DAIRY CATTLE PRODUCTION

YEAR 2 SEMESTER II
2005-2006

SCHOOL OF VETERINARY MEDICINE
UWI
MOUNT HOPE

AN INTRODUCTION TO RUMINANT PRODUCTION SYSTEMS

BY

GARY WAYNE GARCIA
DEPARTMENT OF FOOD PRODUCTION
FACULTY OF AGRICULTURE AND NATURAL SCIENCES
UWI

Table of Contents

Introduction

Welcome to our discussion of Dairy Cattle Production in the Tropics!

- Þ **Breeds and Breeding**
- Þ **Dairy Cattle Nutrition**
- Þ **Management Considerations**
- Þ **Fundamentals of Calf Rearing**
- Þ **The St. Stanislaus Dairy Model - Guyana**

Learning Objectives

The most important Learning Objective of this module is to have you understand the systems of management of Dairy Cattle production such that you will be able to make knowledgeable decisions for the **good** management of any dairy farm in the tropics.

In this module, the following will be the specific learning objectives:

Unit 1: BREEDS AND BREEDING

- Ü to be able to identify the more popular breeds of dairy cattle suited to the Tropics and to be familiar with their attributes;
- Ü to know the desired composition of a dairy herd;
- Ü to know the basic principles of cow and sire selection;
- Ü to know the principles of reproduction and breeding of dairy cattle; and
- Ü to know how to detect “heat” or oestrus (estrus) in dairy cattle.

Unit 2: DAIRY CATTLE NUTRITION

- Ü to understand and know the physiological states of dairy cattle;

- Ü to know the base feeding requirements of Dairy Cattle;
- Ü to know the role and function of minerals, the signs of their deficiencies and toxicities and their interrelationships in Dairy Cattle feeding;
- Ü to know the feeding value of some common dairy feeds;
- Ü to describe feeding strategies for Dairy Cattle Replacement Heifers;
- Ü to know and describe the methods of feeding lactating Dairy Cattle;
- Ü to be able to describe Sugarcane-Molasses Based Feeding models for Dairy Cattle Production; and
- Ü to know how to prepare for feeding Dairy Cattle in the Dry Season.

Unit 3: MILK AND MILKING MANAGEMENT

- Ü to know about the interaction between fertility and early lactation;
- Ü to know about the composition of milk and the factors affecting its composition;
- Ü to know about the changes within, and the nature of the Lactation Curve;
- Ü to know about the interaction between intake, live weight changes and lactation yield;
- Ü to know about the composition and make up of colostrum;
- Ü to know about body condition scoring in dairy cattle;
- Ü to know about milking and milking management; and
- Ü to know and describe methods of mastitis prevention and control.

Unit 4: FUNDAMENTALS OF CALF REARING

- Ü to understand the importance of prenatal nutrition on calf well being;

Ü to describe how the cow should be managed before, during and immediately after calving; and

Ü to understand and describe methods of feeding and housing of the Dairy Calf.

Unit 5: THE ST. STANISLAUS DAIRY PRODUCTION MODEL

Ü to be able to describe the elements of the St. Stanislaus Dairy Production Model; and

Ü to know and describe the Target Performance Coefficients for Dairy Cattle in the Tropics.

UNIT 1 -- BREEDS AND BREEDING

Quick Start h

Within the tropics and certainly within the Caribbean area you will find a number of dairy cattle production systems. The systems vary as follows:

- Ü the relatively unsophisticated single animal unit
- Ü the extensive set-stocking units
- Ü the highly sophisticated intensive units

Each category is characterized by certain common features. All of the above will be discussed in depth in the module.

The usual production system employed throughout the Caribbean is one involving a multi-component approach characterised by the use of **roadside grazing**, **cut and carry**, **communal grazing**, and **tethering** or **combinations of thereof**. These systems are dominant among small farmers in which herd management (in terms of improved husbandry) exists in only the most rudimentary form. Subsistence is the basis underlying their operations, as is exemplified by the fact that milk production generated under such a system is primarily used for home consumption with any excess going to the local market.

Another production system that occurs within the region, primarily Guyana and Belize, is **extensive grazing**. Extensive grazing is one step up in sophistication from the multi-component system described above. Here, you would see in use indigenous grass species, although it is not uncommon for some improved forage species (such as Pangola, Guinea, Star and Coast Cross I) to be included. In such a system you will usually find improved husbandry and production. Animals are usually milked once per day with the milk being disposed of through an organised system of marketing. A major limitation of this system is the reduced efficiency of performance occasioned by the farmers not being able to make the maximum use of the forage all through the year.

Finally, there exists the **intensive system** characterised by improved husbandry and increased inputs with the expressed intention of maximising performance as measured by increased productivity. Here, high producing animals are used along with high producing forage species, rotational grazing, increased energy allocation through supplementary feeding and improved carrying capacity. Animals are milked twice per day and the milk is disposed of through an organised milk market. This is the system found among the large dairy farmers in Barbados, Belize, Costa Rica, Cuba, the Dominican Republic Guyana, Jamaica, Puerto Rico, and Trinidad & Tobago.

The Lesson I

1.0 Breeds and Breeding: Reproduction and Mating Systems

Let's look at the breeds of dairy cattle used in the Caribbean region which may also be popular in other parts of the Tropics. They can be divided into three main groups:

- Breeds of tropical origin
- Western breeds of cattle
- Breeds developed by crossing (synthetic breeds).

Table 1. Main Groups of Breeds of Dairy Cattle

1. BREEDS OF TROPICAL ORIGIN	2. WESTERN BREEDS OF CATTLE	3. BREEDS DEVELOPED BY CROSSING (Synthetic Breeds)
Criollo	Holstein-Friesian Jersey Brown Swiss	Jamaica Hope Sibonet (Cuba)

1.1 Characteristics of Common Breeds of Dairy Cattle

1.1.1 Criollo

These are large angular animals, well suited to conditions prevailing in the Caribbean and various Latin-American countries. They display a high degree of immunity and/or tolerance to tick borne diseases.

Mature cows weigh 400 to 500 kg (800 lbs to 1100 lbs). Milk production is estimated at 2,400 to 3,000 kg (5280 lbs to 6600 lb) per lactation, with a fat content of 4%.

1.1.2 Holstein-Friesian

You can easily identify this breed because they are muscular animals with a very large udder capacity and a distinctive black and white colour pattern.

Average mature body weight is 600 kg (1320 lbs). These animals are capable of producing 5000 kg (1100 lb) of milk (305 days), with a 3.9% fat content.

1.1.3 Jersey

Jerseys are small-framed animals with fine strong legs. They are noted for possessing high heat tolerance and a light brown colour pattern. They have a long, wide udder, that is soft and elastic with well formed teats, symmetrically placed.

A mature cow weighs between 350 and 450 kg (770 and 990 lbs). The average milk yield under good conditions is 3,300 kg (7260 lbs) per lactation period, with a 5% fat content.

1.1.4 Brown Swiss

These are heavy animals with strong, muscular legs and hard hooves. They have good fattening qualities and are very suitable for the rougher types of ground at higher altitudes. The udder has a large capacity, with well formed, satisfactorily placed teats.

The average mature cow weighs 600 kg (1320 lbs). Average milk yield is 4,000 kg) (305 days) with a 3.9% fat content. They have a characteristic dark brown colour pattern.

1.1.5 Jamaica Hope

This is a breed of dairy cattle developed in Jamaica by crossing the Sahiwal *(Bos indicus)* with the Jersey *(Bos taurus)* and adding some Holstein-Friesian *(Bos taurus)*. Having the genetic qualities of the Sahiwal and the Jersey they are heat tolerant and possess a high degree of immunity to tick-borne diseases. Although the fawn colour predominates, there is no distinct colour pattern as such with the range of colour going from yellowish brown to dark brown.

The average weight of the mature cow is 410 kg (900 lbs). The average milk yield of the mature Jamaica Hope is 3500 kg (7700 lbs) in 305 days with a fat content of 4.88%.

1.1.6 The Sibonet of Cuba

These animals are large-bodied, consisting of a Genepool of 5/8 Purebred Holstein and 3/8 Brahaman cattle.

Activity L

Please turn for further reading to: Garcia, G.W., Williams, H.E., Jeans, S., Baksh, C. and Best, R. (1993): *The Performance of Two Small Herds of Jamaica Hope Dairy Cattle Imported Into Trinidad.* In Dairy Development in the Caribbean Region, Caribbean Research and Development Institute; Internal Dairy Federation (IDF) Brussels, Belgium; Technical Centre for Agricultural Cooperation (CTA). March 1998, D. Walmsley Editor, CTA-Actes de Seminares # 466:73-84

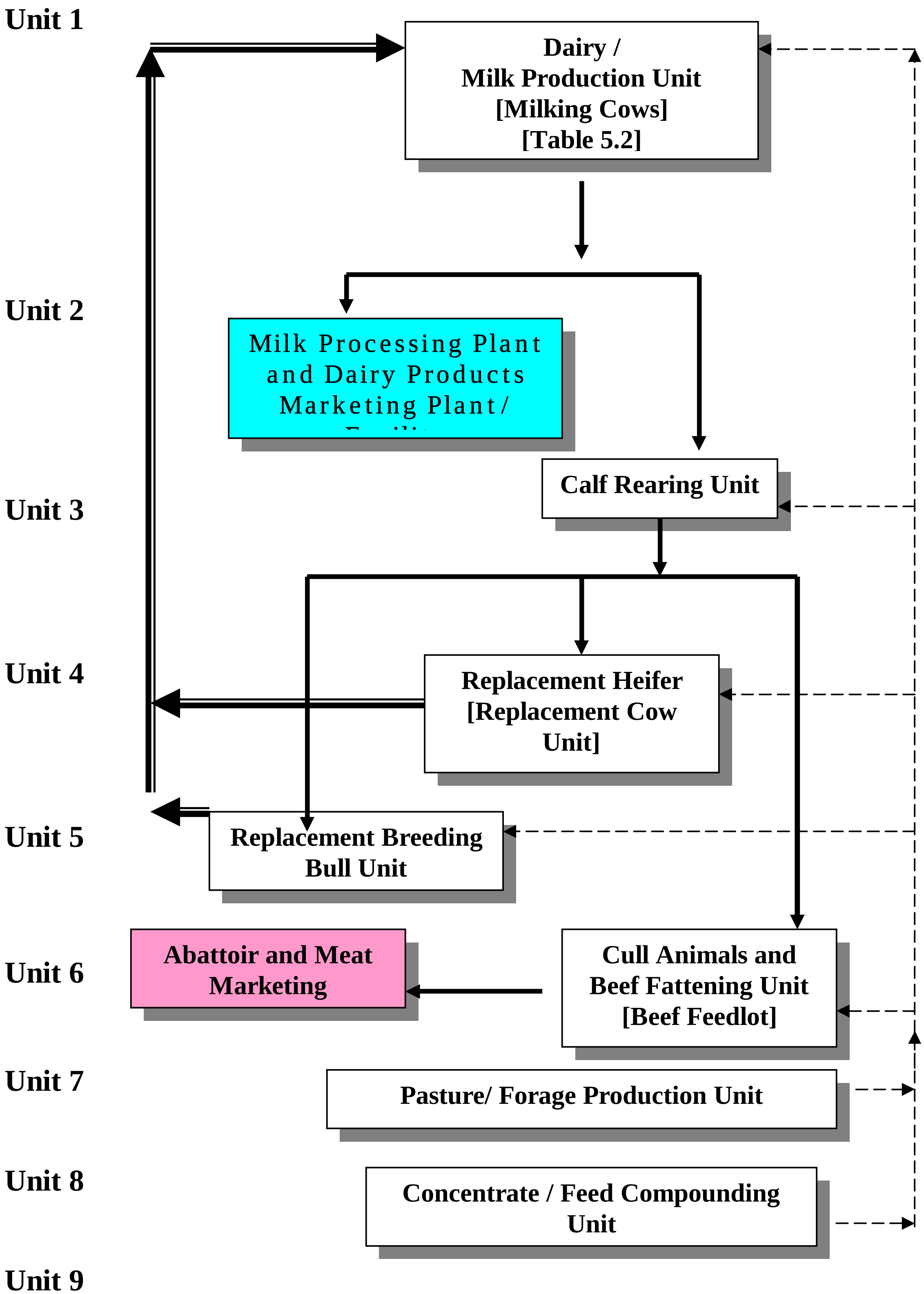
1.1.7 Other Breeds of Tropical Dairy Cattle

Maule (1990) listed about 200 well defined breeds and numerous non-descript cattle. Some breeds are for specialized milk production, while others are dual purpose (meat and milk). Matthewman (1993) indicated that the specialized dairy breeds were the Ayrshire, Shorthorn, Guernsey, Jersey, Brown Swiss, Friesian and Danish Red (those underlined were previously described).

On the Indian sub-continent the **Sahiwal**, **Red Sindi** and **Gir** are the better Dairy Breeds. The West African Breeds are the **White Fulani (Bunaji)** and the **Sokoto Gudali** and **N'Dama**.

The other African breeds include: the **Bovan**, **Butana**, **Kenana**, **East African Zebu**, **Nardi**, **Maasai**, **N'Kedi**, **Lugware**, the **Ankole** and the **Barotse**. Porter (1991) gives a more detailed description of the Breeds of Cattle in South America, Asia and Africa.

Figure 1: Dairy Cattle Industry Production Units Process Flow



1.2 Dairy Herd Management

Proper herd management is critical for the achievement of optimal herd performance. The relevance of proper management is pertinent over the entire range of herd-related activities. All these activities contribute to the primary objective of a dairy farm (which is the efficient and economic maximization of milk production). What follows will set out some of the important areas of concern involved in Dairy Herd Management.

1.2.1 Desirable Herd Composition-Herd Projections

Table 2. Herd Comnposition for a 100 cow, 50 cow and 25 cow Dairy herd.

	%	# in a 100 cow herd	# in a 50 cow herd	# in a 25 cow herd
Cows in Milk				
Early	15.4	25	12	6
Middle	15.4	25	13	7
Late	15.4	25	12	6
Dry Pregnant Cows	15.4	25	13	6
Total Cows	61.6	100	50	25
Calves	12.3	20	10	5
Yearlings	12.3	20	10	5
Replacement Heifers	12.3	20	10	5
Breeding Bulls	1.2	2	1	1
Total Animals		162	81	41
Total Animal Units		133	66.5	33.3

1.2.2 Principles of Cow and Sire Selection

Selection begins when a herd is assembled, in that it involves the selection of those animals which will constitute your herd. Once the herd is established, you choose the sire and females that will be allowed to leave offspring in your herd. **If** *you do not select superior cows and sires as the parents for the next generation of calves, and conversely, do not make sure that inferior cows are removed or culled from the herd and the use of inferior bulls avoided,* **your herd will not improve genetically**.

