommendations made by the National Breeding Committee, consisting of experts in the fields of animal genetics and breeding, for breeding of buffaloes and cattle in the different agro-climatic zones of Sri Lanka. The veterinarian and the artificial insemination technician must appreciate the importance of educating the farmer to enable him to select the correct type of semen for his animals. Participation of all three groups (veterinarians, AI technicians and farmers) in this process is extremely important.

7.4 Different types of upgrading programmes

Genetic up-grading of animals could be achieved through several approaches. Three approaches adopted in Sri Lanka are a) continuous upgrading, b) rotational cross breeding and c) stabilising a desirable genetic composition by inter-se mating. These three approaches are used in different regions of the country to develop suitable genotypes, which have the ability to thrive and produce and reproduce efficiently, as shown in Fig. 7.1.

Continuous upgrading  	Cows of low producing breeds are mated to bulls of breeds with high production potential. The female progeny of the subsequent generations continue to be bred to bulls of this same breed thus gradually upgrading the production potential of the progeny to that of the breed of the bull.

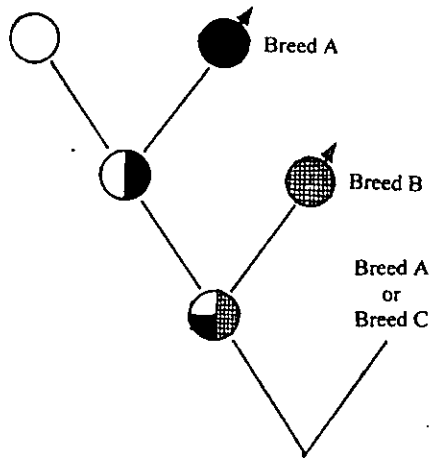
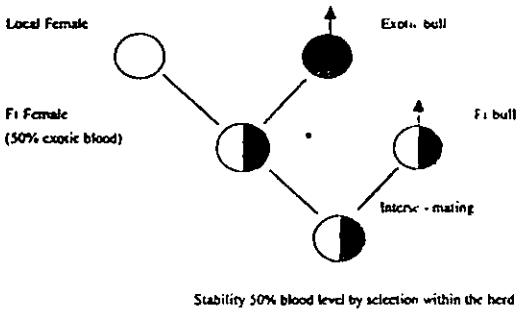
Rotational cross breeding  	Here, the upgrading of the production potential of low producing animals is achieved by breeding successive generations alternatively to two or three superior breeds with high production potential in rotation.
Stabilising desired blood levels by interse mating  	I this system, low producing cows are bred to a bull with a higher breeding potential either to achieve a 50% blood level or higher in the first generation. Thereafter interse mating with this generation is carried out to stabilise the blood level at 50% by intensive selection.

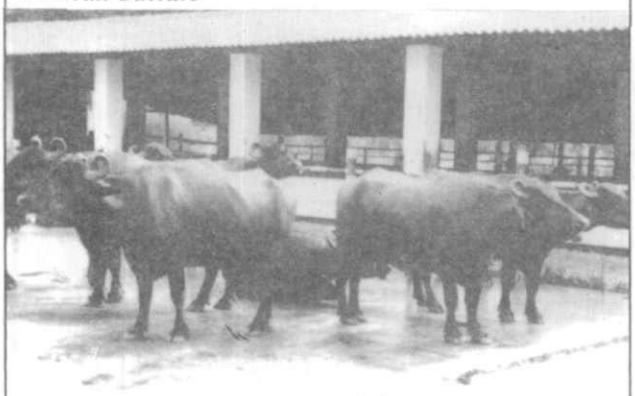
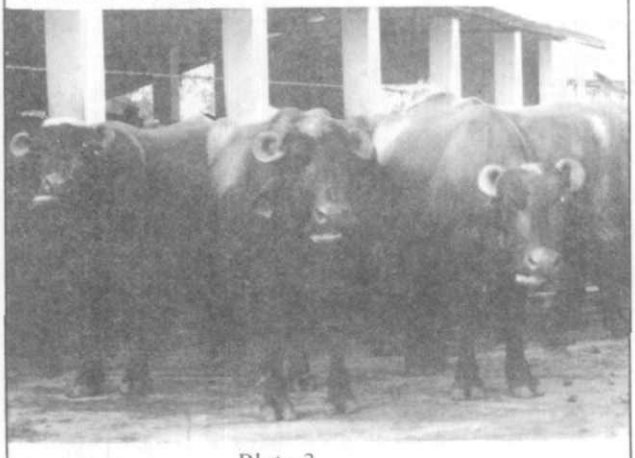
Fig. 7.1 Different types of breeding approaches

7.5 Breeding of Buffaloes

In order to upgrade the production potential of Lanka buffaloes, river type breeds such as Murrah, Surti and Nili-Ravi have been imported from India and Pakistan. They have been bred in their native countries for higher milk yield and also have the ability to perform well under tropical conditions.

The characteristics of these breeds, their genetic potential for milk production and where they are found in Sri Lanka are given below (Plates 1 to 3).

Crossbreeding of Lanka buffaloes and exotic river type buffaloes produce healthy calves which have the potential to produce more milk than the local cow but less than the pure exotic buffalo. But by continuous crossbreeding with genetically superior pure bred males,

Murrah buffalo  Plate 1	Murrah animals have been bred for high milk yield. They are large, with jet black skin and tightly curved horns. Can survive, reproduce and produce under hot and humid conditions. They have the potential to produce 3000-5000 kg of milk during per lactation (10-16 litres/day), provided they are well fed. They are maintained at the NLDB Farms in Polonnaruwa and Ridiyagama.
Surti buffalo  Plate 2	Surti animals have been bred for high milk yield and butter fat content. They are smaller in body size than Murrah, their horns are flat, sickle shaped and directed downwards. The skin is greyish and the hair is grey to brown. They resemble Lanka buffaloes, but are better milk producers and are docile. Potential to produce 2000-4000 kg of milk per lactation (7-12 litres/day), provided they are well fed. They are maintained at the NLDB Farm at Melsiripura.
Nili-Ravi buffalo  Plate 3	Nili-Ravi animals have been bred for high milk yield and butter fat content. They are large, stocky animals with black skin and white markings on forehead, face, muzzle, legs and tail switch. Horns are short and broad at the base and closely curled back. Introduced to Sri Lanka only recently, they have the potential to produce 3000-6000 kg of milk per lactation (10-20 litres/day). They are found on NLDB Farm at Nikaweratiya and Mahaweli Farms at Kalankuttiya and Girandurukotte.

the productivity of successive generations will gradually improve and ultimately reach levels as high as that of pure bred animals, provided they are managed and fed well.

7.6 Breeding recommendations for buffaloes

In all three major regions of Sri Lanka (wet, dry and intermediate zones), cross-breeding of indigenous (Lanka) buffaloes for continuous upgrading to the exotic river type has been recommended. However, the up-graded progeny need to be managed and fed well if their full genetic potential is to be realised. Therefore, two types of approaches are recommended, one for the intensive system and the other for extensive system of management (Fig. 7.2).

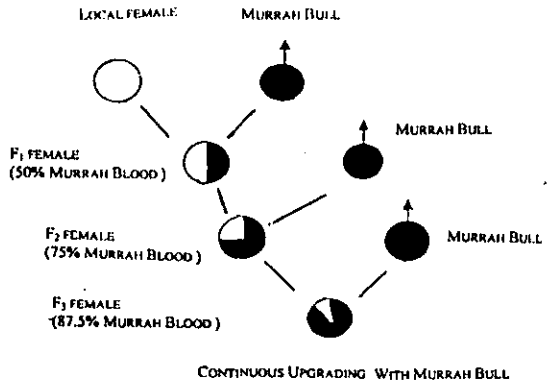
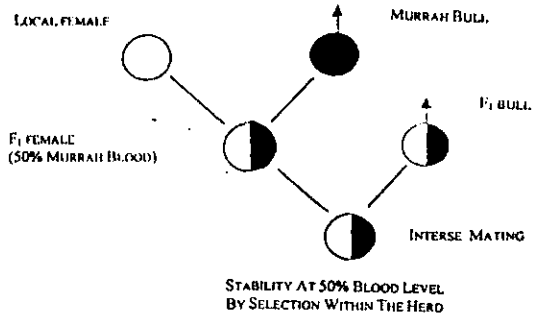
For intensive system  	The existing buffaloes must be upgraded using Murrah or Nili Ravi buffalo bulls, with continuous selection at each generation. As shown in the diagram, after nearly 5 generations (approximately after 15 years), the progeny will have more than 90% of genetic material derived from the river type bulls. Hence, there would be an incremental increase in milk yield from indigenous parent populations through F_1, F_2, F_3, F4 and F5 where the F5 progeny is capable of producing milk at levels equivalent to those of exotic parent.
For extensive system -  	As the climatic and management conditions may not favour rearing 100% river type buffaloes, it is recommended that the existing population is upgraded to 50% exotic blood levels by cross breeding with Murrah or Nili Ravi buffalo bulls to obtain F1 population. The F1 population is mated among themselves (F1 x F1 - interse mating) to stabilise the 50% blood level. Only the selected males of F1 and selected females of F1 must be mated to obtained the desired results.

Fig 7.2 Breeding recommendations for buffaloes

As shown in the diagram above, for intensive management systems, which are practised in wet and dry intermediate zone and some areas of the wet zone, continuous upgrading of indigenous animals to 100% of exotic blood levels by back-crossing to the exotic river type pure-bred males is recommended. The offspring will be gradually transformed, through 50% exotic type in the first generation (F1), 75% in the second generation (F2), 87.5% in the third generation (F3) and almost up to pure breed level after in five generations. If the upgrading process continues by back-crossing to pure exotic buffalo bulls, you can obtain animals

whose production levels are as good as those of exotic pure-bred animals and also with high adaptability to the local environmental and management conditions.

But for the extensive system which is found in most areas of the dry zone, where improvement of feeding and management practices would not be possible in the foreseeable future, upgrading of indigenous buffalo or existing crosses up to 50% exotic levels and stabilising this blood levels by interse mating is recommended.

7.7 Breeding of Cattle

As a result of the introduction of temperate dairy breeds during the colonial era and the availability of widespread AI services, the cattle population found in the country is very diverse and heterogeneous. In general, indigenous zebu animals and "up graded" zebus are primarily found in the dry and dry-intermediate zones while more temperate dairy type, pure and "up graded" cows are found in the wet and wet-intermediate zones. Within these regions too, there may be variations in the types of genotypes found. Further, this distribution of animals across the country has occurred primarily on the basis of agro-ecological conditions. For example, a temperate, dairy type cow may not be able to produce and reproduce satisfactorily or even survive under harsh climatic conditions prevailing in the dry and dry-intermediate zones. Similarly, rearing indigenous or "up graded" zebu animals may not be economical in the wet and wet-intermediate zones, as the climatic conditions are more conducive to the rearing of better dairy type animals.

7.8 The recommended cattle breeds for genetic upgrading programmes

The Department of Animal Production and Health now recommends 4 breed types for genetic up-grading programmes across the country: Friesian, Jersey, AFS (Australian Friesian Sahiwal), and Sahiwal. The characteristics of these breeds, production potentials, suitable climatic conditions and where they can be found in Sri Lanka are given below in Plates 4 to 7.

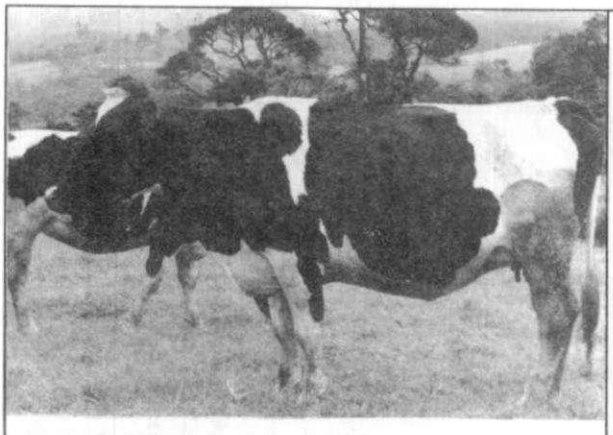
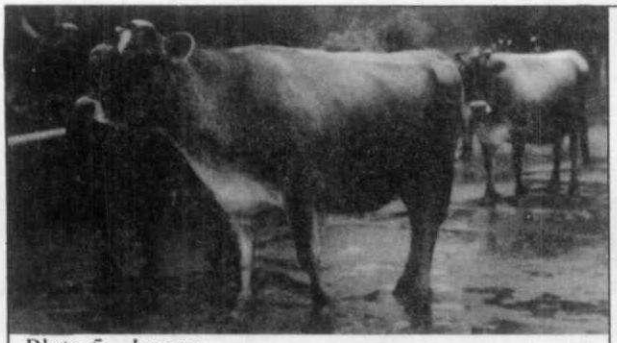
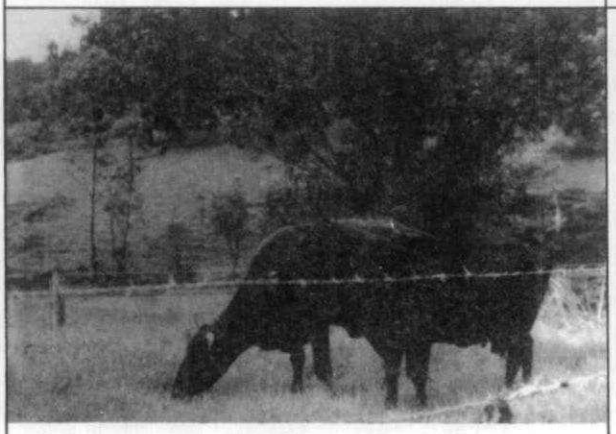
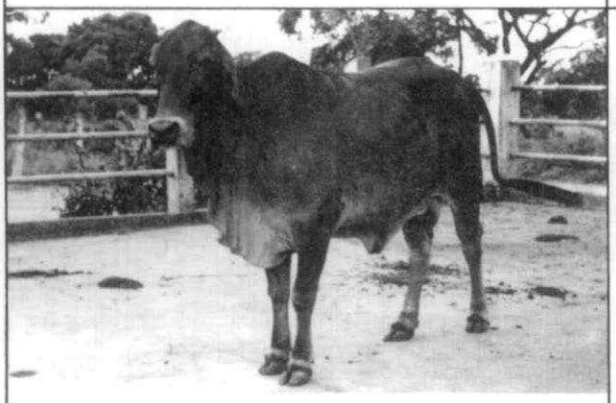


Plate 4 - Friesian

Black and white animal, bred in temperate regions (North America, Europe), with large body frame. Has the potential to produce 5000-10000 kg of milk per lactation. However, they are able to survive, reproduce and produce well only in cool, wet climatic conditions (hill and mid-country) and on high quality feeds. Very susceptible to tick-borne diseases (Babesiosis, Ehrlichiosis) and metabolic disorders (milk fever, ketosis). Pure Friesians are maintained in NLDB Farms at New Zealand, Ambewela and Bopathalawa.

 Plate 5 - Jersey	Light to dark brown animal, bred in temperate regions (Europe, N. America), with small body frame. Very docile and easy to handle. Has the potential to produce 3000-6000 kg of milk per lactation with high fat content. Performs well under cool, wet climatic conditions and on high quality feeds. In contrast to Friesians, can adapt to moderately hot and humid conditions (such as in the coconut triangle), provided they are fed well. Pure Jerseys are maintained in NLDB Farm at Dayagama.
 Plate 6 - AFS (Australian Friesian Sahiwal)	A synthetic breed, developed in Australia by cross-breeding Friesian and Sahiwal. Stocky animal, wide variety of skin colour (black, brown with or without white patches). Has the potential for moderately high milk production (4000-5000 kg of milk per lactation) with high butter fat content and ability to perform under a wide variety of climatic conditions (wet as well as intermediate zones), provided they are fed well. AFS semen is produced at the Central Semen Processing Centre at Kundasale and is available at VS offices. This breed is recommended for cross-breeding of extensively managed stock.
 Plate 7 - Sahiwal	Brown to reddish in colour, bred in the Indo-Pakistan sub-continent. Medium sized body frame with well developed dewlap. Has the potential for moderately high milk production (2000-4000 kg milk per lactation) with high butter fat content. Able to survive, reproduce and perform under a wide variety of climatic conditions (wet, intermediate and dry zones). Resistant to tick borne diseases. Pure Sahiwals are maintained on NLDB farms at Nikaweratiya, Udubaddawa, Polonnaruwa and Melsiripura.

7.9 Breeding recommendations for cattle

Taking into consideration the variation in agro-ecology and the potential resources available, the National Breeding Committee has recommended breeding policies for different agro-ecological regions. The description below is a very simple guide prepared on the basis of these recommendations (Table 7.1).

Table 7.1 Breeding recommendations for cattle

Agro-climatic Zone	Management System	Breeding Recommendations
Wet zone-Hill country	Intensive system	Continuous grading up to temperate breeds (e.g. Friesian or Jersey) to raise temperate blood level to near 100%.
	Extensive system	Crossing with temperate breeds (Friesian or Jersey) to produce first generation (F1) with 50% temperate blood. F1 is then mated with another F1 (of the same breed or different breed) to maintain temperate blood level at 50%.
Wet zone-Mid country	Intensive system	Continuous grading up to temperate breeds, to raise temperate blood to near 100%.
	Extensive system	Crossing with temperate breeds to produce F1 with 50% temperate blood level. Thereafter cross to F1 cross-bred bulls or bulls of AFS or AMZ.
Wet zone-Low country	Intensive system	Crossing with temperate breeds to produce F1 with 50% temperate blood level. Thereafter cross to F1 cross-bred bulls or bulls of AFS or AMZ.
	Extensive system	Continuous grading up or crossing to Indian Zebu breeds (e.g. Sahiwal) to raise exotic zebu blood levels to near 100%.
Dry zone	Intensive system	Crossing with temperate breeds (e.g. Friesian or Jersey) to produce F1 with 50% temperate blood level. Stabilize temperate blood level at 50% by mating to F1 bulls or bulls of AFS or AMZ.
	Extensive system	Continuous grading up with Indian zebu bulls to raise exotic zebu blood level to near 100%.
Coconut Triangle	Intensive system	Crossing with temperate breeds (e.g. Jersey or Friesian) to produce F1 with 50% temperate blood level. Stabilize temperate blood level at 50% by mating to F1 bulls or bulls of AFS or AMZ.
	Extensive system	Continuous grading up with Indian zebu (e.g. Sahiwal) to raise exotic zebu blood level to near 100%.
Jaffna	Intensive system	Continuous grading up to temperate breeds (e.g. Friesian or Jersey) to raise temperate blood level up to 75% or more
	Extensive system	(a) Continuous upgrading with Indian zebu breeds to raise exotic zebu blood level to near 100%. (b) Stabilize blood levels of existing temperate cross-bred animals (i.e. at 50% or above) by mating to good bulls of same population or by mating to bulls of AFS or AMZ.

7.10 Role of veterinarian, AI technician and the farmer in genetic upgrading programmes

1. The Veterinarian, AI technician and farmer must always adhere to the breeding recommendations applicable to the particular area. The Veterinarian and AI technician must discuss with the farmer, the choice of semen that should be used on his animals. The farmer must be made to understand that if a wrong type of semen is used on his animals, the progeny resulting from insemination may not be compatible with the environment of the area, resulting in stunted and unproductive animals.

2. The Veterinarian and the AI technician must encourage farmers to maintain records of events in their farms such as calving dates, service dates, type of semen used, milk production, etc. This will enable the farmer, the Veterinarian and the AI technician, to decide on the right type of semen to be used on the farmers' cows. Besides this will be useful in deciding on veterinary interventions that may be necessary to rectify the breeding problems.

3. The Veterinarian and AI technician must take a leading role in rigidly implementing the breeding programme. They must be involved in the selection of both males (or semen) and females for desirable productive traits. They must decide on the breeding value of semen to be used in the particular area and ensure that the cows and heifers are served with bulls or semen of higher breeding value (see Box 7.1 for explanatory notes on breeding value). Encourage the farmers to monitor the growth rates of the progeny and to keep only the progeny of high producing dams, showing higher growth rates and other desirable traits (e.g. body conformation and temperament) as replacement heifers in the smallholder herds.

Box 7.1 Explanatory notes on the use of breeding value of bull/semen and cows/heifers in the selection of bull/semen in upgrading programmes

The actual genetic potential of a cow or a bull for milk production or fat production is called the breeding value. This cannot be measured directly. But it can be estimated based on the performance of the animal and its relatives or offspring. The estimated breeding value (EBV) of an animal is the difference between the average milk production of the animal and the average milk production of animals of the same breed managed under similar conditions. Example on how to calculate the EBV for a cow and the expected performance of its calf is given below.

1. Calculation of EBV of a buffalo cow

If the average milk production of a Murrah cow in the Coconut Triangle is 2200 litres in a 305 day lactation period, and the average milk production of all Murrah cows in the Coconut Triangle is 1900 litres / 305 lactation period, then the EBV for milk production of the cow is + 300 litres (i.e. 2200-1900 litres). The estimated breeding values of the dam and the bull could be used to predict the milk production potential of the offspring. The predicted value of the calf is called the Expected Progeny Difference (EPD). An example of calculating EPD of a calf from known EBVs from a cow and a sire is given below.

2. Calculation of EPD of a calf

Assume that the average milk production of the cows in the area	=	1900 lts (a)
and the EBV (for milk) of the dam	=	+ 300 lts
Assume that the EBV (for milk) of the sire	=	+ 800 lts (given with semen)
Then (a) the contribution of the dam to the expected progeny difference of the calf	=	1/2 x 300 = 150 lit (b)
(b) the contribution of the Sire to the expected progeny difference	=	1/2 x 800 = 400 lit (c)
Then the EPD of the calf is b+c =		150 + 400 lts
	=	550 litres (d)

3. Expected performance of the calf

The expected actual performance of the calf will be the sum of the average milk production of Murrah cows in the Coconut Triangle and the EBV of the calf (a and d) which is 1900 + 550 = 2450 for a 305 day lactation period.

Therefore in making on the decision the choice of the bull to mate this cow, the farmer should select a bull which has a higher EBV than the cow. In doing so, he should bear in mind that he should not select a sire with a very high EBV. The reason for this is that the low producing cow will not be able to produce sufficient milk to satisfy the higher milk requirement of the calf necessary to support the higher growth rate of a superior calf

This chapter was prepared by Drs. H. Abeygunawardena, B.M.A.O. Perera, M.G. Jeyaruban and J.A. de S. Siriwardene for the SAREC/NSF (NARESA) Buffalo Research and Development Programme.

Chapter 8: Health and Disease of Buffaloes and Cattle

Productivity in buffaloes and cattle depends on a variety of factors such as the genetic potential, management, nutritional status, reproductive efficiency and health status. Disease conditions have adverse effects on productivity (and therefore on profits) in several ways including the following: retarded growth, lowered production and reproductive efficiency and death.

8.1 Causes of Diseases

Diseases are caused by specific external agents which may be infectious (e.g. micro-organisms) or non-infectious (e.g. toxic substances) or as a result of internal factors such as metabolic disorders, or the deficiency or excess of essential nutrients. This chapter deals with those diseases caused by infectious agents such as a) parasites, b) bacteria and c) viruses.

(a) Parasites: The parasites which cause disease can be broadly categorised as worms (helminths), blood parasites and external parasites (ectoparasites). The helminth parasites are found mainly in the gastro-intestinal tract and consist of the round worms, flat worms and tape worms. Blood parasites invade the red or white cells causing disease. The ectoparasites in addition to their direct pathogenic effects also serve as agents in the transmission of other diseases.

(b) Bacteria: A variety of bacteria produce disease in cattle and buffaloes. Some of these are specific pathogens (e.g. *Pasteurella multocida*) while others constitute the normal bacterial flora (e.g. *E. coli*) which play an opportunistic role and produce disease only when the resistance of the animal is low.

(c) Viruses: A number of specific viral diseases have also been described in cattle and buffaloes. The most common viral agents are foot and mouth disease virus, ephemeral fever virus etc.

8.2 Resistance to Diseases

When an animal (or host) is exposed to a disease causing agent, the chances of the occurrence of disease will depend on the virulence of the agent on the one hand and the ability of the animal to resist infection on the other. Several factors influence the resistance of the host animal, including the following:

(a) Genetic: Factors: some animals are genetically more resistant to disease than others. Genetic resistance varies with species, breed and individual animals.

(b) Nutrition: A well nourished animal is always more resistant to disease than an ill-nourished one

(c) Concurrent diseases: Animals weakened by parasites, internal or external, are always more prone to other diseases.

(d) Specific immunity: This is acquired naturally by exposure to disease, or induced by vaccination.

Thus the chances of an animal acquiring disease can be minimised by good feeding and proper health care such as by regular worming and by development of specific immunity through vaccination.

8.3 Diseases of Young Calves

(a) Navel Ill and Joint Ill: This is an infection of the navel cord, immediately following birth, caused by bacteria found in unhygienic calving sheds. This can be prevented by maintaining a good level of hygiene in the calving sheds and by prompt disinfection of the navel cord soon after birth, using an antiseptic solution such as tincture of iodine. Navel ill once established has to be treated with antibiotics. If not treated, it will lead to invasion of the blood stream by bacteria (bacteraemia) and localisation of the infection in the joints. This causes swollen joints and limping, a condition called "joint ill". Joint ill has also to be treated with appropriate antibiotics. If not treated in time, the limp will persist and the growth of the animal will be retarded.