1.2.2.1 Cow Selection

In assembling your dairy herd it is advisable that you select the females that will constitute that herd from farms where production and pedigree or production records are kept. Do not rely on verbal assurance as to the capability of the animal. In the absence of established production and pedigree records, general appearance or body conformation (type) will be the main criterion on which your selection is based. This is based on the fact that there are certain physical characteristics which are indicative of an animal's potential milking capacity. These characteristics include: **size, constitution, barrel capacity, mammary development, dairy temperament** and **quality**.

þ ***Size***

Under some conditions, the view has been held that larger animals are more predisposed to higher production when compared to smaller animals. However, recent research generally and practical experience under tropical conditions do not support this view. Indeed, small size appears to be an advantage under tropical conditions. It has been observed that the small size of indigenous breeds in the tropics is largely due to their adaptation over time, to a harsh environment, enabling efficiency of in their production. In addition, there exists the possibility of higher stocking rates and a high proportion of calves reared per breeding cow.

þ *Constitution*

Constitution is indicated by the cow's width between the forelegs, and a large heart girth with well sprung foreribs. This allows adequate room for the heart and lungs which affect the circulation and cooling of the cow.

þ *Barrel Capacity*

A well developed digestive system is indicated by a large barrel, shown by the **length, depth,** and **width** of the body**.** The ribs should be **long, far apart** and **well sprung. The loin should be wide and level**, and the flanks deep and full. The large barrel indicates the animal's capacity to consume large amounts of roughage, the major constituent of its feed ration.

þ *Mammary Development*

This is the most important part of your dairy cow and should receive your careful consideration in the process of selection. The udder should have **capacity,** be **well shaped, long and wide,** of **moderate depth, extending well forward; rear attachment high and wide** with **rear quarters extremely cleft**. The floor of the udder should be reasonably **level, quarters evenly balanced** and **symmetrical. Teats should be uniform of convenient length** (at least 6 to 8 cm) and **size, well apart** and **squarely placed.**

þ *Dairy Temperament*

The cow should exhibit "dairy temperament," ***i.e.,*** she should be quiet, docile and motherly. She should not only be capable of giving a large amount of milk for the calf, but also allow the milk to be extracted.

þ *Quality*

The quality of your dairy cow is reflected in a loose, mellow and fairly thin skin, and by smooth clean bones. Other desired features are a fine, clean-cut head with wide muzzle and open nostrils and prominent bright eyes, indicative of a good state of health. All teats should be fully functional and there should be no evidence of mastitis. The cow should also have been tested and found free of bovine Tuberculosis and Brucellosis (contagious abortion).

Some traits used for selecting dairy cattle and their h^2 value for breeding and selection proposed are presented in the block below.

þ *Body comformation and description*

Selection of Dairy Cattle Breeding Stock		
Trait	**Goal**	**h^2 (%)**
Reproductive		
calving interval, mo	12	0-15
mortality (birth to calving),%	5	0-10
longevity, number lactations	6	10-30
Productive		
birth weight, lb	50-95	35-50
milk yield, lb per lacation	12 x body wt.	20-30
persistency of lactation, %	95	20-40
Qualitaive		
milk fat, %	a	50-70
Milk Solids not fat, %	a	40-70
protein, %	a	50-60
Anatomical		
type score	b	20-30

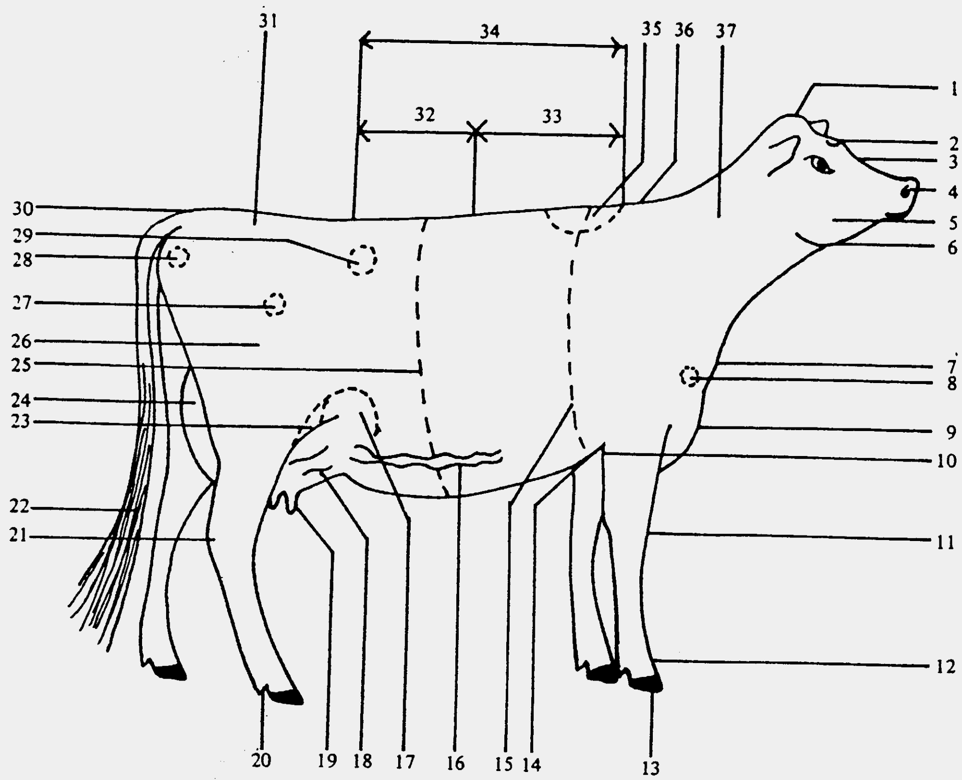
a - Whatever is needed to meet the market demands

b - Depends upon the dairyman's goals. If selling breeding animals the higher type animals will sell for more money. The better type animals are not necessarily superior milk producers.

Source: Modified from Brant and Kenealy (1994)

DAIRY CATTLE (Bovine)

External body parts



1. Poll
2. Forehead
3. Bridge of nose
4. Muzzle
5. Jaw
6. Throat
7. Dewlap
8. Point of shoulder
9. Brisket
10. Point of elbow
11. Knee
12. Pastern (front and rear)
13. Hoof
14. Floor of chest
15. Heart girth
16. Mammary vein
17. Rear flank
18. Fore udder
19. Teat
20. Dewclaw (front and rear)
21. Hock
22. Switch
23. Stifle
24. Rear udder
25. Barrel
26. Thigh
27. Thurl
28. Pin bone
29. Hip or hook bone
30. Tailhead
31. Rump
32. Loin
33. Chine
34. Back
35. Crops
36. Withers
37. Neck

Source: Modified from Brant, G. and Kenealy, M.D. (1994): Introductory Animal Science: Laboratory Manual. Paladin House, Zanda, Wisconsin, USA

1.2.2.2 Sire Selection

Since the sire supplies one-half the inheritance of each animal born, your greatest opportunity for the improvement of a herd lies in the introduction of desirable characters through the sire. A good cow has only a small influence upon the herd, since the number of offspring which she can produce is limited compared to the number of offspring of a bull. The necessity of a good sire is therefore evident.

Method of Selecting the Sire

Since selection of a sire is one of the most important tasks that you will have to perform in managing your dairy herd, the bull that is chosen will determine to a large extent the kind of cows that will be in the herd.

The sire should be a purebred of the breed selected. In addition, he must be one that will increase, or at least maintain, the production of the present herd.

Several methods you can use in selecting a sire and these are used either alone or in combination. They are:

(i) *Selecting by Type and General Appearance:* The dairy sire, bred for milk production, does not show his milk producing qualities. He may however, show some of the body characteristics that he will transmit to his daughters. To the extent that a limited genetic correlation is estimated to exist between ***type*** and production (in the absence of more reliable information) type conformation is of some value in selecting a sire. However, some important characteristics that contribute to the type and value of dairy cows are not revealed in the conformation of the bull. Such things as mammary system, persistency of production, length of life, breeding efficiency and milk yield you cannot see by outward appearance. On this basis it would be unwise for you to expect great improvement in the production of a herd by selecting for type alone. Nor should you

expect great improvement in type when selecting for production alone. You must give both consideration in improving a herd.

(ii) ***Selecting by Production of Daughters (Using Proven Sires)***: By definition, a proven sire is one with five or more unselected daughters whose production and/or type can be compared with that of their dam. By this definition a proven sire is not necessarily a good sire. His daughter may have better production than their dams, or they may show little difference in production from their dams. For more complete evaluation of a sire, other information on the daughters should be known, such as:

- Type of the individuals, including feet, legs and udders
- Longevity
- Level of feeding and management during the time when the various records were made
- Ease of milking
- Temperament

Selection of the Artificial Insemination (A.I.) Proven Sire

Previously most bulls were proven in only one herd. Now, with the expansion in the use of artificial breeding, the A.I. sires are proven in many herds. All the tools of measuring the transmitting ability of the sire through progeny testing have been used. Many refinements have been included in evaluating proven sires. One such refinement which indicates most accurately the transmitting ability of a bull is the comparison of the performance of his daughters with that of their herdmates. This comparison when carried out in several environments appears to offer the most accurate means of measuring the inheritance for production that the bull transmits to his offspring.

Other factors that you should be take into consideration in using a proven sire are the following:

- þ The daughter of the proven sire should also have good type if the bull is to be of greatest value. Udders that may be seriously pendulous and legs that may be badly sickled or cow-hocked, can become problematic in breeding herds of dairy cattle if these characteristics are concentrated through the use of several sires carrying these traits.
- þ In terms of health of the bull, it is important that he be checked thoroughly for disease, particularly the sexually transmitted diseases, and breeding efficiency.
- þ The herd should be of a size to justify the expenditure of a sum of money large enough to buy a good proven sire. The farm should be well equipped to handle older bulls, such as having available strong fences, safety pens and breeding chutes.

(iii) *Selecting a Herd Sire by Pedigree*

In a situation where there are not enough proven sires, selecting a herd sire by pedigree in combination with type is an available option for you, the breeder. If the pedigree of a bull is sufficiently complete in every detail, this method might be as successful as selecting a proven sire. On the basis of pedigree some of the factors you need to look for in selecting a bull are as follows:

- þ His sire should be well proven
- þ The dam (mother) of the young bull should have a good, unselected record **what is an unselected record?**. The average of these records should exceed the herd average by an appreciable amount.
- þ The offspring of the dam are important. The records of daughters of a dam have been considered more important than the dam's own record in estimating her breeding worth.
- þ It is of little importance in putting excessive emphasis on ancestors too far back in the pedigree. There is no need to

go beyond the sire, the dam, the sisters (full-sibs), the half-sisters (half-sibs), and the grandparents.

- þ Select a sire that is from a good cow family. Some of the things making up a good family are:
  - Ü High yearly production
  - Ü Regular breeders
  - Ü Persistency
  - Ü The type of the animals in the pedigree

(iv) *Other Factors in Selecting a Sire*

- þ On the basis of only the age factor, a young sire is preferable to an old one. If a sire is to be purchased upon his pedigree, a young one should be chosen because young sires are surer breeders and have a longer period of usefulness ahead of them.
- þ Age of the Dam of the Sire: It is usually advisable to select a sire from a mature cow, at least one that already has had a lactation. This is primarily so because the heifer has not had the opportunity to demonstrate her inheritance in terms of milk production. With the mature animal an opportunity is usually available to ascertain the producing ability of the dam.

1.3 Culling

Culling is defined as *the selective elimination of undesirable animals from the herd.* Culling forms the basis for maintaining the integrity of your herd, that is, to maintain a sound healthy herd with as high a level of production as is possible. Generally, milk contributes approximately 80% to the gross income of a dairy farm, therefore, the principal reason for culling of a cow is low production of milk.

There are other reasons why you would cull a cow:

L Udder problems

L Sterility

L Abortion

L Old Age

L Injury

L Tuberculosis

L Sexually Transmitted Diseases

In the final analysis, it must be noted that your ideal dairy cow is one which is:

J Healthy

J Reaches economic production at an early age

J Calves each year

J Yields the type of milk wanted, on the feed available

J Produces to an old age (at least for five lactations).

The culling of bulls is not as critical as it is for cows, since A.I. (Artificial Insemination) is the usual method of mating employed. However, where bulls are kept they are usually culled due to the relevant reasons among those given above. However, it should be noted that in natural breeding systems, you should cull individual bulls every 2-3 years to prevent inbreeding with their offspring, i.e. to prevent the bulls from serving their daughters.

1.4 Reproduction and Breeding

Reproduction is concerned with the sexual processes necessary for the continuation of life. Of course, profitable milk production and the improvement of dairy cattle are dependent on normal reproduction. Any factor that lowers breeding efficiency will lessen the rate at which hard improvement in your production can take place.

Sterility, which is the complete absence of reproductive ability, usually is easy to recognise. On the other hand, lowered fertility (which is subnormal breeding efficiency) is not so easily detected, and such animals sometimes will cost you more than those that are completely sterile, because they (those with lowered fertility) are often kept in the herd with the hope that fertility will be restored.

1.4.1 Measuring Breeding Efficiency

You can use any one of the following methods to measure breeding efficiency, depending on the condition and especially upon the information available:

- *The number of services per conception:* As a general rule, services per conception within the range 1.3-2.0 are regarded as satisfactory.
- *The percentage of non-returns:* This is the measure used by most artificial breeding associations to measure the breeding efficiency of bulls. A non-return is an animal that has been bred for which there is no request for another breeding. Of course some of your cows may die, others may be sold, and still others may be bred naturally, so that the non-returns are not an exact measure of breeding efficiency. An acceptable record is seventy-four percent (74%) non-returns up to 60 days after breeding, or 68% non-returns up to 90 days after breeding.
- *The length of the calving interval:* This would be ideal if a cow calved every 12 months. This is seldom achieved in practice, as usually some of your animals will fail to conceive at first service. When your dairy herd averages less than 13 months between calvings it is considered a highly fertile herd.

- þ *<u>The percentage of cows that calve within a year</u>*:
  This has been used to estimate the breeding efficiency of a herd. A fertile herd should produce a 90% calf crop a year.