(b) Gastro-intestinal Infections in Young Calves: Gastro-enteritis is caused by a variety of agents, including helminth worms, bacteria and viruses. Diarrhoea is a common sign of gastro-enteritis caused by bacteria or viruses. It takes a more acute form and may be associated with more generalised signs of illness including fever. Blood or mucous may be present in the excreta. Uncontrolled bacterial or viral diarrhoea could lead to dehydration and death. Treatment of gastro-enteritis is based on identification of the cause. The disease picture will give some indication of the cause. For confirmation, laboratory examination of faecal samples is necessary. Acute bacterial gastro-enteritis has to be treated with appropriate antibiotics and with fluid therapy when necessary.

Coccidiosis a disease caused by a protozoan parasite will also produce symptoms of acute diarrhoea. Gastro-enteritis and diarrhoea caused by helminth worms is of a more chronic nature. Calves will be off feed, with a ruffled coat and there will be impaired growth. Coccidiosis must be treated with anticoccidial drugs. A veterinarian should be consulted for proper diagnosis and treatment.

Routine worming as recommended in Table 8.1 will eliminate helminth gastro-enteritis. Ideally, a routine worming programme has to be formulated to suit the particular farming situation, climatic conditions, management system, stocking rate and the type of worms involved. Indiscriminate use of de-worming drugs can lead to the development of drug resistance and the drugs will then be ineffective. The veterinarian will help to develop a routine deworming programme (see Table 8.1).

Gastro-enteritis is preventable. If bacterial and viral infections occur frequently, they should be controlled by faecal examination, identification of the agent and adoption of measure to improve the hygienic conditions on the farm.

(c) Respiratory Infections (Pneumonia): This is another common condition that occurs

among young calves. The incidence of these disease conditions is brought about when animals are reared in congested animal sheds. Moist bedding, humid atmosphere and poor ventilation are generally the contributory causes. Calf pneumonia is primarily caused by one of many viruses. The symptoms of primary viral pneumonia are coughing, clear nasal discharge and fever. If untreated, secondary bacterial infection caused by normal bacterial flora of the upper respiratory tract will set in. Animals will show respiratory distress, purulent nasal discharge and death will result if untreated. Bacterial pneumonia has to be treated with appropriate antibiotics. Antibiotic treatment during the early viral stage will prevent death from bacterial pneumonia.

8.4 Diseases of adults

(a) Mastitis: The udder of a milking cow is an organ of utmost importance. Mastitis is an infection of the udder caused by one or more types of bacteria commonly present in the environment. The disease may occur as clinical mastitis, when visible symptoms are present or as sub-clinical mastitis when no obvious signs are visible. In either case, there is considerable loss of milk production and therefore heavy economic losses. If mastitis is not treated in time, permanent damage will occur to the udder and milk production may never return to normal.

The symptoms of clinical mastitis include changes in the structure of the udder, the milk and the animal is general. The udder will be swollen, hard, reddened and painful to touch, particularly noticeable at milking time. The milk will be discoloured, contain milk clots and sometimes blood. One or more quarters of the udder may be affected. In mastitis caused by some bacteria, the cow will show signs of general illness such as fever, depression and inapetance.

Treatment of mastitis is effected by administration of a suitable antibiotic preparation, as an infusion into the udder through the teat canal. The correct choice of the antibiotic is important. Infusion must be done after milking out the contents of the affected quarter and must be repeated for several days. The veterinarian will decide on the choice of antibiotic infusion to be administered. If commonly used antibiotics are ineffective, a sample of milk collected into a sterile bottle should be despatched to a laboratory for culture and antibiotic sensitivity testing. The laboratory report will indicate the choice of the antibiotic, which is the most effective against the infective agent.

Subclinical mastitis can be detected by a simple test called the California Mastitis Test (CMT) which is a cow-side test and one which can be carried out at milking time or any other time. If mastitis occurs frequently in a milking herd, it is advisable to get the herd tested by CMT periodically. Mastitis is better controlled than cured. As control programmes cost less than treatment, there will be a saving by the application of control measures that will prevent a loss of milk production.

Mastitis Control Program:

(i) Hygienic housing - Cattle sheds should be clean and as dry as is practically possible. Sheds should have clean floors without pot-holes where dirty water can collect.

(ii) Hygienic milking - The udder must be washed with clean, preferably running water before milking. Avoid using of the same cloth to clean the udders of several animals.

(iii) Teat Dipping - Immediately after milking, each teat should be dipped in a solution of an suitable antiseptic in the correct concentration. Many commercial teat dipping solutions are available. The manufacturer's instructions should be strictly followed. A cheap, effective, locally available solution is 1.6% formic acid.

(iv) Cases of clinical mastitis should be promptly treated.

(v) The entire milking herd should be CMT tested periodically (e.g. once in 3 months). Cows showing signs of subclinical mastitis should be isolated. Such animals should be treated during their dry period with special antibiotic infusions.

(vi) The herd must be milked in the following order.
- (i) Healthy CMT negative animals
- (ii) Clinically normal but CMT positive animals
- (iii) Clinically mastitic animals.

Following antibiotic treatment, milk from the treated animal should be discarded up to 48 hours after the last antibiotic infusion.

(b) Brucellosis: Brucellosis is a disease of the reproductive tract of cattle and buffaloes caused by a bacterium. Infection will occur at any age, but the disease will manifest itself only during pregnancy. In the first instance, it will cause abortion in late pregnancy. When first introduced into a herd, the disease causes a "storm" of abortions. Subsequently, it will cause infertility, still births, retained placenta and other related disorders and the birth of weak calves.

Brucellosis is a disease communicable to man and causes undulant fever. Normally the infection occurs by drinking raw milk from infected animals. Abattoir workers and veterinarians may acquire infection through contact with infective material.

Animal brucellosis is not treated. Hence the efforts must be directed towards elimination or control of the disease. Control of the disease rather than elimination of infected animals is the accepted strategy.

Control of brucellosis: If an abortion occurs in a herd, farmer must immediately bring this to the notice of the veterinarian in his area. The farmer must keep the aborted foetus and the foetal membranes for inspection by the veterinarian. Prevent the other animals coming in contact with the aborted cow and aborted material. Farmer also must remember to take due precautions in handling the material as brucellosis is communicable to man. The Veterinarian upon examination of the history, the animal and the aborted material, would come to a tentative conclusion as regard to the possible cause of abortion. He may also collect samples from the foetus and placental material for further examination in a laboratory. Once a proper diagnosis is established the veterinarian will adopt one of following methods to control the spread of the disease.

(a) Testing and culling of animals - Several tests are available for this purpose. If the percentage of positive animals is low, it is best to slaughter them and keep the herd clean and brucellosis free.

(b) Regular vaccination - when the percentage of positive animals is high and culling is not feasible, the entire herd may be vaccinated. A single dose vaccine given once in a life time is adequate. All new animals growing up should be vaccinated at around 5-6 months of age.

The farmer must strictly adhere to the instructions given by the veterinarian regarding the control programme recommended to suit the particular situation.

(c) Leptospirosis: Leptospirosis is another disease caused by a bacterium that causes abortions in late pregnancy. This disease may have an initial phase of fever, reddening of mucous membranes, etc. which may pass unnoticed. Leptospirosis is also communicable to man. Affected animals and also animals that have recovered from the disease will excrete the organisms in urine. Animals working in paddy fields will thus contaminate the environment and be a source of infection to paddy field workers. The infection in man can also occur through inhalation of the urine spray caused by wind and the switching of the tail.

Unlike brucellosis, animals affected with leptospirosis can be cured by antibiotic treatment. Animals so treated will not become carriers, but animals that spontaneously recover may become persistent carriers and be a potential source of infection. Laboratory serological tests using blood collected from the jugular vein can differentiate between brucellosis and leptospirosis. Thus in the event of an abortion, the farmer must contact the veterinary surgeon who will establish a tentative diagnosis and collect samples (e.g. blood) for despatch to a laboratory to establish a definite diagnosis

(d) Haemorrhagic Septicaemia (HS): This is a highly fatal disease of cattle and buffaloes caused by a bacterium. Buffaloes are more susceptible to the disease than cattle. In endemic areas, it effects mainly young adult animals generally from 6 months to 2 years of age. The disease is endemic in the dry zone. It may also occur sporadically in other areas except in the hill country. Outbreaks of HS can cause very heavy losses in unvaccinated herds of cattle and buffaloes.

The disease is characterised by high fever, loss of appetite and swelling under the jaw which spreads into the breast region and even to the fore-legs. Later, there will be respiratory distress leading to recumbence and death. In the acute form, animals will die suddenly without showing any symptoms. Once the disease gets established in the animal, death invariably results. The course of disease is so rapid that early signs may escape notice and treatment may be not be practicable. Treatment is possible in a herd where a few animals have died of HS, by regularly checking the rectal temperature of all in-contact animals and separating those showing a rise of temperature and treating with antibiotics.

The disease is preventable by vaccination. Calves should be first vaccinated ideally at 4 months of age and preferably again 6 months of age. A booster should be given within 3-6 months of the first vaccination and thereafter, annual vaccination should be done (see Table

8.2). The HS vaccine is made locally and vaccination is done free of charge by the Government Veterinary Surgeon.

(e) Black Quarter Disease (BQ): BQ is an acute disease caused by a bacterium. It is characterised by inflammation of muscles leading to lameness and high fever. Once clinical disease gets established in the animal, death occurs invariably. Treatment with antibiotics may be effective only in the early stages. The disease effects zebu cattle and buffaloes mainly in the 6 months to 2 years age group. In the case of temperate breeds however, older animals are also affected. BQ occurs only in certain localised areas in the Northern, Eastern, North-Western, North-Central and Uva provinces. The disease is preventable by vaccination (see Table 8.2). The vaccine is made locally and vaccination is carried out by the Government Veterinary surgeon free of charge.

(f) Foot and Mouth Disease (FMD): Foot and mouth disease is an extremely contagious disease of all cloven footed animals particularly cattle and buffaloes. It is caused by a virus that spreads rapidly through wind, water, contaminated feed and pastures. Affected animals develop vesicular lesions in the mouth and feet. These vesicles will rupture, and if they get infected, healing will be delayed. Adult indigenous animals will recover but some deaths may occur among young animals and in temperate breeds. Affected animals will show excessive secretion of ropy, stringy saliva and will show a characteristic smacking of lips. Eating will be impaired with the consequent loss of body condition and a drop in milk yield. Foot lesions will often cause lameness. The animal's heat regulatory mechanisms of affected animals may be impaired and there will be visible 'panting'.

There are other rare diseases that resemble FMD. The veterinarian will collect appropriate materials from effected animals and despatch these to the laboratory for confirmation of diagnosis of FMD. FMD is preventable by vaccination, which is done free of charge by the Government Veterinary Surgeon (see Table 8.2).

(g) Rinderpest: Rinderpest is an acute, highly contagious disease effecting cattle and buffaloes. The disease was eradicated from Sri Lanka in the early 1940's but was re-introduced in 1988. It is now confined to the Northern and Eastern provinces, but cattle and buffalo owners elsewhere should always keep a watchful eye for this disease. It is caused by a virus that is fragile and therefore does not persist for more than a few hours outside the body of the animal. Thus, close contact between animals is necessary for transmission. The distinctive signs of the disease are conjunctivitis and inflammation of the mucosa of the mouth and nostrils, with consequent lacrimation and salivation. Discrete necrotic lesions appear on the mouth and tongue. There will be severe diarrhoea with blood. Absence of foot lesions helps to differentiate rinderpest from FMD.

The present policy for controlling of rinderpest is the destruction of all effected and immediate in-contact animals. Ring vaccination around the areas of the outbreak will be carried out by the Government Veterinary Surgeon in the case an outbreak.

(h) Infectious Keratoconjunctivitis: Infectious keratoconjunctivitis in cattle and buffaloes (also known as 'pink eye') is a bacterial infection which occurs in epidemic form. Red eyes, with copious lacrimation are characteristic features. In this disease only the eyes are affected and no lesions appear elsewhere. Most animals recover spontaneously. A few animals may

become blind. Early treatment with antibiotic eye ointment can effect complete recovery.