- þ *<u>The number of days per year that a cow carries a calf</u>:* This has been used as a measure of reproductive efficiency. If your cow carries a calf 9 months in a year she is rated as having a 100% reproductive efficiency. You can use the following formula which has been developed for estimating the reproductive efficiency [RE] of dairy animals:

$$R.E. = 12 \times \frac{(\text{No. of calves born}) \times 100}{\text{Age of cow (mths)} - \text{age at 1st breeding (mths)} + 3}$$

1.4.2 Maintaining Breeding Efficiency

Profitable dairy production is, to a large extent, dependent on having your cows calve regularly each year. The ideal is a uniform 12-month interval between calving for the entire milking herd. This will result in increased total milk production by individual cows over their lifetime when compared with longer intervals between calving. In addition, more calves will be produced in a given period of time and, as a result of these two factors, returns should be higher. As most of the variation in herd breeding problems can be attributed to differences in herd management rather than to inherited characteristics, the following points should help improve your herd's breeding performance:

a) Keep accurate and complete records of dates of heat, breeding, calving, and symptoms of abnormal conditions of the reproductive system. This is the most important thing you can do, otherwise you are not going to be successful as a dairy farmer.

b) Observe your cows or heifers carefully for signs of heat at least twice daily.

c) Give your cows a rest of at least 60 days following calving. You should breed all normal cows during the first heat period after 60 days if a 12-month calving interval is desired.

d) Provide service at the most opportune time for conception. Do not breed your cows during the early part of the heat period. The cows you first observe in heat in the morning should be bred later the same day for best results. The cows you first observe during the afternoon should be bred the following morning.

e) Breed your females to a sire known to have a high fertility level.

f) Follow a programme of regular pregnancy diagnosis after 6 weeks from the date of last service.

g) Supply adequate amounts of energy, protein, phosphorous, and Vitamin A in the ration for the optimum reproductive performance of your cows.

h) Consult your veterinarian for treatment of problem cows, such as those:

    i) Which fail to conceive after three services to a fertile sire,

    ii) Not exhibiting signs of oestrus within 60 days following calving, or has irregular heat cycles, and

    iii) Showing symptoms of cystic ovaries or other abnormal conditions.

i) Do not breed a cow showing any unnatural discharge and isolate aborted cows until all discharge has ceased.

1.4.3 Natural Mating Systems

There are basically two natural mating systems, namely:

- Ü Hand mating, whereby the sires are held in confinement and selected females taken to them, and
- Ü Bulls running with the herd.

In the latter situation, you can use single or depending on the size of your herd. In either situation, you should exercise care not to overlook the bull in terms of the amount of females with which he is allowed to mate. Consequently, there are certain well established male to female ratios designed to minimize this risk, **what risk? Explain** depending on the maturity of the bull, as given below.Table 3. Natural Mating Systems: Male to Female Ratios

Animal	**Mature (Age)**	**Young (Age)**
Cows - Single Sire	1 Bull (2 yrs old & over) to 30 - 40 cows	1 Bull (18-14 mths) 12 - 15 cows
Multiple Sires	1 bull to 25 Cows	

The major limitations to natural mating systems are the cost of acquiring and maintaining these bulls and the reduced genetic gain of the herd due to the reduced possibility of acquiring and using proven sires, besides the recordkeeping problems incurred with bulls running the herd.

1.4.4 Artificial Insemination (AI)

Let's look at another mating system. Artificial insemination is the process of breeding a female to a male without the incidence of natural mating. The semen is collected from the males by artificial means. The female is inseminated by placing a portion of the semen, either as collected or diluted, into the cervix or uterus by mechanical methods during the oestrus period.

The following are some of the advantages of artificial insemination or artificial breeding.

Advantages of AI

1. It makes available to all farmers sires of proven inheritance for milk production within a given area.
2. The services of superior sires are greatly extended.
3. The dairy farmer does not have to keep a herd sire.
4. The dairy farmer does not have to purchase a herd sire every 2 years.
5. The cost of breeding cows artificially is less than purchasing and maintaining a bull of the same quality.
6. There is less danger of spreading reproductive diseases.
7. There is less chance of using poor semen given that the semen is examined frequently.
8. Large mature bulls often cannot be used on small heifers naturally.
9. Some bulls, because of injury or other reasons, cannot be used naturally but may be used artificially.

There are some limitations to the use of artificial breeding, such as the following:

Limitations of AI

1. A well-trained technician is necessary.
2. The equipment must be kept clean and sterilised, and strict sanitation methods must be practiced or diseases may be spread from cow to cow or from one herd to another.
3. Fewer bulls are needed; consequently; the sale of bulls from purebred herds is reduced.

1.4.5 Embryo Transfer

Embryo Transfer (ET) is a technique used to produce many offspring from one female. This is done by finding the female with the desired superior traits (in this case milk production) then extracting as many ova from her, fertilizing these many ova within the donor using AI. The fertilized ova are then placed into receptive females (one in each female). These females will then carry the embryo to full term. All that is required of these receptive females is that they have good reproductive tracts, and are able to support a pregnancy. The offspring so produced will have no genetic traits of the female which carried them. In this way, very many offspring can be obtained from a superior dam. This will be very useful, especially if she is a very high milk producer.

The Steps involved in ET

I. MANAGING DONOR AND RECIPIENT HERDS

- Donor Selection
- Sire Selection
- Management of Donors
- Selection of Recipients
- Management of Recipients
- Oestrus Detection
- Pregnancy Diagnosis
- Managing Pregnant Recipients

II. THE PROCESS

1. Superovulation of the Donor
2. Insemination
3. Recovery of the Embryos
   - non-surgical recovery
   - isolation of Embryos
   - reflushing and prevention of multiple pregnancies in donors
4. Synchronization of Estrus of the Recipients
5. Maintaining Embryos in vitro (in glassware outside the animal)
6. Evaluation of Embryos
7. Transfer of Embryos into the oestrus synchronized recipients

Source: Seidel, G.E., Jr. and Seidel, S.M. (1991): Training Manual for Embryo Transfer in Cattle. FAO Animal Production and Health Paper # 77. FAO, Rome.

1.4.6 Estrus (Heat/Standing Heat) Detection

Oestrus (Estrus) is the physiological processes that occur within the female enhancing her receptiveness to mating and hence the possibility of initiating reproduction. The detection of oestrus is critical to the effective use of Artificial Insemination. Your cow will display symptoms of oestrus when:

Signs of Estrus

- **She bellows for sustained periods.**
- **She spends little time grazing and rarely ruminates.**
- **She will mount other cows during the early phase of heat by attempting to copulate.**
- **She will stand quietly and receptive while allowing other cows to mount her - this phase is called "standing heat [Estrus]".**
- **Her vulva may be enlarged and congested with an exudate of mucus secretions which may be seen around the tail head, on the tail itself, or may be seen to be flowing from the vulva. This may be different from a discharge as the discharges (which may be an indicator of infection) are usually foul smelling.**
- **Constant mounting by other cows will result in the top portion of the tail head and pinbone region being bruised or reddened.**
- **Lactating cows may show a significant drop in production on the day of "heat."**

Have you ever seen a Cow in Standing Heat?

Activity P

Contact a Dairy Farm and pay them a visit to observe standing heat. Please refer to and read carefully the CARDI Fact Sheet # ??.

1.4.7 Optimum Time for Insemination

When is the optimum time for inseminating your cow? This is critical to realising conception through the process of Artificial Insemination. Maximal results seem to be obtained when cows are bred from mid-estrus to the end of standing estrus with good results after estrus. The following recommendations summarise the appropriate time to inseminate your cow to maximise conception.

Table-4. Insemination Times for Optimum Conception

Cows coming into estrus	**Should be bred**	**Too late for best results**
In the morning	The afternoon of the same day	The next day
In the afternoon or evening	The forenoon of the following day	After 2 pm the next day

Activity L

1. The Jamaica Hope is a tropically adapted breed of dairy cattle. What are the primary characteristics justifying this distinction and what are some of the other attributes peculiar to this breed?
2. List points to bear in mind to improve breeding performance.
3. What are some of the physical characteristics to consider in selecting cows to constitute a dairy herd?
4. What are some of the factors to look for in selecting herd sire on the basis of pedigree?
5. List some of the advantages of artificial insemination in artificial breeding.
6. What is oestrus? List the symptoms of oestrus.

References

ANON (1983): Feeding of Animals in the Caribbean: An SFC-CARDI Sponsored Workshop, 11-16 April, 1983. Editors; F. Neckles, W. Cateau and D. Walmsley.

ANON (1983): *Livestock Manual for the Tropics,* Jamaica Livestock Association, Kingston, Jamaica.

ANON (1984): *Alberta Dairy Production Course,* Alberta Agriculture Dairy Production Branch in Cooperation with Homes Study, Alberta Agriculture, Alberta, Canada.

ANON (1985): *Dairy Housing and Equipment Handbook,* Fourth Edition, Mid West Plans Service, Iowa State University, Ames, Iowa.

ANON (1991): *Cattle Nutrition Course,* Alberta Agriculture Beef Cattle and Sheep Branch and Home Study Programme, Alberta Agriculture, Alberta, Canada.

Beth, D.L.; Dickinson, F.N.; Tucker, H.A.; and Appleman, R.D. (1985): *Dairy Cattle, Principles, Practices, Problems, Profits,* Lea & Febiger, Philadelphia, Pennsylvania, U.S.A.

Brant, G. and Kenealy, M.D. (1994): Introductory Animal Science Laboratory Manual. Paladin House, Zenda, Wisconsin, USA.

Chamberlain, A. (????): Milk Production in the Tropics. Intermediate Tropical Agriculture Acience Series. Longman, UK.

Jarriage, R. (Editor) (1988): Ruminant Nutrition: Recommended Allowances and Feed Tables. INRA, John Libbey, Eurotext, London and Paris.

Matthewman, R.W. (1993): Dairying. The Tropical Agriculturalist. CTA-MacMillian, UK.

Maule, J.P. (1990): The Cattle of the Tropics. Universuity of Edinburgh Press, Edinburgh, UK.

Nelson, R. (1986): *Stockman's Veterinary Handbook,* Livestock Development Company, Georgetown, Guyana.

NRC (1989): *Nutrient Requirements of Dairy Cattle,* National Academy Press, 6th Revised Edition, Washington, D.C., U.S.A.

Payne, W.J.A. (1990): *An Introduction to Animal Husbandry in the Tropics,* ELBS, Longman, London and New York, Fourth Edition.

Porter, V. (1991): Cattle: A Handbook to the Breeds of the World. Christopher Helm, A & C Black, London.

Accompanying Reading

CARDI Facht Sheet on Heat Detection

Garcia, G.W., Williams, H.E., Jeans, S., Baksh, C. and Best, R. (1993): *The Performance of Two Small Herds of Jamaica Hope Dairy Cattle Imported Into Trinidad.* In Dairy Development in the Caribbean Region, Caribbean Research and Development Institute; Internal Dairy Federation (IDF) Brussels, Belgium; Technical Centre for Agricultural Cooperation (CTA). March 1998, D. Walmsley Editor, CTA-Actes de Seminares # 466:73-84

Suggested Reading

O'Garro, J. (1990): Reproductive Management in the Dairy Herd. (Unpublished).

UNIT 2 -- DAIRY CATLE NUTRITION

2 Dairy Cattle Nutrition

Quick Start h

In order for you to develop an appropriate strategy for the feeding of dairy cattle for efficient production you must be informed by a knowledge of two basic factors:

- Ü The nutrient requirements for any given level of production (*i.e.,* the animal's physiological state and level of milk production), and
- Ü The feeding value of available feed stuffs.
- Ü **The physiological states of dairy cattle, which are as follows:**

1. Milking or Lactating
   - (a) Early Lactation (wks. 1-10)
   - (b) Middle Lactation (wks. 11-30)
   - (c) Late Lactation (wks. 31-44)
2. Dry and Pregnant
3. Dry and Open
4. Calves
   - (a) Milk Feeding Phase (up to 5 oto 12 weeks)
   - (b) Early Weaned Calves
   - (c) Growing Calves < 1 year
5. Replacement Heifers
6. Bulls

NOTE:	What makes dairy cattle management challenging is that a dairy cow could be still growing (if she is in her first or second lactation), pregnant and lactating all at the same time.

The Lesson /

2.1 Nutrient Requirements

Let's consider the nutrients required by dairy cattle for growth, maintenance and milk production, the composition of animal feeds commonly available in the Caribbean region and propose models for the nutritional management of the dairy heifer and lactating cow based upon the effective utilisation of pasture.

The major nutrients required for maintenance, growth or milk production are:

- Water
- Energy
- Protein (including non-protein nitrogen)
- Minerals and
- Vitamins

Extensive treatment of the subject of nutrient requirements is given in Nutrient Requirements of Dairy Cattle (National Research Council - National Academy of Sciences, Washington, DC 1989/90). You will need to remember that this is not a course on nutrition, and therefore you will only be exposed to nutritional facts to be able to gain an appreciation of the subject as it relates to Dairy Cattle. The self-instructional text and Distance Course on nutrition will enable you to design feeding systems and formulate diets and prepare rations.

2.1.1 Water

Water plays an important part in how much milk your cows are able to produce. The basic demand for water will depend on the intake of Dry Matter (DM) necessary for maintenance, production and development. The amount of DM consumed for maintenance depends on the liveweight of the animal. For each kg of DM consumed, a non-lactating cow will drink 3 to 4 kgs of water. The lactating cow will require a further 3 to 4 kgs water per kilogram of milk produced. Ambient temperature exerts a strong influence on daily water consumption, thus a 545 kg cow producing 20 litres of milk per day will drink 81.2 litres at 26.4 ^{o}C increasing to 127.3 litres at 32.2 o C.

If water is lacking, the animal will decrease its normal DM intake proportionately to the volume of liquid intake. You should take care that water is available in sufficient quantity to promote maximum production.

2.1.2 Energy

Energy is required for all metabolic functions. Although all feeds are used at varying levels of efficiency as energy sources, carbohydrates and fats provide the major sources of energy in feeds, (with sugar being the most quickly converted to energy, while fats provide the highest amount of energy/unit weight of material).

The energy required for the maintenance of a cow is determined by the animal's level of activity. The variation in maintenance energy requirement might be as much as 8 to 10 percent between cows of the same breed and of equal size.

Thus, lactating cows have 10 to 12 percent greater maintenance than to dry non-pregnant cows. With respect to milk production, *under tropical conditions* energy is commonly the limiting nutrient resulting in depressed milk production. In young animals prolonged energy deficiency in the diet will lead to retarded growth, delayed puberty, and an almost absence of body fat deposits.

2.1.3 Protein

Protein is the only nutrient containing nitrogen.

Protein is measured in terms of crude protein (%N x 6.25 %CP) or digestible crude protein.

A deficiency of protein is reflected in lowered utilization of the diet by the animal and depressed milk production. It is suggested that a critical protein deficiency in grazing dairy cows will only occur where the protein content of the pasture declines to below 8 percent. The ratio between protein (CP) and energy (E) in the diet is critical to the efficiency of milk production. It has been suggested that a CP:E ratio of 7.8 rumen-degradable protein per megajoule metabolisable energy is optimal.

Non-protein nitrogen (NPN) sources such as urea provide a cheaper source of protein by capitalising on the action of the rumen microflora in converting NPN into true protein (which then enters the small intestines). The conversion of NPN to true protein requires the supply of a source of readily fermentable carbohydrate, such as molasses. Urea has provided up to one quarter of the nitrogen in concentrate feed for cattle, however it is recommended that when you include urea in concentrate feeds that the urea can be limited to a maximum of one (1) percent in order to prevent depressed intake. Recent developments with multinutrient blocks based on urea/molasses allows for the use of urea at levels well above ten (10) percent in the form of a self-limiting lick.

Activity L

Please turn for further reading to:

Asiedu, F.H.; Fearon, A.L.; Hosein, A.A. and Barnes, R. (1994): Directions for Making and Feeding Molasses-Urea Feed Blocks. CARDI Fact Sheet # AP-F/37.94

2.1.4 Minerals

The major mineral elements required by dairy cattle are the Macro minerals (calcium, phosphorus, magnesium, potassium, sodium, chlorine, sulphur) and the Micro minerals (iodine, iron, copper, cobalt, manganese, zinc, selenium and molybdenum). You should remember that the major limiting minerals for lactating cattle are calcium and phosphorus and the balance between these elements in the diet is critical to efficient milk production. Milk fever in cows is caused by a disturbance in calcium (Ca) metabolism marked by a drop in the level of calcium in the blood-serum. The desirable ratio between Ca:P is considered to be 2:1 for dairy cattle. Another important mineral ratio is a 10:1 for the N:S [Sulphur] ratio. The latter is a particularly important ratio for diets containing urea, and non protein nitrogen.

2.1.5 Vitamins

Under most tropical conditions the requirements for vitamins or their precursors are adequately provided in natural feeds. Furthermore, the B-vitamins and vitamin K are synthesized in the rumen while vitamin C is synthesized in the tissues.

Vitamin deficiencies may, however, occur under specific conditions, such as when low levels, or olw quality is fed, when large amounts of hay are fed to animals whihc have limited access to sunlight. In young calves fed extensively on milk replacer, vitamin supplementation may also be necessary.

Table 5. Summary of Individual Mineral Functions, Deficiencies, Toxicities and Inter-Relationships

MINERAL	MAJOR FUNCTIONS	SPECIFIC DEFICIENCY SYMPTOMS	MAJOR INTER-RELATIONSHIPS AND TOXICITIES
CALCIUM (Ca)	• Bone formation • Blood coagulation • Muscle contraction • Nerve function • Cell permeability • Major component of milk	• Rickets (young) • Osteomalacia (adults) • Milk Fever (parturient paresis)	• Vitamin D - absorption and bone deposition. • Excess phosphate decreases absorption • Excess magnesium decreases absorption, replaces Ca in bone and increases Ca excretion.
PHOSPHOROUS (P)	• Bone formation Phosphorylation • High energy phosphate - chief anion radical of intracellular fluid; important in acid-base balance	• Rickets (young) • Osteomalacia (adult) • Anestrus/low conception rates	• Vitamin D - renal absorption and bone deposition • Excess Ca and Mg causes decrease in absorption • Desirable Ca:P ratio should be 2:1
MAGNESIUM (Mg)	• Enzyme activator primarily in glycolytic system • Bone formation	• Tetany • Vasodilatation • Hyper-irritability with convulsions • Loss of equilibrium and trembling	• Excess Mg upsets Ca and P metabolism
SODIUM (Na)	• Major indication of extracellular fluid • Involved in osmotic pressure and acid-base equilibrium • Preservation of normal muscle-cell irritability • Cell permeability	• Reduced growth • Eye disturbances with corneal lesions • Impaired reproductive capacity	

CHLORINE (Cl)	• Major anion of extracellular fluid • With Na, involved in osmotic pressure and acid-base equilibrium • HCl important is digestion	• Hypochloremic alkalosis (usually due to physiological disturbances as vomiting rather than deficiency)	
MINERAL	**MAJOR FUNCTIONS**	**SPECIFIC DEFICIENCY SYMPTOMS**	**MAJOR INTER-RELATIONSHIPS AND TOXICITIES**
POTASSIUM (K)	• Major action of intracellular fluid -- involved in osmotic pressure and acid-base equilibrium • Muscle activity	• Hypokalemia • Lethargic condition with high incidence of coma and death • Diarrhea, distended abdomen and untidy appearance	
SULPHUR (S)	• Sulphur-containing amino acids (methionine & cysteine) SH group function in tissue restoration	• Retarded growth due to sulphur amino requirement for protein synthesis	• N:S ratio of 10:1 important for diets containing NPN
IRON (Fe)	• Cellular respiration Haemoglobin Ctochromes Myoglobin	• Hypochromic-Microcytic anaemia. Seldom occurs in adults except where there is major loss of blood from parasites or disease.	• Ca:P ratio influences absorption • Cu required for proper metabolism • Pyridoxine deficiency decreases absorption
COPPER (Cu)	• Cofactor in several oxidation-reduction enzyme systems • Bone formation • Maintenance of myelin of nerves	• Fading hair coat • Nervous symptoms • Lameness • Swelling of joints • Anaemia	• Excess Molybdenum, zinc inhibits its utilisation • Toxicity occurs at levels above 250 ppm with symptoms similar to those due to deficiency
ZINC (Zn)	• Component or cofactor of several enzyme systems, including peptidases and carbonic anhydrase	• Rough, thickened skin or parakeratosis	• High Ca and P level requirement • Excess Zn interferes with Cu metabolism and may cause anaemia

MANGANESE (Mn)	• Implicated in activation of enzyme systems involved in oxidative phosphorylation, amino acid metabolism, fatty acid synthesis and cholesterol metabolism • Bone formation • Growth and reproduction	• Deficiency has been difficult to produce experimentally	• Excess Ca and P decrease absorption
MINERAL	**MAJOR FUNCTIONS**	**SPECIFIC DEFICIENCY SYMPTOMS**	**MAJOR INTER-RELATIONSHIPS AND TOXICITIES**
COBALT (Co)	• Synthesis of Vitamin B12	• Anaemia. Occurs frequently in grazing animals	• Raising soil pH by liming reduces Co intake by plants and may induce deficiency in grazing animals
IODINE (I)	• Component of thyroxine: controls rate of oxidation of all cells, *i.e.*, regulates energy metabolism	• Goitre • Still births	
SELENIUM (Se)	• Implicated in Vitamin E absorption and/or retention	• Reduced growth and muscular dystrophy • White muscle disease in calves • Impaired reproductive performance	• Chronic Toxicity: • Blind staggers 10-20 ppm Alkali disease - 5-10 ppm • Acute toxicity: 20 ppm and above • Sudden death • SO_4 protects against toxicity
MOLYBDENUM (Mb)	• Essential component of certain enzyme systems, principally Purine	• Unlikely to be deficient in natural diet. • Toxicity more easily encountered • Anaemia and diarrhea •SO_4 protects against toxicity	• Excess interferes with Cu activation of enzymes

FLUORINE (Fl)	• Its essentiality in farm animals has not been established • Important due to its toxic effects		• Levels above 5-10 ppm block vital oxidative enzymes by interfering with Mn • Cause bone deformities and organ degeneration • Ca and Al salts protect against toxicity

Activity L

Please turn for further reading to:

Proverbs, Gerald A. and Asiedu, Francis H., June 1994. *Feed Terms Defined,* Factsheet, Caribbean Agricultural Research and Development Institute (CARDI), Order No.: AP-F/38-94.

Proverbs, Gerald A. and Asiedu, Francis H., June 1994. *Vitamins A, D and E for Cattle,* Factsheet, Caribbean Agricultural Research and Development Institute (CARDI), Order No.: AP-F/35-94.

Proverbs, Gerald A., June 1994. *Macro-Mineral Requirements for Cattle,* Factsheet, Caribbean Agricultural Research and Development Institute (CARDI), Order No.: AP-F/39-94.

2.1.6 Fibre

It is generally agreed that in order to allow for adequate milk fat synthesis, cows should be fed about 17 percent crude fibre in their diet. In addition to lowered milk yield and fat, diets deficient in fibre may lead to digestive disorders, displacement of the abomasum, acidosis and rumen parakeratosis. Heifers and bulls require a minimum crude fibre level in the diet of 15 percent.

Given that tropical forages generally contain in the region of 30% crude fibre and concentrates, about 7%, in order to ensure the optimal level of fibre (17%) in the diets of high-producing cows, a ratio of forage to concentrate of the order of 45 to 55% would be required.

2.2 Feeding Value of Common Tropical Feeds for Dairy Cattle Production

Forages provide the most abundant source of locally produced feeding material for ruminant production in the Humid and Wet and Dry Seasonal Tropics. Cereal grains and oilseeds are produced only in relatively small quantities.

Compared to the production of milk from forages in temperate countries, the potential milk production from tropical forages is low.

Major among the reasons for the limited potential of tropical forages (and in particular, grasses) are:

- *Low dry matter digestibility.* Maximum digestibility is normally of the order of 60-65%. The higher values are obtained with forage legumes.
- *Low leaf to stem rations.* This reduces the ease of grazing by the cow. The high proportion of stem (given the higher level of lignification in the stem) contributes to the reduced digestibility of grazed herbage.
- *Marked fluctuations in energy and protein content* inhibiting intake for large parts of the year.

Notwithstanding the lower feeding value of tropical, compared with temperate forages, comparatively high levels of milk production may be realised with efficient management of pastures. Cuban workers have reported yields above 4908 kg of milk per lactation from unsupplemented Coast Cross I pasture grazed at 25-day intervals by a leader/follower rotational system and liberally fertilised. Similarly, in Jamaica, Pangola grass pastures fertilised at a modest level (240 lb/acre N) have supported 2 cows per acre producing 4800 lbs milk per cow lactation without supplementary feeding.

In order to coherently harmonise the approach to an interpretation of the nutritive value of tropical forages, Soldevila (1987) has proposed the classification system shown in Table 5.6.

Table 6. Classification of Tropical Forages

Chemical Composition of Forage				
Quality	**Dry Matter %**	**Crude Protein %**	**Metabolise Energy (Mcal/kg)**	**TDN[1] of Forage %**
High	20 - 24	>11	>2	>55
Medium	20 - 24	6.1 - 10.9	1.9 - 2.1	50 - 55
Low	20 - 24	<6	<1.9	<50

The classification is based on the contents of dry matter, crude protein and energy of the aerial portion of the forage. A more comprehensive guide to the nutritive composition of common tropical feeds is given in *Table 5.7.*

With regard to the feeding of forages, the following should be noted:

- Lactating cows may consume total dry matter equivalent to 2.5 - 3.5 percent of body weight daily. Thus intake of high quality forages may reach as high as 15 kg DM per day;
- A high quality forage will provide approximately 4/5 the energy supplied by an equal dry weight of grain.

1 TDN – Total Digestible Nutrients.

Table 7. Composition of Animal Feeds - As Fed (x) and 100% Dry Matter(y) Basis

Scientific Name / Local Name	x / y	Dry Matter %	TDN %	NE (Mcal/ kg)	Protein Total %	Protein Dig %	Crude Fibre %	Ca %	P %
A. *Pastures and Forages fed fresh*									
1. Brachiaria decumbens	x	29.9	—	0.60	2.3	1.3	—	0.04	0.05
Surinam grass	y	100.0	—	2.15	7.5	4.2	4.5	0.13	0.16
2. Brachiaria mutica	x	28.0	14.0	0.31	1.8	0.9	9.4	0.12	0.10
Para grass	y	100.0	50.0	1.11	7.0	3.3	33.9	0.42	0.34
3. Brachiaria spp.	x	18.8	—	0.41	2.0	1.3	6.5		
Signal grass	y	100.0	—	2.18	10.8	7.1	34.5	0.23	0.62
4. Cynodon dactylon	x	34.0	20.0	0.45	4.1	2.6	8.9	0.18	0.07
Coastal Bermuda	y	100.0	60.0	1.35	12.0	7.8	26.5	0.53	0.21
5. Cynodon dactylon	x	33.2	—	0.67	2.5	1.7	10.5	0.01	0.03
Coast grass	y	100.0	—	2.02	8.6	5.2	31.8	0.01	0.09
6. Cynodon plectostachyus	x	27.6	—	0.51	2.4	1.4	9.5	0.18	0.05
African Star grass	y	100.0	—	1.85	8.5	5.1	35.4	0.61	0.16
7. Digitaria decumbens	x	32.2	—		4.2	2.9	10.4	0.06	0.06
Pangola	y	100.0	—	2.04	18.2	9.1	32.3	0.20	0.20
8. Melinis minutiflora	x	21.2	—	0.27	1.9	1.1	6.6	0.08	0.05
Molasses grass	y	100.0	—	1.29	8.8	5.4	30.9	0.31	0.18
9. Panicum maximum	x	18.0	10.0	0.23	2.5	1.7	6.0	0.10	0.06
Guinea grass	y	100.0	57.0	1.28	13.7	9.7	33.2	0.53	0.32
10. Pennisetum purpureum	x	21.0	12.0	0.26	2.0	1.1	7.2	0.09	0.07
Napier grass	y	100.0	55.0	1.23	9.2	5.2	33.9	0.44	0.35
11. Saccharum officinarum	x	88.4	—	1.08	3.6	0.4	25.9	0.35	0.04
Cane stalks chopped	y	100.0	—	1.23	4.1	0.5	29.3	0.40	0.05
12. Saccharum officinarum	x	30.0	—	0.59	1.7	0.8	8.6	0.37	0.04
Cane tops	y	100.0	—	1.98	5.7	2.7	28.5	1.23	0.13
13. Saccharum officinarum	x	93.6	—	0.75	1.8	1.3	39.0	0.14	0.11
Cane bagasse	y	100.0	—	0.80	1.9	1.4	41.6	0.15	0.12
B. *Silages*									
1. Digitaria decumbens	x	32.0	18.0	0.40	2.9	1.4	—	0.13	0.03
Pangola silage	y	100.0	56.0	1.25	8.9	4.3	—	0.39	0.08
2. Glycine max	x	35.0	19.0	0.43	6.2	4.3	9.5	0.48	0.12
Soybean	y	100.0	55.0	1.23	18.0	12.5	27.5	1.38	0.36
3. Pennisetum purpureum	x	26.0	11.0	0.24	1.2	0.1	10.0	0.08	0.08
Napier silage	y	100.0	43.0	0.93	4.8	0.5	39.1	0.31	0.31
4. Sorghum bicolor	x	26.0	15.0	0.34	1.5	0.4	7.9	0.07	0.04
Sorghum silage	y	100.0	58.0	1.30	5.8	1.5	30.6	0.27	0.15
5. Zea Mays	x	26.0	19.0	0.42	2.1	0.9	6.5	0.07	0.05
Corn silage	y	100.0	70.0	1.60	7.8	3.3	24.5	0.27	0.19
C. *Hays and Dry Roughages*									
1. Cynodon dactylon	x	91.0	42.0	0.92	8.9	4.2	27.8	0.43	0.16
Bermuda hay	y	100.0	46.0	1.01	9.8	4.6	30.4	0.47	0.17
2. Digitaria decumbens	x	88.0	45.0	1.01	8.4	4.8	24.0	—	—
Pangola hay	y	100.0	52.0	1.15	9.6	5.5	27.4	—	—
3. Glycine max	x	94.0	50.0	1.10	16.7	12.3	27.9	1.18	0.25
Soybean hay	y	100.0	53.0	1.18	17.8	13.2	29.8	1.26	0.27
4. Oryza sativa	x	91.0	41.0	0.89	4.0	0.6	32.0	0.19	0.07
Rice straw	y	100.0	45.0	0.98	4.4	0.6	35.3	0.21	0.08
5. Panicum maximum	x	92.0	53.0	1.20	15.4	—	26.0	0.44	0.19
Gineau grass	y	100.0	58.0	1.30	16.7	—	28.2	0.48	0.21
6. Pennisetum purpureum	x	91.0	45.0	0.98	7.7	4.1	30.5	—	—
Napier grass	y	100.0	49.0	1.08	8.5	4.5	33.6	—	—
7. Pueraria spp.	x	91.0	50.0	1.12	13.1	9.1	35.7	2.15	0.32
Kudzu	y	100.0	55.0	1.23	14.3	9.9	39.1	2.35	0.35
8. Saccharum officinarum	x	91.0	44.0	0.96	1.5	0.0	43.9	0.82	0.27
Sugar cane bagasse	y	100.0	48.0	1.06	1.6	0.0	48.1	0.90	0.29
9. Zea mays	x	90.0	45.0	1.00	2.8	0.0	32.7	0.11	0.04
Corn cobs ground	y	100.0	50.0	1.11	3.2	0.0	36.2	0.12	0.04
10. Vigna sinensis	x	90.0	53.0	1.19	17.5	13.2	24.0	1.26	0.31
Cow pea hay	y	100.0	58.0	1.33	19.4	14.7	26.7	1.40	0.35
D. *Energy Feeds*									
1. Citrus spp.	x	90.0	66.0	1.50	6.2	3.2	12.8	1.79	0.12
Citrus pulp meal	y	100.0	73.0	1.67	6.9	3.5	14.2	1.98	0.13
2. Daucus spp.	x	12.0	10.0	0.23	1.2	0.7	1.2	0.05	0.04
Carrot roots fresh	y	100.0	84.0	1.94	9.9	6.3	9.7	0.40	0.35