(i) Tick Bone Diseases: There are several diseases caused by blood parasites that infect the blood cells. These diseases are transmitted by ticks. The most important of these is babesiosis caused by a protozoan parasite that infects the red blood cells. Babesiosis is prevalent mainly in the mid and hill country and effects mostly the temperate breeds of animals. It is characterised by fever and the passage of red urine and is accompanied by other general signs of illness such as depression, lack of appetite and in the case of milking cows, a fall in the milk production. If untreated, death will result. The diagnosis of the disease is confirmed by the examination of a blood smear from the animal. Once diagnosed, treatment with specific drugs will have to be carried out by your veterinarian. In endemic areas vaccination is advised. Young calves should be vaccinated at 4-6 months of age. The vaccine is produced at the Veterinary Research Institute and advance notice must be given by your veterinarian to obtain the vaccine.

Table 8.1 Schedule for routine de-worming in buffaloes and cattle

Species and age group	Timing of Treatment	Recommended drug and procedure for worming
Buffalo		
Calves	Day 10-16 of age	Pyrantel Palmoate: 2 tablets or250 mg per calf. One worming is sufficient.
Adults	In general, adults do not require worm treatment. However, if animal show evidence of weight loss, diarrhoea, reduced milk production, contact a veterinarian for advice.	Follow the recommendations of your veterinarian
Cattle		
Calves	1st worming at one month 2nd worming at 3 months ***other recommendations:*** Calves managed intensively in the wet zone may be de-wormed once in 2-3 months up to 12 –18 months of age. In areas where worm infestation is endemic; worm the young animal at the commencement of Yala (April/May) and Maha (September/October) rains and on each occasions follow the same treatment 3 weeks later.	Albendazole; half a tablet or 750 mg per calf **.or** Febantel at the rate of 75 mg/kg body weight (about 3 grams per calf) There are other drugs suitable for worming. For details contact your local veterinarian
Adults	For young as well as adults de-worming is required only if the animal shows signs of worm infestation. Your veterinarian will examine dung samples and tell you whether worm treatment is required or not.	Follow the recommendations of your veterinarian

Table 8.2 Vaccination schedule against common infectious diseases of buffaloes and cattle

Disease	Primary Vaccination (Age)	Secondary vaccination (Age)	Booster vaccination (Age)
Haemorrhagic septicaemia	4 months	7 months	12 months + annually thereafter
FMD	4 months	5 months and 7 months	12 months and bi-annually thereafter
BQ	9 months	9 months	12 months and bi-annually (up to 2 years)

This chapter was prepared by Drs. M.C.L. de Alwis, H. Abeygunawardena, J.A. de S. siriwardene, D.H.A. Subasinghe and N.U. Horadagoda for the SAREC/NSF (NARESA) Buffalo Research and Development Programme

Chapter 9: Management of Buffaloes and Dairy Cattle

The efficiency of a livestock farm operation depends heavily on good management of the livestock and other farm resources. To achieve the desired level of management efficiency, the farmer has invariably to pay adequate attention to the following important aspects: (i) animal handling and management, (ii) feeding and nutrition, (iii) reproductive management (iv) health care and (v) in the case of buffaloes, regulation of body temperature.

It must also be recognized that the biological and physiological needs of dairy cattle and buffaloes vary according to the breed type, age, sex, reproductive status, production level, status of health and the environment. It is therefore imperative that these varied requirements should be considered, in the care and management of the different categories of livestock in farms. These relate particularly to the needs of (1) calves (i.e. new born and neonatal calves, pre-weaner calves), (2) growers (prepubertal heifers, pregnant heifers) and (3) adults (i.e. pregnant cows, parturient cows and postpartum cows).

In this chapter, we have attempted to provide a basic guide to you on the more important aspects of dairy cattle and buffalo management, from the newborn calf to adults of various age groups and physiological states. You will see a repetition of the material provided in the previous chapters. This has been deliberately done to reiterate the important aspects of livestock farming and also for the convenience of the reader.

9.1 Management of Calves

(a) Management of a new born calf

At parturition, the neonatal calf is, for the first time exposed to a very stressful environment compared to the protected environment within the mother's uterus. Apart from necessary adjustments in respiration and nutrition, the neonatal calf has to face the challenge of survival from infections. The chances of infection are much greater in the neonate if the calving has taken place under unhygienic conditions and also if the intake of colostrum is inadequate or delayed. Therefore, it is very important to ensure that calving takes place under clean conditions, free from possible contamination. Soon after birth, it is necessary to remove the placental tissue and clean the calf with dry straw, grass or a clean piece of cloth. At this time, clean the mucous from the nostrils to enable the calf to breathe freely. If the dam attempts to lick the calf, this should be encouraged. This would in addition to the cleaning and drying effect, stimulate breathing and invoke the material instinct. Always remember to record the birth weight of the calf and thereafter carry out regular weighing. This will help to monitor the growth rate. Sever the naval cord by gentle stretching, and if necessary cut the naval cord of the calf with a suitable instrument and apply a suitable disinfectant like tincture of iodine on the wound to prevent infection. Application of margosa oil around the navel would be useful as a fly repellant.

The newborn calf will normally stand and begin to suckle within 1-2 hours of birth. However, if this does not happen, the calf should be assisted to suckle the dam. Ensure that the baby calf gets the first milk (colostrum) from the dam within the first few hours of life, and allow the animal to suckle freely during the next 3-4 days. Colostrum is essential to the new born calf for not only as nutrition and also to develop resistance to disease, as it is rich in antibodies (i.e. weapons against diseases) against common as well as for specific pathogenic organisms. Antibodies have the capacity to fight against common diseases. In the baby calf, colostrum is absorbed (directly and the optimum period for absorption of colostrum is) during the first 36 hours of life, since its absorption is impaired thereafter as the intestine loses the capacity to absorb whole molecules. Colostrum has also laxative properties which facilitates the removal of meconium (first faeces) from the gut within a few hours of its ingestion. The daily colostrum requirement is about 5-8 % of the body weight of the calf. Hence the ingestion of colostrum in early life is of vital importance to ensure a healthy calf. The baby calf should also be provided with warmth and dry bedding and clean drinking water.

(b) Management of calf from 7 days to weaning

Nutrition Management: Milk forms the bulk of the diet in the young calf, and it should therefore be provided in adequate amounts to ensure satisfactory growth. In general a calf would require 10% of its body weight to meet its daily requirement. This volume of milk can be supplied twice a day.

Suckling is the most convenient and common method of calf feeding, practiced by the small holder farmer in feeding pre-weaner calves. However suckling should be controlled to avoid over-feeding and under-feeding and so that the surplus milk could be extracted for domestic use or sale. It is best to limit suckling to twice a day (i.e. once at each milking). Research has revealed that limited suckling helps in reducing the time from calving to first oestrus. In practice this done in two ways. One method is to completely milk three quarters of the udder and reserve the other quarter for the calf (depending on the milk yield of the cow and the requirement of the calf). The quarter left for the calf can be changed rotationally at the subsequent milkings. The other method is to empty all 4 quarters, but leave a portion (about one fourth) in one quarter for the calf. The calf will be also able to extract the milk the farmer was not able to extract.

Tender grass and hay (50-100g) may be introduced as feed on about day 10, to allow for the development of the rumen in the young calf. Concentrate feeds like a calf starter (commercial feed, coconut poonac or rice polish) may be provided to supplement the diet, at about two weeks of age, particularly for fast growing animals of European breeds or their crosses. The daily allowance of concentrates may be increased gradually to 500-750 g/day at two months of age. The weight of the calf should be recorded at least once a month to monitor its growth. The gain in weight of a calf should generally be about 400-500 grams per day, which would depend very much on the genetic composition, the level of feeding and management and the environment.

Weaning: When the calf is about 21/2 to 3 months old, the calf may be weaned if it has reached twice the birth weight. At weaning, the calf can be fed totally on forage, as milk is not an essential component of its diet. The dry matter consumption should then be about 2% its body weight. In addition to forage, the calf would require important minerals like calcium and phosphorous as well

as trace minerals that can be provided by means of a good quality, commercial mineral mixture. Access to clean drinking water should be ensured throughout the day within the calf pen. Continue to provide dry bedding and avoid cold wind draughts. If the calves are reared in groups, they should be prevented from licking one another, as this may lead to the formation of hair balls in the rumen.

Health Care: Most calf deaths occur during the pre-weaning period. This could be prevented or reduced by taking appropriate measures to adopt hygienic measures in feeding and management. A common problem encountered in early life of the calf, particularly the buffalo is the round worm infection called "Ascariasis". The worm eggs are transmitted from the cow to the young calf through the milk, although the cow does not show any clinical signs of the disease. The parasitic eggs develop in the calf to become adult worms within 3 weeks, after which the calf may show signs of disease characterized by lethargy, diarrhoea, weakness and sometimes death. Therefore, strategic de-worming of the calves is necessary to prevent the infection. All buffalo calves should therefore be dewormed between 10-16 days of age with an effective drug, such as pyrental palmoate. (Combantrin - two 125mg tablets).

Another common parasitic problem that occurs in calves (also in buffalo calves) at a young age is a protozoan infection of the gut called 'coccidiosis'. This occurs generally, at the age of about 3-4 weeks. The clinical signs of the disease are the loss of appetite, diarrhoea with blood stained mucous and a rise in body temperature. Prompt veterinary advice and treatment should be sought in all such cases in order to prevent calf losses. Sulphadimidine is an effective drug in the treatment of coccidiosis. Other roundworm and tapeworm infections may occur between 1-3 months of age in calves. Affected animals will usually show signs of weakness, swelling under the jaw, diarrhoea and a pot bellied appearance. If any of these signs are observed, early veterinary attention should to be sought for proper diagnosis and treatment. For more details on health care refer Chapter 8.

9.2 Management of Growers (weaning to puberty)

Providing good nutrition is of primary importance for the growing calves in order to maintain the desired growth rate and to ensure the development of resistance to infections. Well-nourished livestock can withstand disease much better than undernourished animals. Since the weaned calf could now depend entirely on roughage feed, good quality hay, pasture and fodder should be provided *ad libitum* quantities. The mineral and vitamin requirements of the growing animal should also be provided in the daily diet and this could be achieved by feeding a commercially available mineral mixture. Good quality grass and fodder supplemented with tree fodder would provide enough nutrients for a calf with potential for a moderate growth rate (e.g. Indian dairy breeds and crosses). However, for calves with the potential for higher growth rates (e.g. pure European breeds or their crosses >75% European blood) may need concentrates such as coconut meal, rice polish or compounded feeds to express the full potential for growth and may be given as supplementary feed if the cost can be accommodated. However, alternative feed resources such as paddy straw supplemented with UMMM feed supplements, tree fodder may be useful in meeting nutritional deficiencies and also during the dry season, when good quality grass is in short supply. Detailed aspects of feeding are described in chapter 1, 2, 3, and 4.

Proper nutrition management promotes steady growth of the young and the achievement of early puberty. Attainment of early puberty increases the reproductive and productive life of the animal and hence they bring enhanced economic returns to the farmer. The growth of the animal should be regularly monitored, by recording its body weight every month. In general, the calf is expected to gain about 500g/day. Both cattle and buffalo cows commence sexual activity (i.e. puberty) as they reach two thirds of the mature body weight. Hence a calf with higher birth weight and faster growth rate will achieve puberty earlier than a calf of smaller body weight and slower growth rate. In a well nourished buffalo, the first signs of heat occurs at 15-18 month of age and as they reach a body weight of about 200-250kg. Similarly a well-nourished female dairy heifer may reach puberty by 12-14 months of age, as it reaches 200-250 kg body weight. After the initiation of the oestrus cycle in the young heifer, heat signs will occur with normal regularity at intervals of 21-22 days.

Health Care: If the calf sometimes shows poor growth despite proper nutrition, it could an indication of ill health which will require the attention of a veterinarian, to establish the cause of the problem and administer specific treatment. Most of the diseases occurring in this age group could be prevented by routine deworming and by vaccination to promote the development of specific immunity against these diseases, as described in chapter 8 (Tables 8.1 and 8.2). Therefore routine deworming programmes should be adopted from two weeks of age and the vaccination programs should be commenced from the age of 4 months.

Breeding the heifer: Adequate attention should be paid to breed heifers and cows at the appropriate age and time. If a young heifer does not reach the desired weight (i.e. approximately two thirds of the mature body weight) for the specific breed or breed type, mating may be postponed until the desired weight is reached. The recommended body weight to breed a heifer is when she reaches 2/3 the mature body weight of the particular breed type. The best time to breed the heifer is 6-18 hours after the onset of heat. If artificial insemination (AI) services is not available, one could resort to natural service (NS) using a superior stud bull. If the heifer does not come to heat in 21 or 42 days after AI or NS, the animal should be examined by a veterinarian for pregnancy diagnosis, 60-90 days after the service.