(Continued)

Scientific Name / Local Name	x / y	Dry Matter %	TDN %	NE (Mcal/kg)	Protein Total %	Protein Dig %	Crude Fibre %	Ca %	P %
3. Ipomoea potatoes	x	33.0	27.0	0.62	1.7	0.6	1.2	0.03	0.05
Sweet potato tubes	y	100.0	81.0	1.87	5.0	1.9	3.6	0.10	0.15
4. Manihot esculenta	x	37.0	30.0	0.68	1.3	0.2	1.7	—	—
Cassava tubers	y	100.0	80.0	1.84	3.6	0.5	4.6	—	—
5. Saccharum officinarum	x	75.0	54.0	1.23	4.4	1.9	—	0.75	0.08
Cane molasses 79.5 prix	y	100.0	72.0	1.64	5.8	2.6	—	1.00	0.11
6. Zea mays	x	87.0	71.0	1.66	7.8	4.8	8.2	0.04	0.24
Corn grain	y	100.0	83.0	1.91	9.0	5.5	9.4	0.05	0.28
E. *Protein Supplements*									
1. Peanut meal	x	92.0	70.0	1.62	48.1	—	9.9	0.26	0.62
	y	100.0	77.0	1.77	52.3	—	10.8	0.29	0.68
2. Blood meal	x	93.0	85.0	1.96	82.8	78.9	1.2	0.48	0.24
	y	100.0	91.0	2.11	89.0	84.8	1.3	0.52	0.26
3. Cows milk fresh	x	12.0	16.0	0.38	3.3	3.1	—	0.12	0.09
	y	100.0	129.0	3.04	26.7	25.4	—	0.95	0.76
4. Brewers grain	x	92.0	65.0	1.47	27.1	19.7	13.2	0.30	0.51
Brewers grain dehydrated	y	100.0	70.0	1.60	29.4	21.4	14.4	0.33	0.55
5. Cocos nucifera	x	91.0	69.0	1.56	21.3	—	14.0	0.17	0.60
Coconut meal	y	100.0	75.0	1.73	23.4	—	15.4	0.19	0.66
6. Glycine max	x	90.0	78.0	1.83	44.8	41.5	5.8	0.30	0.63
Soybean meal	y	100.0	88.0	2.04	49.9	46.3	6.5	0.34	0.70
7. Gossypium spp.	x	91.0	69.0	1.59	41.2	—	12.1	0.17	1.10
Cotton seed meal	y	100.0	76.0	1.74	45.2	—	13.3	0.18	1.21
8. Helianthus annuus	x	93.0	60.0	1.37	46.3	—	11.4	0.41	0.91
Sunflower meal	y	100.0	65.0	1.47	49.8	—	12.2	0.44	0.98
9. Meat and bone meal	x	93.0	66.0	1.51	50.4	—	2.2	10.30	5.10
Meat and bone meal rendered	y	100.0	71.0	1.62	54.1	—	2.4	11.06	5.48
10. Poultry feathers meal	x	91.0	64.0	1.46	83.2	—	1.4	0.25	0.66
Poultry feathers meal hydrolysed	y	100.0	70.0	1.60	91.1	—	1.5	0.28	0.72
11. Urea 45% N	x	99.0	—	—	275.8	—	—	—	—
281% protein equivalent	y	100.0	—	—	279.6	—	—	—	—

Source: Jamaica Livestock Association.

2.3 Nutrient Requirements of Dairy Cattle

Nutrients (concentration in the feed dry matter)	Cow Wt. kg	Lactating cow rations: Daily Milk Yields, kg				Nonlactating cattle rations: Dry Pregnant cows	Mature Bulls	Growing Heifers and bulls	Calf starter concentrate mix	Calf milk replacer	Maximum concentrations (all classes)
	<400	<8	8-13	13-18	>18						
	500	<11	11-17	17-23	>23						
	600	<14	14-21	21-29	>29						
	>700	<18	18-26	26-35	>35						
Ration No.		I	II	III	IV	V	VI	VII	VIII	IX	Max.
Crude Protein, %		13	14	15	16	11	8.5	12	16	22	-
Energy											-
NE, Mcal/kg		1.42	1.52	1.62	1.72	1.35	-	-	-	-	-
NE, Mcal/kg		-	-	-	-	-	-	-	-	-	-
NE, Mcal/kg		-	-	-	-	-	-	-	-	-	-
ME, Mcal/kg		2.36	2.53	2.71	2.89	2.23	2.04	2.23	3.12	3.78	-
DE, Mcal/kg		2.78	2.95	3.13	3.31	2.65	2.47	2.65	3.53	4.19	-
TDN, %		63	67	71	75	60	56	60	80	95	-
Crude Fibre, %		17	17	17	17	17	15	15	-	-	-
Acid detergent fibre, %		21	21	21	21	21	19	19	-	-	-
Ether extract, %		2	2	2	2	2	2	2	2	10	-
Minerals											-
Calcium, %		0.43	0.48	0.54	0.6	0.37	0.24	0.4	0.6	0.7	-
Phosphorous, %		0.31	0.34	0.38	0.4	0.26	0.18	0.26	0.43	0.5	-
Magnesium, %		0.2	0.2	0.2	0.2	0.16	0.16	0.16	0.07	0.07	-
Potassium, %		0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	-
Sodium, %		0.18	0.18	0.18	0.18	0.1	0.1	0.1	0.1	0.1	-
Sodium chloride, %		0.46	0.46	0.46	0.46	0.25	0.25	0.25	0.25	0.25	5

Sulphur, %		0.2	0.2	0.2	0.2	0.17	0.11	0.16	0.21	0.29	0.35
	Lactating cow rations					Nonlactating cattle rations					
	Cow Wt. kg	Daily Milk Yields, kg									
Nutrients	<400	<8	8-13	13-18	>18			Growing	Calf		
(concentration	500	<11	11-17	17-23	>23	Dry		Heifers	starter	Calf	Maximum
in the feed	600	<14	14-21	21-29	>29	Pregnant	Mature	and	concentrate	milk	concentrations
dry matter)	>700	<18	18-26	26-35	>35	cows	Bulls	bulls	mix	replacer	(all classes)
Ration No.		I	II	III	IV	V	VI	VII	VIII	IX	Max.
Iron, ppm		50	50	50	50	50	50	50	100	100	1,000
Cobalt, ppm		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	10
Copper, ppm		10	10	10	10	10	10	10	10	10	80
Manganese, ppm		40	40	40	40	40	40	40	40	40	1,000
Zinc, ppm		40	40	40	40	40	40	40	40	40	500
Iodine, ppm		0.5	0.5	0.5	0.5	0.5	0.25	0.25	0.25	0.25	50
Molybdenum, ppm		-	-	-	-	-	-	-	-	-	6
Selenium, ppm		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	5
Fluorine, ppm		-	-	-	-	-	-	-	-	-	30
Vitamins											-
Vit A, IU/kg		3,200	3,200	3,200	3,200	3,200	3,200	2,200	2,200	3,800	-
Vit D, IU/kg		300	300	300	300	300	300	300	300	600	-
Vit E, ppm		-	-	-	-	-	-	-	-	300	-

Source: NRC ( ):

2.4 A Proposed Strategy for Low-Cost Production of Replacement Heifers for Early Breeding: Feeding Strategy

Heifer rearing represents a relatively high-cost component of the dairy operation which produces no immediate return on investment. In addition, heifers compete with your productive milking cows for land, feed, labour and other resources. It is therefore essential that your heifer production programme be geared toward early breeding in order to reduce the length of the non-productive phase in the animal's life. In countries practicing advanced dairying it has become the convention to rear out heifers for breeding at 15 months in order that they begin lactation by two years of age. The economic advantage of this strategy is borne out by estimates which show that it would require an extra lactation to pay you back for managing the heifer to calve down at three instead of two years.

Feed represents the major cost component in heifer production. It is therefore essential that your feeding strategies be aimed at reducing the cost of producing replacements for the dairy herd. Such a strategy would have to be based upon the efficient utilisation of pasture, the cheapest feed source (or the feed resource over which you have some control), in conjunction with the rational use of concentrate to meet the nutritional requirements of your growing heifer.

For convenience, the proposed feeding strategy is considered in four distinct phases:

1. Birth to 3 months of age
2. 3 - 6 months
3. 6 - 15 months
4. 15 - 24 months

The technical feasibility of managing heifers for calving at 24 months has been established under both research station conditions, as well as in commercial practice. Your exploitation of this potential will depend largely upon your pasture and feeding management. The pasture management system being advocated is one aimed at providing a 21-28 day regrowth with grass quality of approximately 72g DCP/kg (12% CP) and 2.4 Mcal ME/kg DM

(Metabolizable Energy/kilograme Dry Matter. This would be consistent with modestly fertilised pasture, (140 units N/acre), rotationally grazed according to a leader-follower pattern. This system is such that yearling heifers are allowed a fresh paddock every one or two days ahead of pregnant heifers.

Activity L

Please refer to:

Proverbs and Quintyne (1992): A Guide to better Pastures. CARDI Fact Sheet Order # AP-F/8-83.

You should pay attention to sequencing of grazing dairy animals.

2.4.1 Birth to 3 Months (12 weeks)

A series of calf-rearing trials conducted at Bodles Livestock Station in Jamaica since 1974 has established that average daily gains above 0.4 kg/day may be attained using a range of feeding systems (Jennings and Holness, 1980). These systems involved both artificial (bucket) feeding and sucker systems. Based upon these, the following feeding strategy is proposed for the period from birth to 3 months of age:

- For bucket feeding systems - 0.4 kg milk replacer per 3.4 litres water (or 3.4 litres whole milk) fed twice per day during weeks 1 - 2 and once per day thereafter up to 6 - 8 weeks. For restricted suckling 1/2 hour suckling twice per day after milking should provide at minimum approximately 3.4 - 4.0 litres of milk.
- Introduce calf starter (approx. 0.4 kg) during week 2. Increase by 60 g per week to reach 0.6 - 0.8 kg by weaning at 6 or 8 weeks.
- From weaning to 3 months increase concentrate allocation by 120 g per week to reach 1.3 to 1.5 kg by weaning at 6 or 8 weeks.
- Introduce freshly cut grass or high quality hay *ad lib* at 2 weeks.
- Provide water and mineral lick at all times.

The target weight at 3 months would be 145-150 lbs (58-68 kg) for small breeds such as the Jamaica Hope and 190-200 lbs (86-91 kg) for Holstein cattle.

2.4.2 3-6 Months of Age

At three months you should introduce calves gradually to pasture through the allocation of clean paddocks. Continued close observation is necessary. The target daily gain during this period is 1.2-1.5 lb per day in order to reach 255-330 lbs (116-150 kg) at 6 months depending upon breed. During this period the nutritional requirements for a daily gain of 0.5 kg per day could not be met from pasture only. A supplementary concentrate (16-18% CP) should therefore be offered at 1 - 1.5 kg per head per day. In order to enhance the effectiveness of the nutritional programme during this period, parasite control is of critical importance.

2.4.3 6-15 Months of Age

By six months the calf should have graduated to full ruminant function, capable of efficiently converting grass. Therefore, your management during this period should aim at maximising pasture quality in order to support an average daily gain of 1.1 lb per day (0.5 kg per day) of grass only.

A dry matter intake of 10-14 lbs (4.5-6.4 kg) per day of good quality grass (minimum 12% CP and 2.4 Mcal ME) should sustain this level of gain so that animals would have attained breeding weight of approximately 550 lbs [250 kg] (Jamaica Hope) or 650 lbs [300 kg] (Holstein) at 15 months.

The recommended practice is to breed heifers at 60-65 percent of mature weight. The feeding strategy proposed above ensures a weight-for-age consistent with recommended practice.

2.4.4 15 Months to Calving

At this stage, if you have limitations of available pasture land, it then becomes necessary that you make the highest quality pasture available to the nutritionally more demanding junior heifers and calves.

You should target daily weight gain during this period should be 0.7 to 0.8 lb (-.3 to 0.4 kg) in order that the heifer freshens at approximately 750 lbs [340 kg] (JH) or 900 lbs [409 kg] (Hol.) liveweight. The estimated daily dry matter intake at this stage is 14-15 lb (6.4 -6.8 kg) a head for small breeds and 18-20 lbs (8.2-9.1 kg) for larger breeds. This should adequately meet the requirements for growth and early pregnancy.

During the last third of pregnancy it is suggested that you offer concentrate at 2-3 lbs per day as part of the practice of training your heifer to the dairy routine. A generalised 'steaming-up' programme is not recommended, but based on body condition and relative development, you may offer the individual heifer concentrates additional to the above amounts. It should be cautioned, however, that if you overcondition at this time, it may lead to subsequent fertility and udder problems, eventually curtailing the productive life of the animal.

2.5 Heifer Rearing for Early Breeding

Proper care after weaning is an important consideration if your heifer is to realise her potential as a good replacement for a cow or as an addition to the herd, in any exercise of increasing the herd size.

At anywhere between 9 and 12 months of age calves can be considered heifers. Your feeding programme from then to calving should make maximum use of forages to enhance ruminal development. However, the digestive system of the heifer after weaning is incapable of utilizing adequate amounts of roughage, as obtained through grazing, that will satisfy the rate of growth consistent with that which is required for realizing early breeding. It is therefore advisable that you supplement grazing with an allocation of concentrate that will the reaching of the required weight and age for early breeding.

If you rear your heifers for early breeding there are some possible advantages in management. These include:

Ü lower overhead costs

Ü greater production per month of age

Ü shorter generation interval

Ü earlier sire evaluation

In milking animals, yield economy and life time production of the cow are very important factors since early calving heifers produce more milk than late calving ones up to a certain age because they have a longer productive period. Two main factors determine the time to breed your heifers: their **age** and **size**. Several rearing experiments have shown that onset of puberty, occurs at about the same liveweight within breeds irrespective of feeding intensity. How quickly that weight is reached depends on the intensity of feeding. The ideal weight and age to breed differ among breeds, the weight ranging from 550 lbs - 850 lbs with the smaller size dairy breeds (Jersey, Jamaica Hope, Guernsey and Airship) occupying the lower end of the range and the larger breeds (Holstein and Brown Swiss) the upper end.

Similarly, there is an ideal age, ranging between 15 and 18 months, at which your heifers should be first bred in order to satisfy the objective of higher lifetime production. This is also subject to breed variation, with the breeds similarly distributed by size within the range, as above. Previous work done on the subject of rearing heifers for early breeding indicate that there exists a critical upper limit for daily gain between birth and first calving. This optimal growth rate is often stated as being between 0.5 - 0.75 kg gain per day.

It is also known that pre and post calving feeding contribute jointly towards the attainment of maximum yield in early lactation. Therefore, when the cost of feed is an economic constraint, if you have regard for the influence of feeding on the weight and age of attaining puberty and also its impact on lactation yield (all critical objectives in the rearing of your heifers for early breeding) the possibility exists for over-exploitation or under exploitation.

Therefore, it is important for you to note that you have to manage the intensity of feeding because if you do not, you run the risk of increased incidence of dystocia (difficult calving), fatty deposition in the udder which impairs milk production, breeding problems, feeding cost and reduced longevity. The concerns noted are real and justifiable. High feeding intensity leads to lower growth hormone and prolactin concentration in the blood. Since these hormones stimulate mammary development, and if development is stunted, thereby milk yield will be inhibited.

Severe underfeeding before calving reduces the level of milk production even *with* generous feeding in lactation. It also predisposes the animal to gain weight after calving at the expense of milk production. This is because as animals of most species mature, the maximum growth rate first occurs in the skeleton, later in the muscles and still later in fat deposits. For this reason it may be supposed, that the skeletal development of your underfed heifer would continue at the expenses of the development of her other tissues. Therefore, adequate pre calving and post calving feeding is very necessary in the development of the calf.

Table 5 -8. Proposed Model - Feeding Management of Heifer for Early Breeding[2]

AGE Þ	**0-3 mths**	**3-6 mths**	**6-15 mths**	**15 mths to calving**
Live Weight Range (kg)	25-75	66-110	110-250	250-350
Median Weight (kg)	45-50	80	160	295
Target Daily LWG (kg)	0.3-0.5	0.5	0.5	0.4
Protein Required (g, dcp)	160	210	280	330
Energy Required (MJ ME)	3.0	5.8	10.5	13.7
Estimated Daily DM I (kg)	2.5	1.1	10.0	14.0
Milk (Milk Replacer)	3.3 l	-	-	-
Concentrate Fed (kg)	1	1.2	-	1-1.5 for last 3 months
Estimated Grass Intake (months)				last 3 months
lb DM (kg DM)	*ad lib*	1.2	4	6.4

2 N.B. Model relates more to small breeds, such as Jamaica Hope. For he larger Friesian type cattle, a 20% increase in feed allowance is suggested.

2.6 A Proposed Approach to the Effective Feeding of the Dairy Cow

The approach to feeding dairy cows is traditionally based upon the allocation of concentrate feed retrospectively on a pro-rated basis, in addition to grazing or cut forage *ad libitum*. Forage is often assumed to contribute very little more than maintenance requirements. Grain is offered at rates which might range from 1:1.5 to 1:4 (weight grain:weight milk produced) based upon production during the preceding week. The consequence of such feeding is often reflected in very low efficiency of overall feed use.

New approaches to nutritional management of dairy cattle are based upon a consideration of the life cycle of the dairy cow, as current level of production is known to be related, not only to current nutrition but also to previous nutritional history. Thus, any efficient system of rationing cows has to consider the inter-relationship among the following:

- þ Previous lactation
- þ Dry period
- þ Early lactation (wks 1-12)
- þ Mid lactation (wks 13-30)
- þ Late lactation (wks 31-44)

Much of this will be based upon a consideration of energy requirements, as energy is often the major limiting factor in milk production. Indeed, much of the requirements for protein of a Jamaica Hope cow yielding 9 kg milk per day might easily be satisfied from good quality pasture thus:

- þ Maintenance (225g DCP[3])
- þ Milk Production (63 g DCP kg milk)

3 DCP – Digestible Crude Protein.

5.2.6.1 Nutritional Aspects of Different Stages of Productive Cycle

A general consideration of the dynamics of the production cycle is necessary for an understanding of the nutritional management of your cow. The changes taking place simultaneously during the year are represented below:

Early Lactation (wks 1-12)

Ü Milk yield rises to peak by 5 - 10 weeks;

Ü Simultaneously intake (appetite) increases at a slower rate; energy intake from feed being inadequate to support the high yields of early lactation, creates a negative energy balance. During this period energy intake is unable to satisfy the needs for maintenance and milk production.

Ü Consequently body fat is mobilised (used) reflecting a loss in body weight. Your management should be aimed at arresting this weight loss by 50 days post partum, **see** *Figure 5.1*.

Ü Your management should try to avoid early peaks in milk production (5, 6 and 7 weeks) as this would lead to an earlier decline in milk production in the mid-lactation.

Mid Lactation (wks 13-30)

Ü In the early part, milk yield is relatively stable but soon begins to decline at a consistent rate. In most feed-to-yield systems milk yield declines by about 2-1/2% (.025) per week.

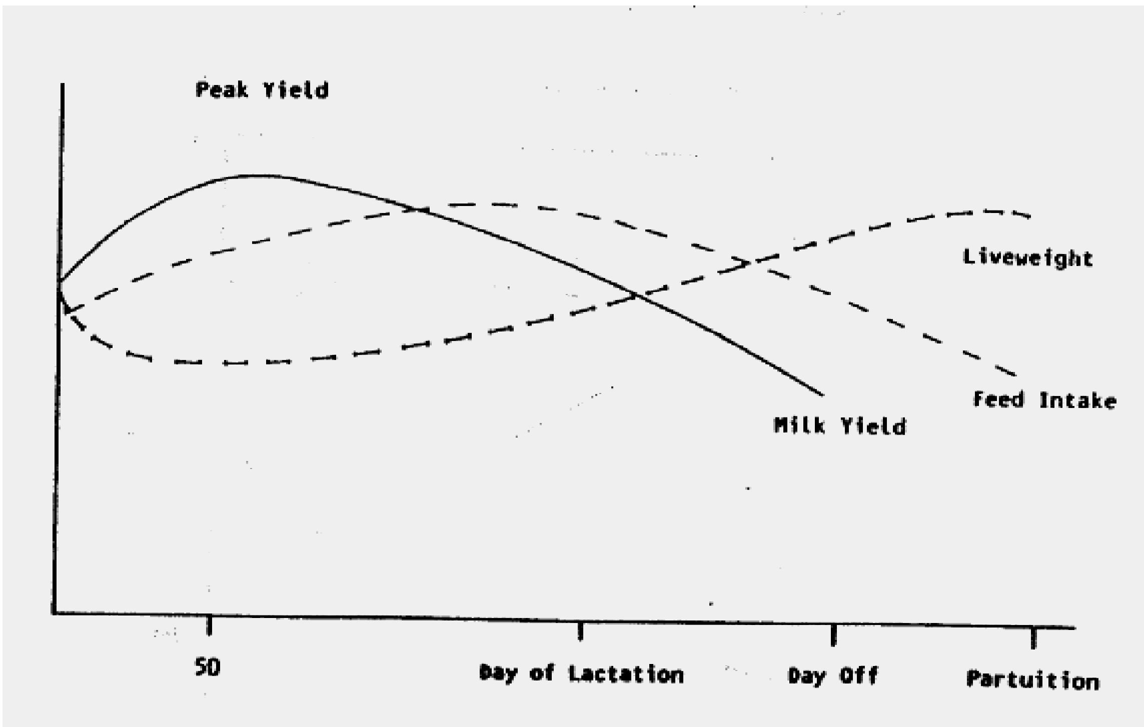
Ü Intake capacity approaches and reaches its peak at approximately 7-8 weeks after peak milk yield is attained.

Ü With increasing intake, weight loss ceases and more of the energy requirement is satisfied from feed intake. By week thirty, your cow should be in distinct positive energy balance, beginning to regain the weight lost in early lactation.

Late Lactation (wks 31-44)

- Ü Milk yield declines at approximately 2-1/2% (.025) per week.
- Ü Intake capacity exceeds requirements for milk.
- Ü Your cow begins to deposit the excess energy as body fat.

Figure 2 Relationship between Milk Production and Live-weight Changes in Dairy Cattle



2.6.2 Implications of Weight Changes During Lactation

Proper nutritional management aims to control the body weight changes of your cow in order to promote the maximum efficiency of feed energy use.

- Ü In early lactation when appetite is depressed, your high yielding cow mobilises her reserves of body fat in order to compensate for the deficit of energy from food intake. For Friesian type cows it is proposed that your cow be fed such that weight loss during the first 6-8 weeks of lactation does not exceed approximately 0.5 kg per day. For Jersey (Jamaica Hope) type cows it is suggested that 0.34 kg per day be your target.
- Ü Body weight should remain essentially stable between weeks 10-20 by which time your cow should have begun to gain weight from the excess energy intake as body fat.
- Ü Feeding during late-lactation should be sufficient to allow a weight gain of approximately 0.5 kg per day increasing to 0.7 kg per day by the time your cow is dried off.
- Ü During the dry period, the energy intake from good pasture should be adequate to sustain the level of bodyweight gain necessary for preparing your cow for the subsequent calving and lactation.

With this type of nutritional management, you obviate the need for a generalised steaming up policy and aim to exploit the greater efficiency of feed energy use for body gain during lactation.

By the time your cow is again ready to calve down she should have stored enough energy reserves for buffering the early part of the next lactation. You should use body condition scoring methods as an aid in evaluating your dairy animals during lactation.

CAUTION: Sections 5.2.6.3 and 5.2.6.4 have been included with some reluctance. But it is for those of you who have some background in Animal Nutrition.

2.6.3 Application of the Foregoing in Practical Feeding of the Dairy Cow

Taking the implications of weight changes during lactation into account, the practical feeding of your dairy cow is based upon being able to accurately predict lactation yield and then adopting a strategy for satisfying the nutritional requirements of the animal's productive cycle. It is possible for you to predict lactation yield using the following:

1. **Previous lactation yield:**
   - Ü Relationship between 1st and 2nd lactation - expected increase 8-10%
   - Ü Relationship between 2nd and later lactation - expected increase 2-5%
   - Ü Relationship decreasing as parity increases.
2. **Current lactation yield:**
   - Ü Relationship between yield (days 8-14) and peak yield 1.2 (1.3)
   - Ü Relationship between peak yield and total lactation yield approximately 200.

Having predicted lactation yield, it is then necessary for you to estimate energy requirements, energy of the content of feeds, and is estimated from the daily intake of dry matter.

ENERGY REQUIREMENTS

Maintenance (per day)

Friesian cow (1200 lb) - 63 MJ ME* (15 MCal ME)

Jersey cow (800 lb) - 40 MJ ME (10 MCal ME)

Milk Production (per kg milk)

Friesian (4% B. fat) - 5.3 MJ/kg (1.4 MCal ME)

Jersey (5% B. fat) - 6.0 MJ/kg (1.4 MCal ME)

Weight Gain (ME per kg gain)

MJ/kg (8.0 MCal ME)

Each kg body weight loss contributes approximately 28 MJ ME (6.7 Mcal ME)

ENERGY OF CONTENT OF FEEDS

Good quality pasture (60% digestible DM)

Dairy Concentrate:

MJ ME/kg DM (2.4 MCal ME/kg)

MJ ME/kg DM (2.7-3.0 MCal ME)

ESTIMATED INTAKE AS DRY MATTER PER DAY

Major Factors:

- Body weight
- Milk yield

Very complex computer models have been developed as predictors of intake involving a large range of factors.

Basic Equation:	**DMI = 0.03 LW + 0.1 MY**

2.6.4 Planning the Rationing of a Cow of a Given Predicted Yield

Once you have established your predicted lactation yield, it is only a matter of calculating the various parameters on an average daily basis and determining the proportion of pasture to concentrate required to satisfy your calculated requirements.

Now let us look at the example:

Parameters	***Example***
Type of cow:	Jamaica Hope
Average yield in 7-14 days of lactation	42 lb (19.0 kg)
Initial live weight of cow	800 lb (363 kg)
Expected average weight gain to drying off[4]	0.25 lb per day (0.1 kg per day)

4 Cow should weigh approximately 880 lb at drying off.

Calculations

þ Milk Yield

Expected peak yield	= 1.2 x 42 = 50 lb
Expected total lactation yield 200 x 50	= 10,000 lb (4500 kg)
Ave. daily milk yield	= 10,000/305 = 33 lb/d (15 kg/d)

þ Daily Energy Requirements

For maintenance	- 40 MJ ME (9.6 MCal)
For liveweight gain	= 0.1 x 34 = 3.4 MJ ME (0.81 MCal)
For milk yield	= 15 x 6 = 90 MJ ME (21.5 MCal)
TOTAL	= 133.4 MJ (32 MCal ME/d)

Note: Add 23 MJ ME (5.5 MCal for pregnancy during last 2-3 months of lactation)

þ Estimated Daily Dry Matter Intake

DMI	=	0.03 LW + 0.1 MY
	=	0.03 (363) + 0.1 (15)
	=	10.9 + 1.5
	=	12.4 kg (27 lb) DM

þ Intake of Pasture vs Concentrates

Experimental evidence suggests that from pasture alone a lactation yield of 4500 **(quarts or lbs?)** milk can be expected. Thus your feeding of your dairy cows should be aimed at exploiting the potential contribution of pasture. However, when you feed concentrates, it results in a substitution of concentrate for pasture, thereby you reduce the effective production of milk from pasture.