9.3 Management of adult animals

(a) Pregnant heifers and cows:

Feeding: Pregnant heifers and cows need to be provided with good care and nutrition. Pregnant heifers need nutrition not only for growth and maintenance, but also for the growing foetus. Lactating and pregnant cows require nutrients for body maintenance, lactation and for the calf. Therefore, animals from either of the above categories should be placed on a higher plane of nutrition, in order to provide her maintenance requirements and those of the developing foetus. Nutrition requirements of the pregnant heifer/cow are at its peak during the last two months of gestation, to cater to the rapid growth of the foetus during this period. On the other hand, she has to build up her own body reserves to improve the milk yield and also sustain milk production throughout the duration of lactation. Special attention is required to provide a quality mineral mixture containing Ca, P, Mg and trace minerals to meet the increased demand in mineral

requirements and also to build up mineral reserves which would be eventually lost during the lactation. If the pregnant animal is a lactating cow she should be dried off two months prior to calving. The feeding guidelines for pregnant heifers and cows and also lactating cow are given in Chapter 4.

(b) Management of the parturient cow

Parturition, the act of giving birth to a calf is a very critical period for an animal. Certain physiological changes occur during the terminal stage of pregnancy indicating the onset of parturition. The changes include relaxation of pelvic and perineum region, engorgement of the udder and swelling of the vulva with a clear mucous discharge. During the last few hours prior to parturition, the cow will urinate frequently, appear to be restless and seek a quiet place to calve down.

The farmer should provide a suitable environment and comfortable conditions for calving, which includes a clean place with dry bedding. The animal should also be provided with clean drinking water and feed. It is a good practice to watch the process of calving in order to provide assistance if the need arises. In a normal calving, the calf will appear at the vagina with the head placed in between the extended fore legs. If any other presentation is observed, it would indicate a difficult calving (dystocia) and veterinary intervention may become necessary to correct the malpresentation and assist in the delivery of the calf. Sometimes, the calving may be unusually delayed after the appearance of the calving signs described above. If the delay is over 5-6 hours, veterinary assistance will be required. In the case of a normal calving, procedures described earlier should be adopted regarding the care and management of the neonatal calf and the dam.

(c) Management of the post partum cow

The aim of dairy cow management is to get one calf every year. As shown in Fig. 6.1 in Chapter 6, the cow should resume oestrous activity within 45 to 60 days following calving and conceive 90 days after calving. This is not a difficult task to achieve, if the optimum management practices mentioned below are followed and possible inhibitory influences are eliminated or reduced.

(i) As described under "management of pregnant heifer and cows", the cow must be dried off at least 8 weeks before the expected date of calving, in the case of the lactating cow. In the case of a heifer a "freshening or flushing" period must be allowed. During this period, feeding of the animal should be at an optimum level, to allow the animal to achieve a body condition score of 3.5 to 4. Excess nutrition is stored, mainly as body fat.

(ii) As shown in Fig 9.1, following calving, body condition drops over the first few weeks, as the nutrient are drained from the body reserves during lactation, because the feed intake even at a high level will not compensate for the loss of body reserves. As depicted in Fig. 9.1, the cow calving at body condition score of 4 or above will begin to regain the body condition by 30 to 45 days and the attainment of this condition will coincide with the commencement of oestrous activity (A in Fig. 9.1). Similarly, a cow calving down at body condition score

of 3.5 will loose her body condition after calving, but regain her body condition later than in the previous case. In this example, this may take 45 to 60 days and the resumption of postpartum ovarian activity will coincide with the improvement of the body condition (B in Fig. 9.1). Cows that begin lactation or calve down in poor body condition (less than a body condition score of 3), and also those that are fed poorly during the postpartum period, take longer to improve the body condition and hence take longer to resume estrous activity (C in Fig. 9.1). Perhaps, they will never commence ovarian activity but remain in anoestrus as long as the body condition remains below 2. Therefore, feeding the cow with a balanced ration is necessary. Guidelines on these are described in Chapters 1,2,3 and 4.

(iii) Many factors other than poor nutrition have been shown to delay the resumption of postpartum ovarian activity and conception. The causes and appropriate corrective measures are given in the Box 9 1 below.

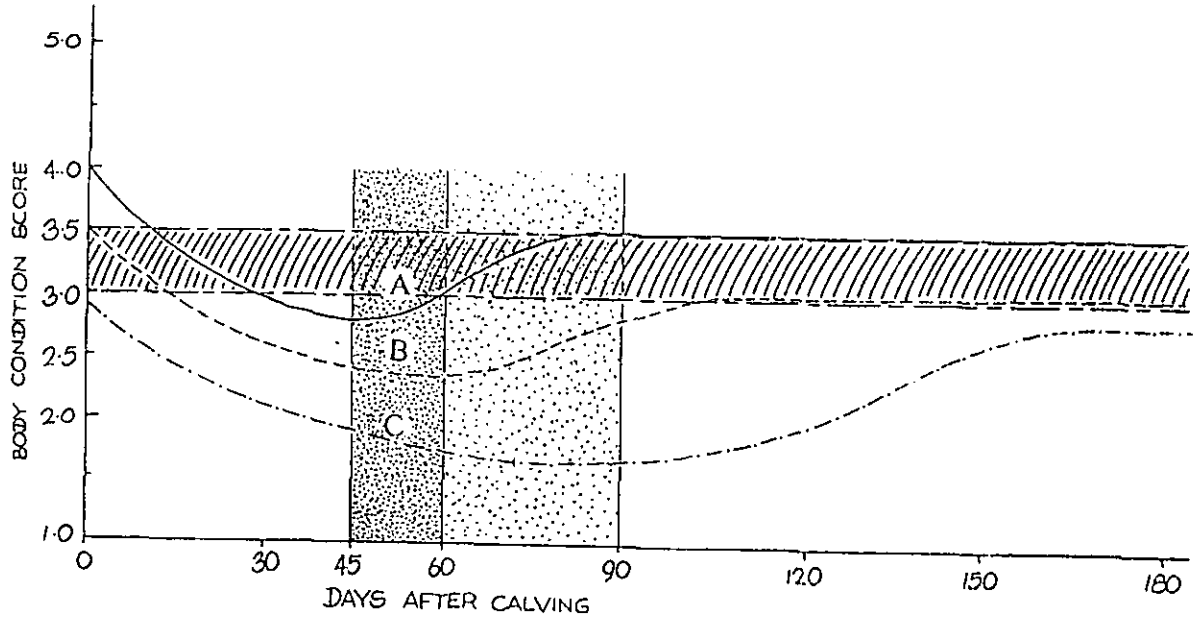


Fig. 9.1 Relationship between body condition and commencement of oestrus in postpartum cows.

Box 9.1 Factors affecting postpartum fertility and remedial measures

Cause	Effect	Remedial measures
1.Old age	Long ancestors period and poor conception rates	Remove old cows regularly from the herd and replace with young animals.
2. Poor hygiene at calving and peri-parturient complications such as dystocia, retained placenta, metritis, etc.	Long anestrous period and poor conception rates.	Ensure that calving occurs under hygienic conditions and seek veterinary assistance promptly for parturient complications
3. Free suckling by the calf and free interaction between cow and calf	Long postpartum anestrous period	Resort to limited suckling and allow calf to suckle the mother only at milking. In situations where calf is required for milk ejection, introduce the calf to the mother very briefly at the beginning of milking and allow the calf to suckle the cow after emptying the udder (while leaving some milk for the calf) for 15-30 minutes. The frequency of suckling in this situation is either once or twice, depending on the frequency of milking.
4. Adverse climatic conditions such as hot and humid weather with poor quality feed.	Long anestrous period	1.Provide shade during the warm periods of the day. Corrugated aluminium sheets are not suitable as roofing material, particularly in the low country wet zone, intermediate zone and dry zone.. 2. Provide enough water throughout the day. 3. Provide buffaloes water for wallowing or for sprinkling water on them at 1-2 hourly intervals, or a few times during the warmer part of the day.

(4) If the cow has not shown oestrous signs by day 60 after calving, consult the veterinary surgeon have the cow examined.

(5) Following a service by a bull or AI, if the cow has not come into estrus again, get the cow examined by a veterinarian within 60-90 days after service. In this way, the farmer could avoid losses that may occur as a result of conception and pregnancy failures.

This chapter was prepared by Drs. D.H.A. Subasinghe, H. Abeygunawardena, (Ms) E.R.K. Perera & A.N.F. Perera. for the SAREC/NSF (NARESA) water Buffalo Information Dissemination Programme.

Chapter 10: Crop-livestock integration in smallholder farms for maximising resource use and income

10.1 Introduction

Crop-livestock integrated farming refers to the complementary use of by-products of crop and livestock farming to maximise the returns from a unit of land holding. Crops would provide animal feed, such as rice straw, maize stover and other crop residues, while animals provide draught power and animal waste, like faeces and urine that could be used as organic fertiliser to enrich soil fertility. Although for generations peasant farmers have reared livestock together along with crops, very little efforts have been made to exploit the complementarity of the two farming activities to the advantage of the farmer.

Livestock plays a very important role in crop-livestock mixed farm enterprises. Integrated farms generate supplementary income through the sale of surplus milk, meat and draught. The income generated is of a regular nature, which helps farming families to stay clear of agricultural debt, a characteristic phenomenon in many rural farming communities. However, the traditional mixed crop-livestock farming enterprises are now being threatened by intensification of land use in most rural areas. The traditional extensive management systems of cattle and buffaloes have become increasingly difficult to practice, because of fragmentation of land and the depletion of communal grazing grounds. Moreover, free grazing of cattle and buffaloes have become a nuisance to the community by causing damage to fences, crops and more importantly to irrigation channels and bunds. In many areas, livestock farmers are on the verge of giving up livestock farming completely. But the need for a supplementary source of income for the rural smallholder farmer has never been so great, and in that context, livestock rearing offers an affordable and a sustainable way of enhancing rural household incomes. Hence, the time has come for smallholder farmers to practise integration of crops and livestock through more intensive farming practices, in order to increase the income from the gradually decreasing size of land holdings. To achieve this, smallholder cattle and buffalo farmers will need to make greater efforts to overcome the above constraints. This can be done by (i) more efficient use of the limited land (ii) judicious use of locally available feeds and non conventional resources (iii) use of appropriate low cost feeding technologies (iv) the use of animal waste as manure and (v) use of idle or surplus family labour.

Towards this end, the SAREC/NARESA Water Buffalo Information Dissemination Programme has prepared this manual, which contains material for 10 training sessions for farmers on feeding, reproduction, breeding, management, preventive health and also on the use of catalytic feed supplements (urea-molasses multinutrient feed formulae). Chapter 10, which is the last in the chapters in this manual, provides information on the development and management of crop-livestock integrated farms. Specific instructions are provided for (1) the establishment and management of feed resources (2) the development of suitable cattle sheds (3) proper management of animals and (4) recycling of crop residues, agro-industrial by-products and animal waste, to help farmers to obtain optimum returns crop livestock integrated farms.

10.2 Forage production, management and utilisation

As the profits from a small holder operation are largely dependent on investment on feeding practices, the use of expensive concentrates must be kept to a minimum. Green forages are the cheaper sources of nutrients for ruminants and efficient production of green forage within the system is therefore an essential feature in the process of maximising production in crop-livestock farms.

Forage, which includes grass, fodder, leguminous and non-leguminous tree fodder, could be easily established in most homesteads in the manner shown in Fig. 10.1. These could be grown (a) along perimeter fences, (b) as internal hedges/hedgerows and (c) in plots around the cattle sheds.

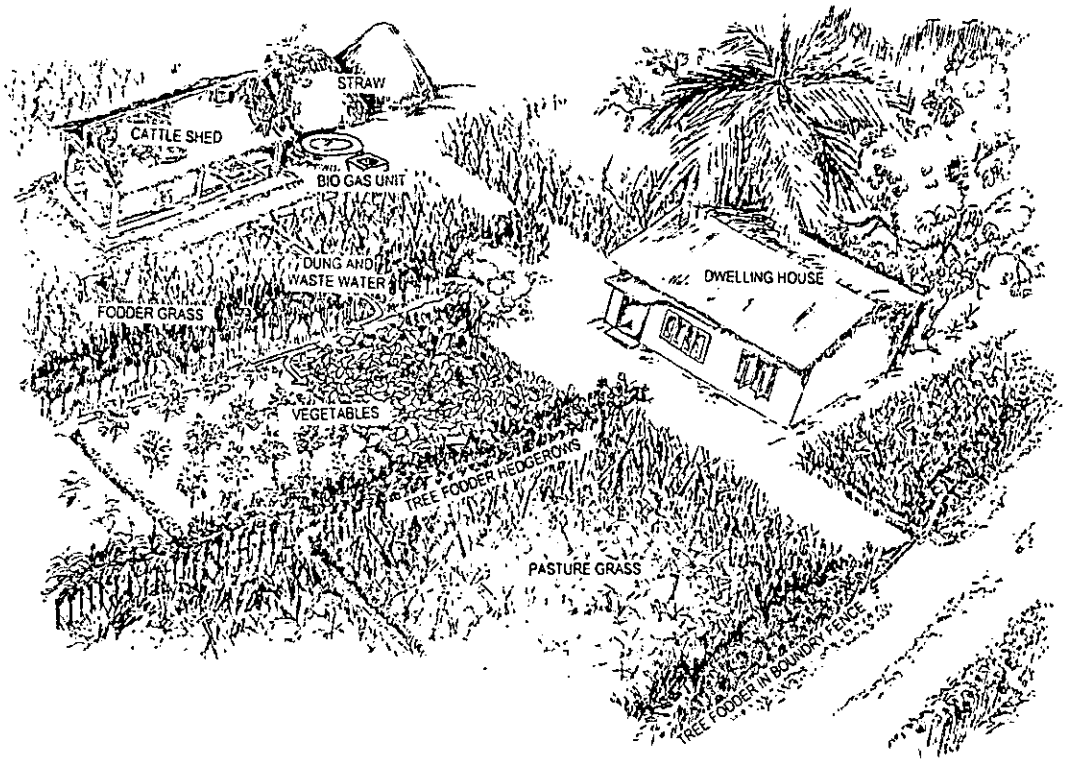


Fig. 10.1 Ground plan for planting pasture and fodder trees in a homestead

a) Forage along perimeter fences: Forage could be established and maintained as live fences as far as possible. Living fences reduce the cost of fence maintenance, particularly on the replacement of fence posts. The planting material is inexpensive and is available locally (e.g. Gliricidia, Ipil-ipil, Dadap etc). Living fences as shown in Fig. 3.1 in Chapter 3, are commonly pollarded at a height of 1.0-2.5 m (3 to 5 feet) and planted spaced 3m (3 feet) apart. Generally, lopping must be done at least once a year. In general, 100 trees planted at 1.5m intervals would provide enough fodder to feed two milking cows throughout the year. This is perhaps one of the most widespread uses for tree fodder in small home garden systems. A live fence of Leucaena around an acre of land will produce enough fodder to satisfy the roughage needs of a cow at a 30% level of intake throughout the year.

The advantages of establishing live fences with fodder trees are many. They provide (1) shade and shelter for livestock, (2) protection against soil erosion, particularly on sloping

land, because of their deep-rooted nature, (3) provide high quality forage for feeding of animals (protein rich feed from tree legumes), (4) supply N-rich manure for crops (green manure), (5) provide timber and fire wood, (6) act as wind barriers and 7) act as live trellises for climbing crops like pepper.

Common fodder trees species recommended different zones and the yields are summarised in Table 3.1 in chapter 3.

b) Forage as internal hedges/hedgerows: Hedgerow inter-cropping in a home garden is a practice where perennial tree legumes or shrubs are grown together with vegetables and pasture crops. The recommended tree (shrub) species suitable for internal hedges are Gliricidia (Wetahiriya), Ipil-ipil, Calliandra, Flemingia, Sesbania (Kathurumunga), Accasia and Dadap.

As shown in Fig. 10.2 (a & b), trees are placed in wide rows and vegetable crops and pasture spp. are grown in the interspaces or alleys between the trees. During the cropping season the trees are pruned and the prunings are used as a mulch for the crops, to improve the organic status of the soil and the nitrogen content to the soil. Hedges should be placed against the slope of the land or in line with the direction of the path of the sun. However, the slope is the main factor to be considered in steep/sloping lands. If hedges are placed along the direction of the slope, short grass strips (e.g. Guinea, Setaria, Savandara) should be grown against to the slope.

The choice of tree species for hedgerow farming is extremely important, because this to a large extent determines the success or failure of the system. There are several attributes that should be considered in selecting the tree species. In most areas, row spacing of trees ranges from 2-7 m, the commonly used spacing being 4-6 m. However, these spacing guidelines would vary depending on the slope of the land. Tree spacing within rows should be as close as possible and experience with species such as Leucaena, Gliricidia and Sesbania spp. indicate that trees should be spaced 10-15 cm apart or as near as possible to form a solid hedge along the row. This helps in the production of a favourable leaf to stem ratio, provides a more effective barrier to soil movement in sloping lands and creates a better microenvironment for crop growth.

The advantages of the internal hedges and hedgerows are many. They (1) increase the productivity of the system and the addition of nutrients and organic matter to the soil stabilises the system; (2) reduce or supplements the use of chemical fertilisers; (3) act as a physical barrier to water movement on sloping lands, resulting in a significant reduction in erosion; (4) provide high quality forage and leaf meal for animals and (5) help weed control (due to the shade effect) and improves the appearance of the home garden.

(c) Forage around the cattle shed: If there are open spaces or less shady places around the cattle shed, high yielding fodder grasses such as Napier and its hybrids. (Bana, clone-13, NB-21, Co-1, Panama etc.) can be grown (Fig. 10.1). Since these grasses prefer higher levels of soil nutrients and water, the area around the cattle shed provides a better environment. However, these grasses are not well adapted to water logging. In general 40 kg of fresh grass (requirement of an average dairy/cow/day) can be harvested from a 50 sq. ft. plot under good management.

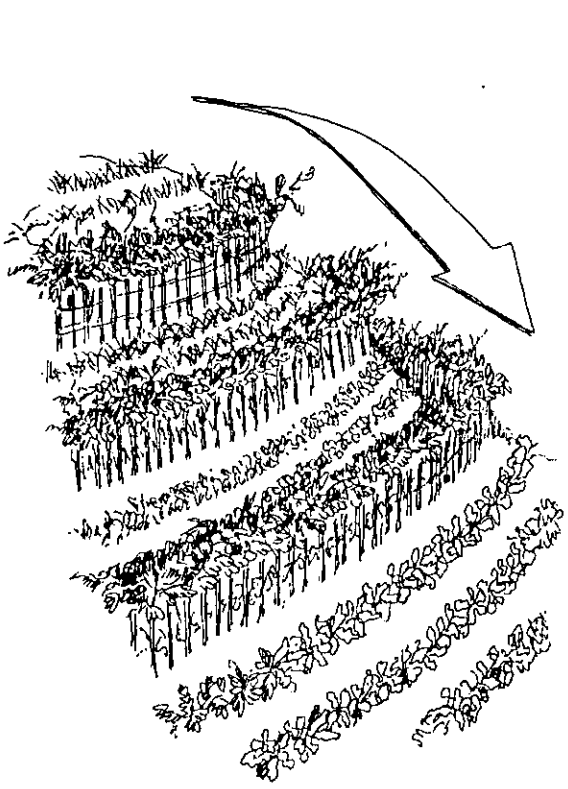


Fig. 10.2 (a)

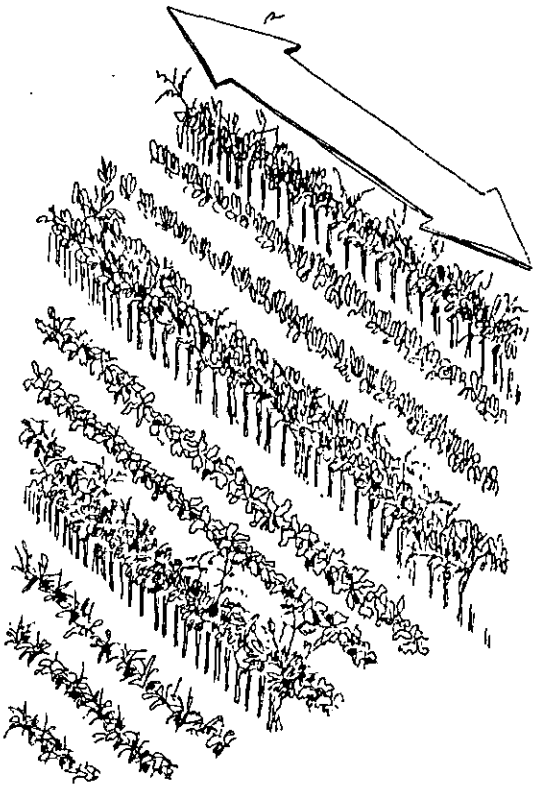


Fig. 10.2 (b)

Fig. 10.2 Diagrammatic plan for planting fodder trees as hedges and hedgerows

(d) Management of forage plants for maximum yield: Good management of the forage during the whole year is very essential. Cutting practices, fertiliser application, weed control and careful management will ensure maximum forage production in the system.

(e) Cutting frequency and cutting height): Harvesting management is a very important factor that influences the productivity of tree legumes, pasture and fodder grasses. Severe pruning or harvesting will produce effects on the subsequent growth. The recommended cutting frequencies are given in Table 10.1.

A sharp cutter, knife or trimmer should be used for lopping tree fodder. Frequent pruning at a lower height can minimise the shading effect of the hedgerows and also reduce biomass production in the hedgerow and nutrient recycling.

Table 10.1 Recommendations on cutting frequencies for fodder trees and grasses

	Cutting frequencies in days	Cutting heights
Tree fodder along the main fences	75-90	4 –5 ft
Tree fodder in the internal hedges	45-60	2 ft
Grasses around the shed	30	5 inches
Grasses in open places	30	3 inches

(f) Fertiliser application for forage plants: It is important to remember that soil nutrients in the farm are constantly being removed either directly by the crops like pasture and fodder, vegetables and fruit trees or indirectly through milk and other animal products. Hence it is vital that nutrients removed that from the soil should be replaced eventually to restore the balance.

(g) Organic fertiliser: Organic fertiliser should be used on forage plants and other crops wherever possible. It would be advantageous to the farmer to use cow dung and shed washings that are available in the farm as this will help to cut down on the cost of fertiliser application for crop production. Farmyard manure (FYM) can be used in many ways such as:

a) dry solid manure
b) compost and liquid manure

The advantages of using organic manure are many:

1) It result in an increase in soil microbial population and improves the soil texture
2) It increases the soil moisture content through water retention
3) It creates a healthy soil micro-environment while improving soil fertility
4) Liquid manure prepared from wet cow dung will stimulate plant growth

Details of the method of preparation of compost and other forms of manure and their application on crops may be obtained from the farmer information leaflets issued by the Departments of Agriculture and Animal Production and Health. Organic fertiliser is best applied after the fodder is harvested, either as solid manure or in the fluid form.

(h) Use of Chemical fertiliser: If organic manure is in short supply at the time when needed as fertiliser, chemical fertiliser mixtures may be used in open pasture and fodder blocks. If and when necessary the ratio given below could be applied. Fertiliser application is usually practised twice a year with the onset of rains. Recommendations are given in Table 10.2.

When fertiliser is applied to small plots, proportionate amounts of the mixture may be applied as recommended.

Table 10.2 Recommendation on fertiliser application

Fertiliser	Quantity/ha/year	Quantity/acre/year
Urea (kg)	200	80
Muriate of potash (kg)	120	50
Triple sulphur phosphate (kg)	120	50

1 ha = 2.47 acres

(i) Weed control: Weeds begin to appear particularly in newly established pasture and fodder areas. Weed growth can be minimised by adoption good management practices. Regular manual weeding is the usual method of weed control in smallholder systems.

10.3 Animal Housing

Housing is an essential component of an intensively managed dairy farm. Hygienic animal housing is a pre-requisite for clean milk production. Moreover, a properly designed and well constructed house will ensure that the provision of adequate light and clean conditions to maintain a healthy and comfortable environment. The labour requirement for daily cleaning will also be reduced. The cattle shed need not be an elaborate and expensive structure. It can be a low cost structure, provided that the basic structural features are incorporated, on a scientific basis as shown in Figs. 10.3(a to g). The specifications in Table 10.3 are recommended for the mid and low country wet zone and intermediate and dry zone areas. A few modifications to this model to suit the conditions prevailing in the hill country wet zone areas such as Nuwara Eliya, Maskeliya and Hatton have been incorporated in Table 10.3. The designs incorporating these modifications are shown in Figs. 10.4 (a to d).