You need to use a very complex formula to figure out the required daily allocation of concentrate. It involves using the metabolisable energy content of the pasture and concentrate, as well as the estimated intake of dry matter. The metabolisable energy requirement is used to evaluate the expected daily intake of forage (pasture) and hence:

$$FD = \frac{\left(DM\,I\left(MC - M/D\right)\right)}{\left(MC - MF\right)}$$

Where *FD* = forage *DM I (Dry Matter Intake)*,

MC = *ME* of conc *(Metabolisable Energy of Concentrate)*

M/D = *ME* Req. *(MJ)*

MF = *ME* of Pasture *(MJ) DM I*[5]

HOW DO YOU FIGURE OUT THE FACTORS TO USE THESE EQUATIONS?

After you apply this equation, you will see that for a Jamaican Hope cow yielding approximately 33 lbs (15 kg) or 12-1/2 quarts of milk per day, her voluntary intake of pasture will be approximately 6 kg (13.2 lb) of pasture dry matter. This is approximately 50 percent of her total intake capacity of 12.4 kg (27 lb) DM. Therefore, her requirement for concentrate will be an average of 13.5 lb (6.2 kg) DM or 15.7 lb (fresh weight basis) per day. For the total lactation of 10,000 lb she will therefore require a total allocation of 4788 (~4800) lbs of concentrate.

5 Source - MAFF, 1975.

If you assume similar relationships at other levels of production, your concentrate allocations would be expected to be of the following order:

12,000 lb lactation = 5,700 lb per lactation

8,000 lb lactation = 3,800 lb per lactation

At lower levels of milk production (*i.e.,* for the 8 quart cow), we suggest that a 60:40 (grass:concentrate) ratio might be nutritionally more efficient for you to use. Therefore, your concentrate allocation would be expected to be as follows for a 6,000 lb lactation:

6,000 lb lactation = 2,300 lb conc per lactation

We emphasise that the foregoing assumes your pasture management has been aimed at making available on a year-round basis, pasture supplying on average 10 MJ ME (2.4 MCal)/kg DM consumed. In other words, **Explain.** This would mean that your pasture has an average DM digestibility of 60-65%. In order to achieve this, your pasture requires the application of adequate fertiliser and the adoption of grazing systems aimed at providing a young, leafy regrowth. It also assumes that your cow's requirements for all other nutrients such as protein, minerals, water, etc. are adequately met by the diet.

2.6.5 Feeding Strategy

Once you have calculated the concentrate requirements for the lactation, you must then decide by what system will this quantity of concentrate be allocated daily. The strategies available to you are classified as follows:

Scaled Feeding

Scaled Feeding is where the *quantity* of concentrate offered actually parallels the lactation curve. **What is the lactation curve?** You can simplify this into the following stages of lactation:

- high quantity of concentrate in early lactation
- medium quantity of concentrate in mid lactation
- low quantity of concentrate in late lactation

Flat Rate

This is easy! The Flat Rate is where you give your cow the same total quantity of concentrate in equal daily amounts throughout the lactation.

Experiments in housed systems have shown no difference in total lactation yield between the two basic strategies. However, with tropical pastures, you should choose a system which offers proportionately more feed in early lactation because it is expected to be more beneficial production-wise.

2.7 Sugarcane-Molasses Based Feeding Models

Activity L

Please turn for further reading to:

Asiedu, Francis H., Fearon, Albert L., Hosein, Aman A. and Barnes, Ralston, June 1994. *Directions for Making and Feeding Molasses-Urea Feed Blocks,* Factsheet, Caribbean Agricultural Research and Development Institute (CARDI), Order No.: AP-F/37-94.

Garcia, G.W. and Neckles, F.A., April 1983. *Feeding Sugarcane for the Production of Meat and Milk,* The Caribbean Agricultural Research and Development Institute (CARDI), University of the West Indies, St. Augustine, Trinidad, W.I. and the Sugarcane Feeds Centre, Pokhor Road, Longdenville, Trinidad, W.I.

Garcia, G.W., Neckles, F.A. and Benn, A., September 1982. *Sugarcane as a Feed for Ruminants,* Papers presented at IV Regional Livestock Meeting Regional Livestock Development Programme, Department of Livestock Science, Faculty of Agriculture, The University of the West Indies, St. Augustine, Trinidad, W.I.

Activity P

Make a molasses block using the directions provided by Asideu *et al.* (1994) above.

2.8 Preparing for Feeding in the Dry Season

Activity L

Please read the following:

Garcia, G.W. (1993). The feeding of Dairy Cattle using the Feed Resources available in the Caribbean, Guyana and Suriname. Presented at the IICA Seminar/Workshop on Dairy Cattle Production. August 20, 1993, Georgetown, Guyana.

Garcia, G.W. and Brown-O'Garro, J. (1994). Using local feed resources and strategies for year-round feeding of dairy animals in Trinidad and Tobago. Presented at the IICA Seminar/Workshop on Dairy Cattle Production. October 20, 1994, Trinidad and Tobago, WI.

Garcia, G.W. and Young, G.(1995). Strategies for the Year-round feeding of ruminant (cattle, sheep and goats) livestock in Grenada and Carriacou. Presented at the IICA Seminar/Workshop on the Feeding of Ruminants. November 1, 1995, Grenada. WI.

Activity P

Develop a dry season feeding strategy for your location.

Do's & Don'ts!

DO remember that milk production is directly affected by feed and water intake.

Highlights

What do you think was the highlight of this unit?

Conclusion

We would like you to again review this unit and make your own conclusions on what is contained herein.

Questions for Study

Activity L

1. Calculate the concentrate requirements for the total lactation of a Holstein cow weighing 1,000 lb. liveweight and producing 40 lb. milk during days 8 -14 of lactation. (Butterfat content-4%).

2. Assuming the availability of good quality grass, calculate the concentrate requirement for a Jamaica Hope heifer up to 12 months of age reared under a system aimed at first calving at 24 months of age.

3. Calculate the following:

    a) The N.E. requirements for a lactating cow weighing 1,000 lb. and producing 20 lb. milk (4% fat) during the last 2 months of lactation.

    b) The digestible crude protein requirements for a 900 lb cow producing 45 lb. milk (4.5% fat) during mid lactation.

Activity P

Activity E

References

ANON (1983): Feeding of Animals in the Caribbean: An SFC-CARDI Sponsored Workshop, 11-16 April, 1983. Editors; F. Neckles, W. Cateau and D. Walmsley.

ANON (1983): *Livestock Manual for the Tropics,* Jamaica Livestock Association, Kingston, Jamaica.

ANON (1984): *Alberta Dairy Production Course,* Alberta Agriculture Dairy Production Branch in Cooperation with Homes Study, Alberta Agriculture, Alberta, Canada.

ANON (1985): *Dairy Housing and Equipment Handbook,* Fourth Edition, Mid West Plans Service, Iowa State University, Ames, Iowa.

ANON (1991): *Cattle Nutrition Course*, Alberta Agriculture Beef Cattle and Sheep Branch and Home Study Programme, Alberta Agriculture, Alberta, Canada.

Beth, D.L.; Dickinson, F.N.; Tucker, H.A.; and Appleman, R.D. (1985): *Dairy Cattle, Principles, Practices, Problems, Profits,* Lea & Febiger, Philadelphia, Pennsylvania, U.S.A.

Jarriage, R. (Editor) (1988): Ruminant Nutrition: Recommended Allowances and Feed Tables. INRA, John Libbey, Eurotext, London and Paris.

Nelson, R. (1986): *Stockman's Veterinary Handbook,* Livestock Development Company, Georgetown, Guyana.

NRC (1989): *Nutrient Requirements of Dairy Cattle,* National Academy Press, 6th Revised Edition, Washington, D.C., U.S.A.

Payne, W.J.A. (1990): *An Introduction to Animal Husbandry in the Tropics,* ELBS, Longman, London and New York, Fourth Edition.

Accompanying Reading

Proverbs, G.A. and Quintyne, R.C. (1992): A Guide to Better Pastures. CARDI Fact Sheet Order #: AP-F/8-83. CARDI, St. Augustine Campus, St. Augustine, UWI, Trinidad and Tobago, WI.

UNIT 3 -- MILKING AND MILKING MANAGEMENT

3 Management Considerations

Quick Start h

The Learning Objectives of this unit are for you to know the various factors that will affect the management of your dairy cattle in the tropics. You will learn the factors affecting milk yield, such as heredity, age of cow, cow body conditioning, and seasonal effects. You will be able to describe a normal lactation curve and understand the methods of milking.

At the end of this unit, you should be able to practice mastitis control and practice dry cow therapy.

The Lesson I

3.1 Fertility and Early Lactation Nutrition

Most dairy production systems aim at a 12-month interval between calvings. To achieve this requires that the cows conceive between 70-80 days after calving. Various studies have shown a close association between weight changes at time of insemination and subsequent conception rates. **Therefore, it is important that you stop early lactation weight loss before the service period commences, *i.e.*, before day 60 of lactation.**

In choosing a feeding strategy it is also of importance that you pay attention to the level of feeding at this critical stage, in order to ensure that your cow is at least at a stabilised body condition at time of service.

3.2 Milk and Milk Composition (Main Groups of) Milk Constituents

Milk - a secretion of the mammary gland, is made up of two liquid phases (water and fat). Minerals, proteins and lactose (milk sugar) make up the water soluble part. The water soluble components and the fat make up the total solids. Table 5-9 shows the composition of colostrum and normal milk. The legal definition of milk varies from country to country and is based on chemical composition. In some countries the law only describes the milk of dairy cattle.

3.2.1 Factors Affecting Milk Yield and Composition

The factors can be divided into two main groups, the physiological and the environmental factors. As sources of variation in lactation yield and composition, the physiological factors are in part, genetic in origin and, in part, non-genetic in origin.

These **physiological factors** include age, heredity, number of previous lactations, stage of lactation and pregnancy.

Environmental factors are non-genetic in origin and include feed, mastitis, length of dry period, condition at calving, temperature, etc.

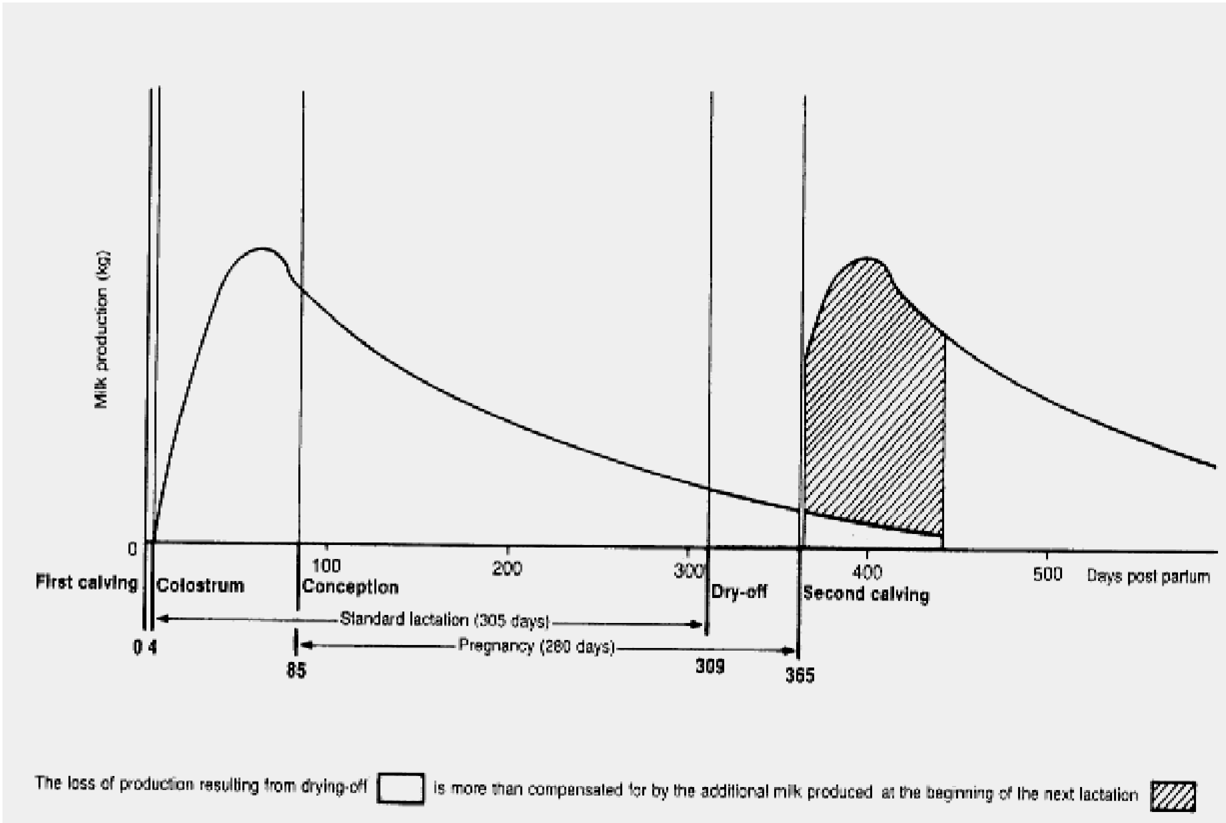
Generally speaking, you as dairyman, will be able to exercise little control over the physiological factors as opposed to environmental factors. A thorough understanding of the factors that affect the yield and composition of milk enables you to fully appreciate and evaluate the changes that take place.