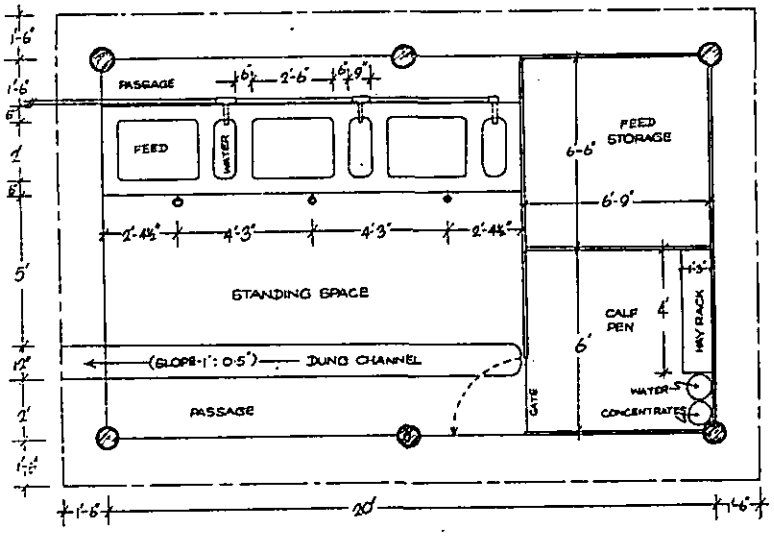


Fig 10.3 (a) Floor plan of cattle shed for the mid and low country wet zone and intermediate and dry zone areas

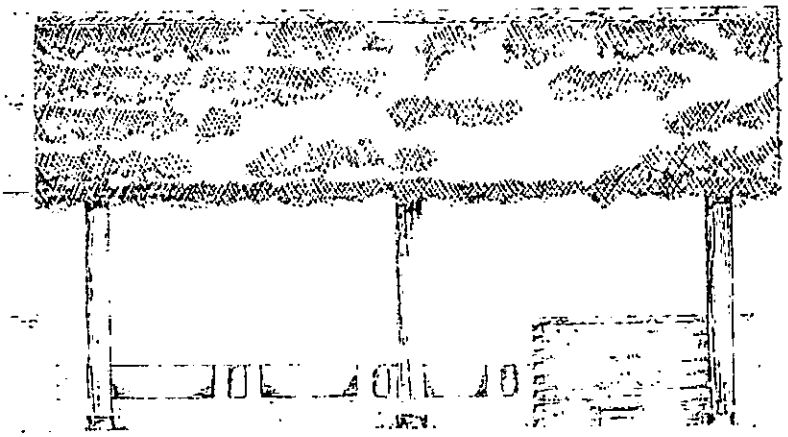


Fig. 10.3 (b) Front view of cattle shed

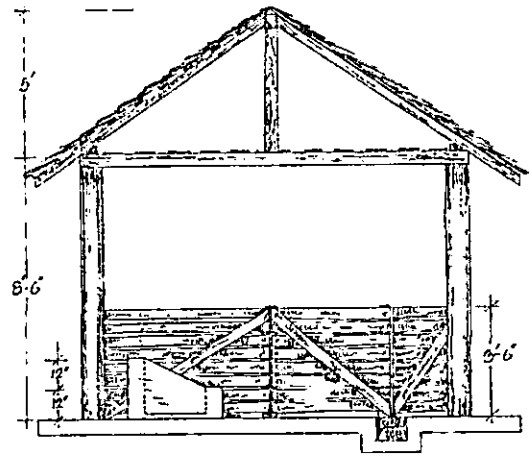


Fig 10.3 (c) Side view of cattle shed

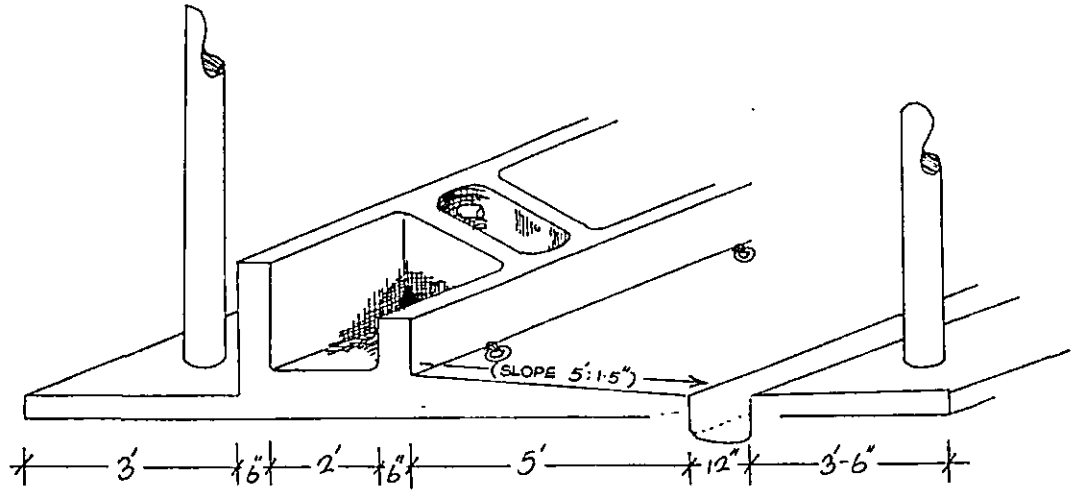


Fig. 10.3 (d) Cross-section of floor plan of cattle shed

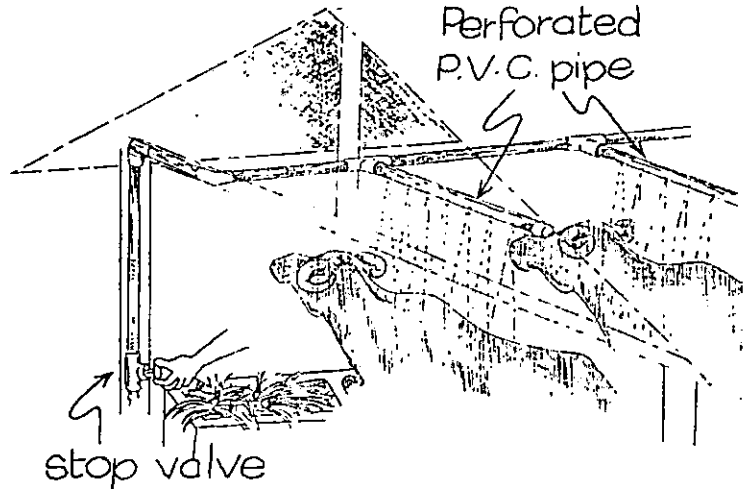


Fig. 10.3 (e) Sprinkler system for cattle shed

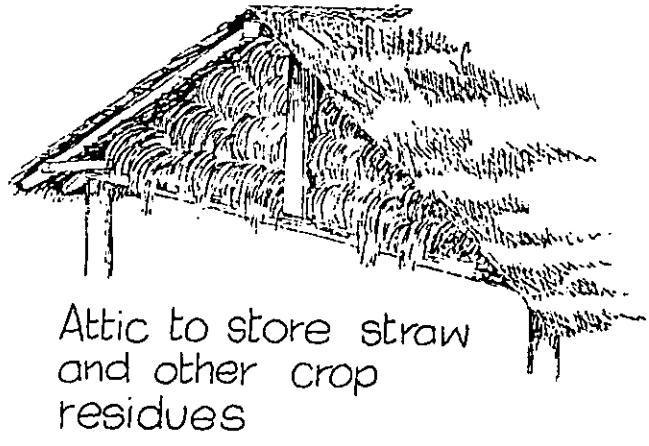


Fig. 10.3 (f) Space for storage of rice straw

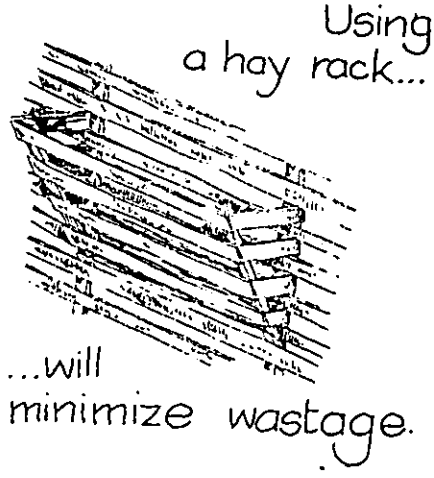


Fig. 10.3 (g) Design for hay rack for calves

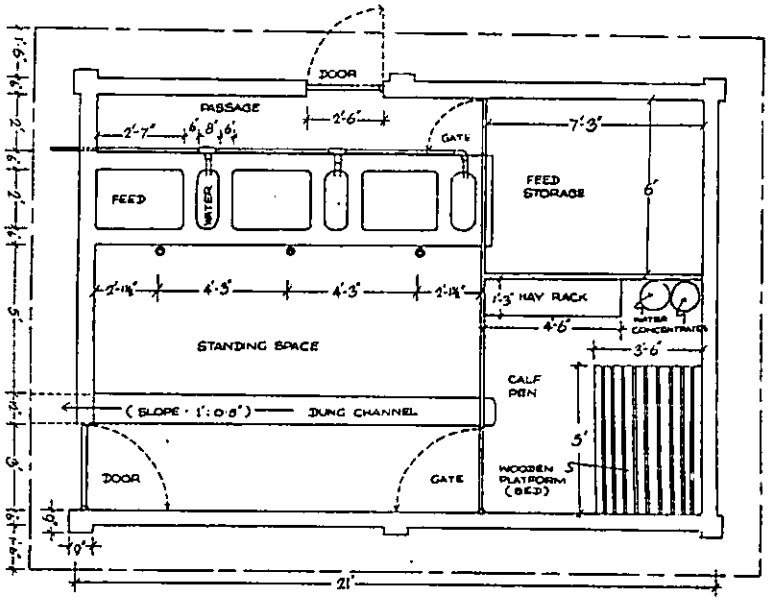


Fig. 10.4 (a) Specifications of floor plan of cattle shed for hill country wet zone

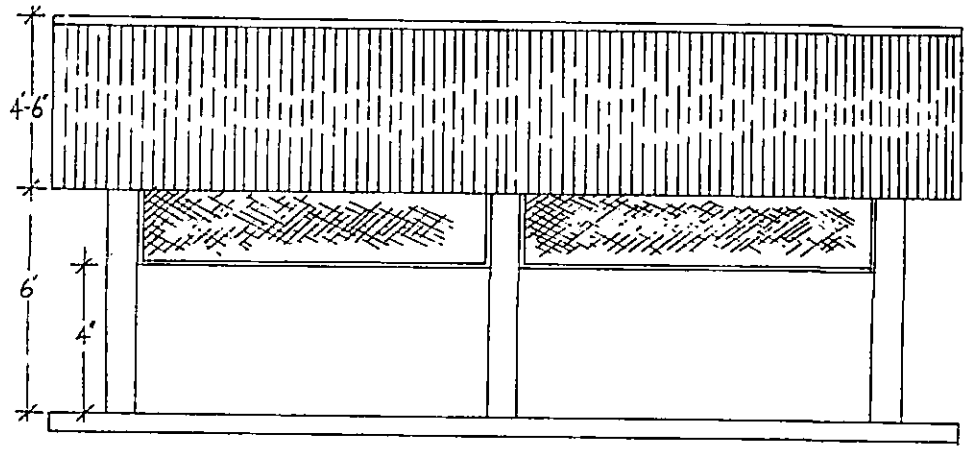


Fig. 10.4(b) Front view of cattle shed

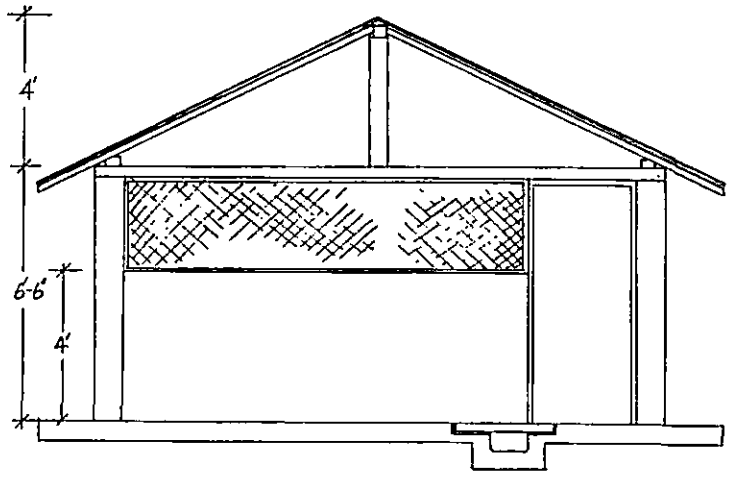


Fig. 10.4 (c) Side view of cattle shed

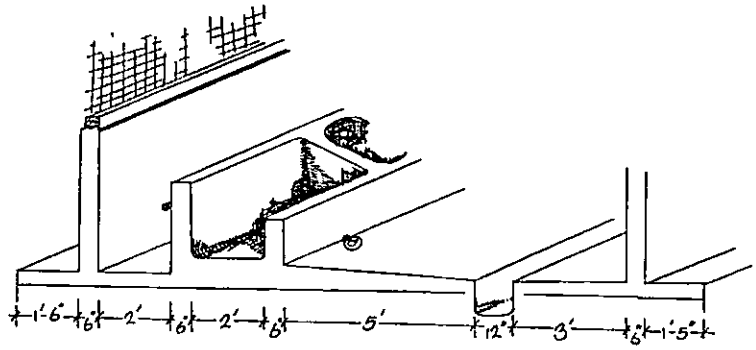


Fig. 10.4 (d) Cross-section of floor plan of cattle shed

Table 10.3 Details of specifications for cattle housing

Item/component/special features	For mid and low country wet zone and dry and intermediate zones	For hill country wet zone
Height of the shed	the minimum height at ridge 13' and side posts is 8'6"	10' x 6' 8"
Length	The length of the shed required to house 3 cows with an enclosure for calves is 18'9". Add 4'3" for each additional cow.	
Width	Between pillars 12' 3"	
Pillars	Though the use of locally available material is encouraged, wooden pillars rot in a few years. If hard wood cannot be found, concrete pillars are recommended.	Pillars should be of concrete. Half walls should be built around the shed up to a height of 4 ft. with 1" x 1" wire mesh above that level.
Roof	It is always better to use cadjans or straw to cover the roof. Aluminium and zinc sheets increase heat burden on animals	
Floor	The floor must be properly paved while the standing area for the cow and the dung channel must be made with concrete. The rest of the shed could be paved with bricks or rubble and cemented.	Concrete flooring is recommended
Feeder space	The length and width of feeder space required for a cow is 4'3"x2'	
Water troughs	These could be placed in between feeders as shown in the diagram *in Plate 10.5*	-
Special features	A simple sprinkler system with ½" PVC pipes for spaying water over the animals during the hot part of the day and storage space in the attic for straw and other crop residues could also be incorporated into the model unit..	-

(a) Location the shed : The cattle shed should preferably be sited at a relatively high location in the farm or homestead, so as to facilitate the use of cattle manure, urine and shed washing directly from the shed to the fodder and vegetable plots, through gravity irrigation. This could be achieved through a system of well designed, simple drains originating from the cattle shed.

(b) Cleaning and maintenance of the shed: The shed should be cleaned twice a day, prior to milking. The animals should also be washed and cleaned at the same time. Soiled animal bedding and left over roughage feed should be collected and put away in a separate place or put into the compost pit before washing the shed. The dung and urine should be pushed out through the dung channel. Subsequently, the shed should be washed, cleaned and the washings directed to the dung pit away from the shed or to a biogas plant. The dung may be recycled as raw material for compost, generation of biogas and in other ways described elsewhere.

10.4 Management of animals

Good management of animals is a prerequisite to an efficient farm operation. The task involves several activities, which include handling and management, feeding, milking, reproduction and breeding, health care and maintenance of records.

Detailed descriptions on some of the above subjects are given in the chapters, which deal with specific topics in this series, such as Management of Buffalo and Dairy Cattle (Chapter 9), Feeding and Nutrition (Chapters 1,2,3 and 4) Reproduction and Breeding (Chapters 5, 6), and Health Care (Chapter 6). This Chapter will emphasise on aspects that are not covered adequately in other chapters.

(a) Handling and management: Animals need love and care and when these are provided, they respond at maximum efficiency. Therefore, herdsmen or farmers must become very friendly with the animals and handle them gently on all occasions. The place where animals are housed must be properly ventilated and well light. During the hot periods of the day, regular bathing of animals may be required to promote heat dissipation. This is particularly important with buffaloes, as their body cooling mechanisms are not very efficient. This is the reason why they prefer to wallow in water during hot part of the day. If buffaloes are reared indoors, as suggested here sprinkling or splashing of water over the body at 1-2 hour intervals 3-4 times a day during the hotter part of the day, is very desirable.

(b) Feeding: Dairy cows and buffaloes must be fed adequately to ensure optimum milk and meat production. In general, they must be given grass and fodder *ad libitum*, the requirement being 10% of the body weight on wet weight basis. The limitations and methods of overcoming these limitations in ruminant feeding have been described in Chapters 1,2,3 & 4. Grass and fodder should be made available in sufficient quantities at all times in the feed trough, to ensure that feed is available both during the day and night. If grass and fodder are poor in quality and not available in sufficient quantities, the feed must be supplemented with a suitable feed supplement such as concentrate feed (Chapter 4), UMMM feed supplement (Chapter 2) or tree fodder (Chapter 3). Animals must be fed adequately to satisfy their maintenance and production requirements. A practical guideline to feeding is given in Chapter 5 (Body conditions scoring system for cattle and buffaloes).

(c) Water requirements: Provision of an adequate supply of clean drinking water throughout the day is of paramount importance. Thirsty stock do not consume as much feed as those that are well watered. An average cow (200-300 kg) requires about 30-40 litres of water (15% of the body weight) for maintenance and an additional 4-5 litres for each litre of milk produced. It is best that animals should have access to clean drinking water

throughout the day and ideally, a built-in water trough within the feed trough as shown in the diagram should be provided. The water trough could be filled via a storage tank of a reasonable size, constructed at the end of the shed with a simple ball value device to regulate the flow of water automatically through a gravity flow system.

(d) Milking and clean milk production: The ultimate aim of dairy farming is to produce milk which is hygienic and fit human consumption. Therefore, practices which will ensure the production of clean milk is of paramount importance. In almost all smallholder operations, cows are milked by hand. Cows of the zebu breeds and indigenous buffaloes require a stimulus for milk let down. This is usually the sight of the calf and/or the suckling process. With most dairy breeds of cattle and buffaloes, the routine procedures at milking, such as the time of milking, washing the udder with warm or cold water, noise of milking buckets, feeding of concentrate, etc. stimulate milk "let down". Milking is carried out by one of by 3 methods:

(i) Strip milking: - where the teat is held between the thumb and first finger and milk is rubbed out by pulling the fingers down along the teat,

(ii) Pinch milking: – where the teat is pinched and stripped rhythmically by holding it between thumb and middle fingers and

(iii) Rhythmic squeezing of the teat:. In this method, the teat is rhythmically squeezed by encircling the upper part of the teat with the thumb and first fingers while keeping the remainder of the fingers in close contact. The milk is squeezed out by tightening the fingers, starting with the index finger and rhythmically followed by the other fingers. All fingers are relaxed simultaneously and a new squeezing sequence is begun. This method is the preferred as it does not cause any damage to the teat, compared to first two methods Fig. 10.5.

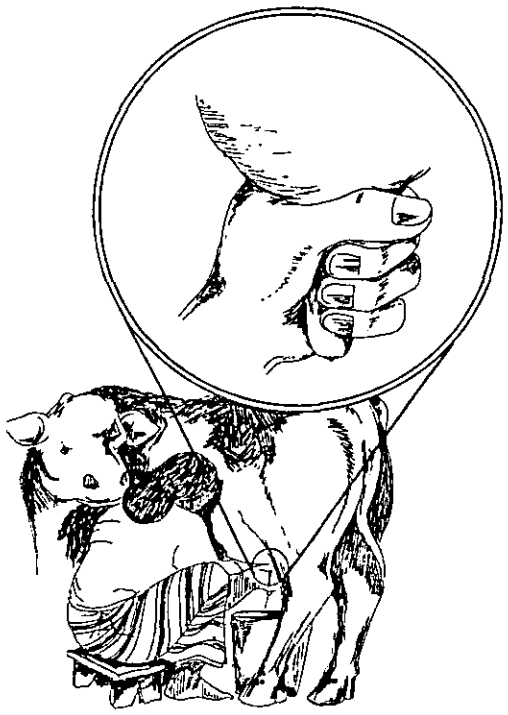


Fig. 10.5 Rhythmic milking procedure

The milk collected from the teat must be free from contamination by pathogenic organisms. Contaminated milk will spoil within a short period of time. Hence the following procedure is recommended in milking cows.

(i) Wash the milk collection bucket soon after milking and also before commencement of the next milking.
(ii) Clean the udder and teats with water or by sprinkling water before milking and dry the teats or wipe with a clean cloth before commencement of milking
(iii) After milking, if zero suckling is practised (calf is not allowed to suckle), dip the teat in a suitable antiseptic solution: a 1.6% solution of formic acid is a common and a cheap antiseptic that could be used for this purpose.
(iv) Milk must be transported in clean bulk containers (5 or 10 litre cans) and this should be done without delay.

10.5 Reproduction and breeding

Heifers must be bred at the first detected heat, if they have reached sufficient body weight or size (2/3 of the mature body weight). Cows should be bred at the first or second oestrus which must occur within 60 days postpartum. It is recommended to skip mating at the first postpartum oestrus if it occurs within 30-45 days postpartum, as the chances of conceiving is very low around this period. The cow should be examined for oestrus at least 2-3 times a day, in addition to milking times and get the cow inseminated between 10-18 hours after the onset of oestrus, for optimum success at conception. Cow should be examined again for oestrus, more frequently between 18 to 22 days after the service and if the animal has not returned to oestrus, get the animal examined by your veterinarian for pregnancy between 65 to 90 days after the service. Any cow that fail to conceive after three repeated inseminations should be checked by a veterinarian for necessary advice and treatment. The goal is to get the cow pregnant within 90 days post calving and thereby get one calf every year. For more details see Chapter 6 (Reproduction in cattle and buffaloes) in this series.

The type of bull or semen to be used to get your cow or buffalo served depends on the genotype of your animal and the purpose and method of rearing which will vary with the agro-ecology of the region. Please refer Chapter 7 (Breeding of Buffaloes and cattle and) follow instruction given therein

10.6 Health care of the animals

The economic efficiency of your farm depends very much on the productivity of the animals and their status of health. Detail information on matters of health are given in Chapter 8 (Health and Diseases of Buffaloes and Cattle) and in Chapter 9 (Management of Buffaloes and Dairy Cattle) in this series. However, here in we give a brief summary of the important aspects of health care and disease prevention (see Tables 8.1 and 8.2 of chapter 8).

Health of the animal is expressed by its appearance and physical activity. Shiny skin coat, alertness (i.e. quick response to stimuli), normal stance and gait and good appetite always signify good health. Any departure from these usually suggest an illness. Consult your veterinarian immediately for necessary advice and treatment. As some of the diseases are preventable, a programme. for routine vaccination and worming are given below for

practical guidance.

10.7 Recycling crop residues and agro-industrial by products

The most advantageous feature in crop-livestock integration is the opportunity the farmer has to recycle animal waste and crop residues. In order to get the maximum advantage, all attempts must be made to utilise the crop residues as animal feed and the animal waste as organic fertiliser for the crops.

a) Crop residues

Crop residues (CR) are mainly fibrous materials that are by-products of crop cultivation. e.g. rice straw, sugar cane bagasse, sugar cane tops, maize stover, soya bean and ground nut straw, cassava leaves, sweet potato vines etc. It has been reported that about 65-70 percent of the total bulk of the crops produced by farmers go waste and hence constitutes a loss to the farm.

b) Agro-industrial by products

Agro-Industrial by-products (AIBP) are the by-products derived from the industry through to processing of the main products such as oil, rice, sugar coconut poonac, rice, soyabean, fruit, etc. These are rich in nutrients compared to crop residues and could be used as strategic feed supplements, such as soluble sugar (e.g. molasses), protein (e.g. rice bran, canary. waste) and minerals (e.g. molasses). If CR and AIBP are properly utilised by the small holders for livestock feeding, a good part of the dry matter shortage could be supplied for greater improvement of dairy cattle and buffalo production. This is the most feasible solution to the ruminant feed shortage, particularly in the dry zone districts of Sri Lanka. For more details please see Leaflet No. 1 in this series.

10.8 Utilisation of animal waste as fertiliser for farm crop

Cattle and buffalo dung and urine (Farm Yard Manure) is a good source of organic nutrients for the soil and plants. They are rich in nitrogen (N), phosphorus(P) and potassium (K). The ratio of N, P and K in FYM is around 2: 0.4 :1.7. Research studies have indicated 1/3 of N, 1/2 of P and most of the K is available in FYM to crops. On the other hand 100 Kg of FYM is equivalent to 15-18 Kg of urea, 12-15 Kg of Triple Super Phosphate and 15-18 Kg of Muriate of Potash.
Therefore animal dung or slurry (faeces and urine when mixed will be an excellent organic fertiliser) that could be applied to crops, thereby reducing the cost an artificial manure.

- It increases the organic matter content of the soil
- It improves the structure of the soil and will help to increase aeration, water movement, microbial activity, root penetration etc.
- It can be applied to the soil surface as a mulch
  - to control weed growth
  - to conserve soil moisture
  - to reduce soil erosion
  - to improve soil organic matter

It can increase the population of soil micro-organisms
It can absorb excess nutrients and toxic substances
It could be directed to a bio-gas plant to generate bio energy for household cooking and lighting.

This information leaflet was prepared by Dr. D.H. A. Subasinghe, Dr. H. Abeygunawardena and Mr. U.G.C. Premalal for the SAREC/NSF (NARESA) Water Buffalo Information Dissemination Programme