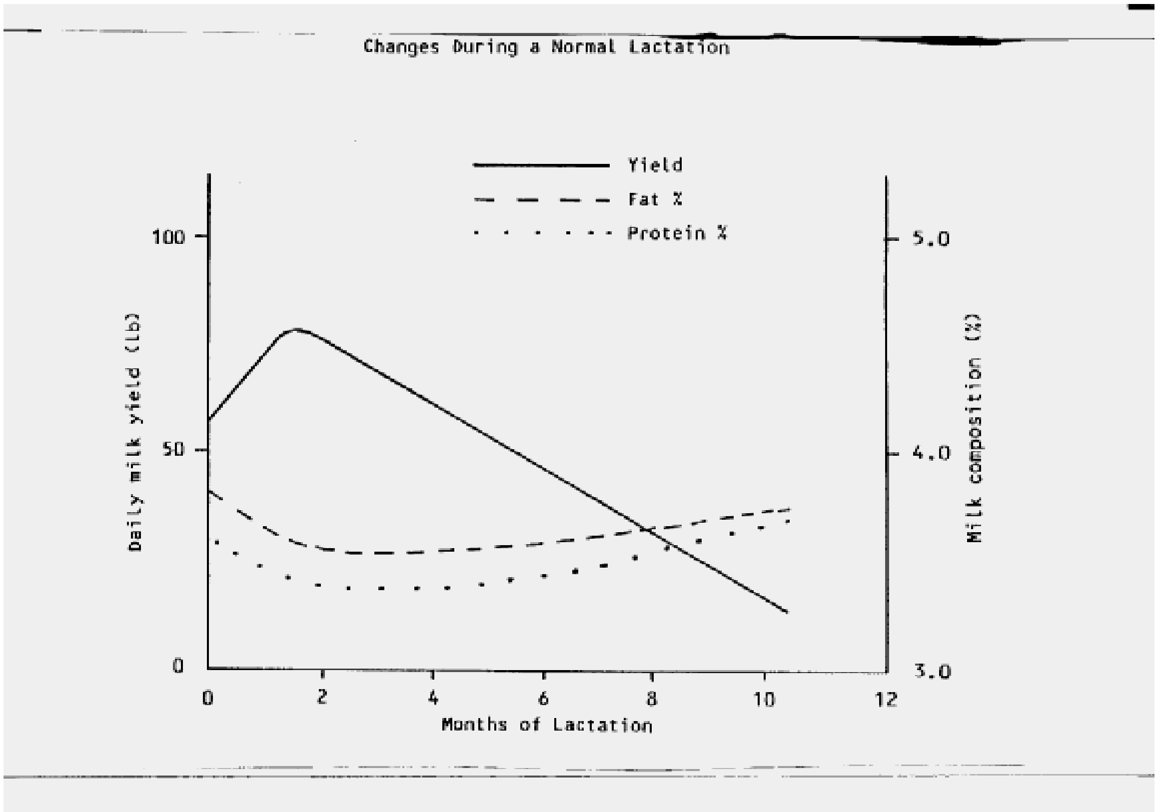
3.2.2 Day to Day Variations

Both the milk yield and the percentage composition of milk vary considerably from day to day. Generally, the day to day variation in milk yield is related to the completeness of the evacuation of milk from the udder. The day to day variations result in higher yields being accompanied by lower milk fat contents. An incomplete evacuation of milk fails to obtain the last drawn milk which is extremely high in milk fat. Experiments have demonstrated that the first drawn milk may be as low as 1% milk fat whereas the last drawn milk may be as high as 8-15%.

Between night and morning milkings, milk fat may vary as much at 1% to 15% in a 15 hr intervals. Part of this is explained by the relationship of pressure to milk and fat secretion. Part is due to the fact that exercise has a tendency to increase milk fat test. On that basis, the evening milking of cows (milked at equal intervals) will usually be of a higher fat test than the morning milking. But milking in the evening also tends to give a lower yield than morning milking. [See Figure 5.3]

Figure .3. Normal Lactation Curve for Dairy Cattle





3.3 Changes During a Normal Lactation

A Normal Lactation Curve

Figure 5.3 shows the relationship of milk yield to the milk fat and protein percentages of the milk from a cow during a normal 305 day lactation period. **<u>The cow reaches her peak production approximately 3 to 7 weeks after parturition, following which a gradual decline in yield takes place.</u>**

The peak yield of the cow is a function of:

- Ü Her body condition at the time of calving
- Ü Her lactation number
- Ü Her genetic potential
- Ü Her thermal comfort
- Ü The extent of freedom from metabolic and infectious diseases

- Ü Water availability and
- Ü The feeding regime after calving

Good body condition at calving and appropriate feeding subsequently, will help to increase the peak milk production. Owing to the high correlation between these 2 factors the peak milk production plays an important role in lactation milk production. Freedom from metabolic diseases, particularly milk fever and ketosis, allows your cow to attain high milk production.

The rate of decline in milk yield after calving measures the persistency of lactation. Your cow must have a high persistency as well as a high peak production to attain a high lactation milk yield. The rate of decline is accentuated by pregnancy. This normally occurs about the 7th to 8th month of the normal lactation, given that your cow is bred back and conceives as early as 60 days after calving.

As indicated by *Figure 5.3*, there is a general inverse relationship between the protein and milk fat percentages. As the yield increases, the percentage composition of these two constituents decreases, being at a low point during the peak lactation and then gradually increasing towards the end of lactation. The lactose content shows a very slight decline towards the end of lactation while the ash content shows a very slight increase with advancing lactation.

3.4 Colostrum

The first milk obtained after calving is colostrum and it has a markedly different composition from normal milk as shown in *Table 5.9* below.

Table 9. Comparison of the Composition of Colostrum and Normal Milk from a typical Bos taurus dairy cow

	Colostrum	% Normal Milk
Total Solids	27.5	12.8
Minerals	1.4	0.7
Protein	14.0	3.5
Fat	8.5	3.7
Lactose	3.6	4.9

The greatest differential occurs between the protein contents, with colostrum having a significantly higher protein percentage than normal milk. A large percentage of this protein is due to the globulin fraction, particularly the immuno-globulins. These carry the antibodies which can be absorbed by the intestinal tract during the first 24 hours of the calf's life. *This is a mechanism by which the newborn calf can acquire passive immunity from its dam.* The fat and ash percentages are somewhat higher than normal milk. These cause the total solids content to be approximately double that of normal milk. Also, there is a very marked increase in the Vitamin A and Vitamin D content of colostrum which is estimated to be about 20 times the content in the normal milk.

3.5 Heredity

It is well known that differences exist in the milk yield and composition among the breeds and within animals of the same breed. This is due primarily to the influence of certain genetic parameters on milk yield and milk composition. The best way of measuring and expressing the role of this influence is through the heritabilities associated with milk yield and the constituents of milk.

Heritability is defined as the portion of total variation among animals due to additive genetic variation. This is expressed as a decimal and 1.0 indicates that a character is completely controlled by heredity and that the environment has no influence on the expression of its character. Common heritability estimates are as follows:

Milk production	**=**	**0.25**
Fat percentage	**=**	**0.5 to 0.55**
Solids-not-fat percentage	**=**	**0.55**.

This demonstrates that the protein and fat composition of milk are more highly heritable than milk yield. Generally, the protein percentage follows the fat percentage and there is an inverse relationship between the yield and the protein and fat percentages.

In order to make rapid progress in the selection for a trait it must have a relatively high heritability and must have enough variation within the population so that selection for that trait can be made. A trait may be highly heritable, but if there is no variation within the population, one cannot expect to change the mean of the population.

The fat percentage of milk is much more variable than is the protein percentage, and consequently, more can be done to change the fat percentage. The protein percentage of milk is primarily responsible for changing the solids-non-fat content of milk, because the lactose and mineral compositions of milk are relatively constant.

3.6 Length of Dry Period and Body Condition at Calving

Length of the dry period and the body condition at calving are related. It has been shown than cows must be in good body condition and must have had a dry period in order to attain maximum production. This makes sense, doesn't it? Cows in poor condition at the end of lactation require a dry period in order to replenish their body reserves.

The extent of body condition at calving, however, is open to question. It is generally agreed that cows should be in good body condition at calving, however, over conditioning may be detrimental. Cows in good condition at calving will also have a slightly higher milk fat percentage than those in fair or poor body condition. The limitation to excess weight at calving is that the conversation of feed to body fat and then to milk is an uneconomical exercise. From an energy standpoint it is more economical to convert feed directly into milk. A cow that is over conditioned at calving is more susceptible to metabolic diseases, particularly ketosis. It is probably more important to have the cow in *good* body condition and willing to consume large amounts of grain at calving than it is to have her in *extremely good* body condition.

The dry period preceding lactation influences milk yield at subsequent lactation in as much as it is important in replenishing body supplies if your cow is in poor condition at calving. Cows also need a dry period to regenerate secretory tissues.

Now let us figure out what is the difference between good body conditioning and *over* conditioning, this we wold see in the next section.

3.7 Body Condition Scoring

Body Condition scoring is a technique used to visually appraise the condition of a cow and then relate it to the cow's physiological state. There are two (2) very good fact sheets on body condition scoring in dairy cattle. One is by Rodenburg (1992), and the other is by Parker (1994). This would form the basis of your next learning activity.

Activity L

Please turn for further reading to:

Rodenburg, J. (1992). *Body Condition Scoring of Dairy Cattle,* Ontario Ministry of Agriculture and Food Fact Sheet, Order No. 92-122, AGDEX 411/10. June 1992

3.8 Age of Cow at Calving

The age of your cow can be recorded as actual age or lactation number. Milk yield usually increases up to an age of 5 to 6 years (4th to 5th lactation), but this varies considerably from breed to breed.

Did you know ....

- **A first-calving cow freshening at 24 months of age will produce about 75% of the yield of a mature cow.**
- **Average figures for the 3 year old indicate that she will produce about 85% of that of the mature cow.**
- **Four and 5 year olds will produce 93% and 98%, respectively.**
- **At 8 or 9 years of age, a slight reduction in the level of milk production occurs and continues until cows die or are removed from the herd.**
- **There is some variation in breeds with the Brown Swiss maturing somewhat slower than the other breeds. In addition to the increase in milk production with age, there is a slight decrease in total solids, solids-non-fat, and milk fat percentages.**

3.9 Seasonal Effects

Temperature and Humidity

For most animals, there are slight temperature effects in the range of 40° to 75°F. **(Also give Celsius)**This temperature range in a large measure covers the comfort zone of most dairy cattle. Under conditions of higher ambient temperatures there is a slight decrease in yield, and a slight decrease in milk fat, solid-non-fat, and total solid percentages.

Temperatures above the comfort zone result in decreased milk yield. Yes, our region is above the comfort zone!

This decrease in milk yield may cause an increase in milk fat composition. A decrease in feed intake, an increase in water intake, an increase in body temperature and in increase in the respiration rate take place when ambient temperature increases.

The smaller breeds, particularly the Jersey and the Jamaica Hope, tend to be more tolerant to high temperatures than the larger breeds, particularly the Holstein.

Season of the Year Effect

The effect of season on milk production would vary from location to location. The main effects of season on milk production is due to rainfall and temperature. The temperature affects your animal's well being and comfort, and the rainfall affects forage production. You should have leant this from Section 5.2.7. If you have not done so, please go back to the learning activity of section 5.2.7.

3.10 Body Condition Scoring as a Management Tool

The best way to learn how body condition scoring can be used as a management tool to do the following Learning Activity.

Activity L

Please turn for further reading to:

Parker, R., March 1994. *Using Body Conditions Scoring in Dairy Herd Management*, Ontario Ministry of Agriculture and Food Fact Sheet, Order No. 94-053, AGDEX 410/20.

If you have not done the previous Activity L of Section 5.3.7, please do so now so that you will be able to fully appreciate Parker (1994).

Activity P

Now that you have completed the readings on Body Condition Scoring, could you please go out to a farm location of your choice and attempt to condition score up to twenty (20) cows there.

Remember you will need to get a history on each of the animals so that you could at least know their stages of lactation or number of days in milk.

3.11 Milking Operations

The milking operations constitute aspects of dairy cattle management that are fundamental to the achievement of a primary economic objective, ***the efficient production of the wholesale, saleable, clean milk***. Milk has its origin in the udder and its extraction for commercial use is normally achieved mechanically or manually. A knowledge of some of the basic facts surrounding the means by which this extraction is realised will assist in determining the efficiency of this extraction. The extraction of milk involves the udder (already described in the second module), the milking personnel, the method of milking (hand or machine) and the milking procedure.

3.11.1 The Milking Personnel

An expert Dairy man/woman is essential for the success of any dairy enterprise. This individual has to be the most disciplined, punctual and even-tempered of all the livestock workers on the farm.

The profile of a Dairy Person:

- Punctual
- Disciplined
- Agile
- Good animal husbandry skills
- Even mannered personality
- Free of Lung or Bronchial Diseases
- Should live close to the Dairy Farm

- Ü Must be able to think on his/her feet

Important things which should the Dairy Person should do on an annual basis:

- Ü be checked for TB
- Ü get a physical examination

3.11.2 The Methods of Milking

Consistency in your approach and speed, are critical elements in realising efficiency in the removal of milk from the udder. This is primarily because <u>milk letdown is a conditioned reflex which is initiated when the cow is subjected to some stimulus which she has been conditioned to associate with milking.</u> Letdown normally occurs within 30 seconds (0.5 minutes) of the stimulus, which may be suckling, handling or washing of the teats, the feeding of concentrates or even the sound of the milking machine. <u>Therefore, it is essential that you establish a regular and unchanging milking routine which stimulates letdown with some clear signal and then remove the milk from the cow as soon as possible, thereafter.</u>

If letdown is incomplete or if milking is delayed unduly after letdown commences, evacuation of the udder will be incomplete regardless of the length of the milking process or the time spent on machine stripping, ***i.e.***, manipulation, of the udder and teatcups. **<u>So, do not delay milking.</u>**

3.11.2.1 Procedure in Hand Milking

The preparation of animals to be machine milked are similar for those of animals that will be hand milked. In addition, you as the milker should adhere to strict general sanitation:

- Ü You should ensure that your hands and person are clean.
- Ü Fingernails should be kept short and clean, both as a measure to reduce the chances of micro-organisms and dirt sheltering under the nails, and to lessen the possibility of damage to the teats during milking.
- Ü Clean clothing should be worn, and
- Ü The milking bucket should be thoroughly washed and sterilised after each milking.

In hand milking, the full fist should be used, with a squeeze and release action and a slight pull towards the bucket. Avoid actions that will cause injury to the teat lining. In other words, don't squeeze the teat too hard or yank it down. All attempts should be made to ensure that dry-hand milking is practiced since wet-hand milking is almost always an unsanitary procedure.

3.11.2.2 Machine Milking

The Milking Machine

The milking machine is probably the most important piece of equipment on the dairy farm. It is used more hours per year than any other piece of equipment. The essential components of the machine are:

- Ü a source of vacuum,
- Ü a receptacle for the collection of milk,
- Ü a pulsator, and
- Ü a teatcup and liner for each teat.

In addition, hoses are necessary to attach the teatcups to the pulsator and milk receptacle and to attach the machine to a vacuum source.

Did you know !! Milk is removed from the udder by the milking machine through the application of a vacuum to the end of the teat.

To avoid damage to the teat and in order to maintain blood circulation, the application of the vacuum is interrupted by rest periods during which the teat is partially protected from the vacuum. This process of interruption is known as *pulsation*. The vacuum used for this purpose is also used to transfer the milk either to a sealed bucket or jar or by pipeline to the dairy.

The vacuum is created by a pump which extracts air from the system and discharges it into the atmosphere. It is important for the vacuum pump to be powerful enough to provide the correct level of vacuum required for milking and to generate a sufficient reserve of vacuum to compensate for the admission of air through the application and removal of clusters and milk transfer.

To allow this reserve vacuum capacity to be available when required, a device called a *regulator* is incorporated into the system. This is set to maintain the vacuum at the chosen level and is normally partially open during milking, opening further to admit air into the system when the vacuum level rises above the desired level and closing when the vacuum level falls too low. Regulators may be operated by spring or by weight, but the latter is usual.

To permit a check to be kept on both the level of vacuum and/or any undue fluctuations in it, a *vacuum gauge* is incorporated in the vacuum line, preferably where it can be seen by you/the operator during milking.

Unwanted liquids, such as the circulation wash or milk, sometimes enter the vacuum line, and to prevent them from reaching and damaging the vacuum pump, an *interceptor* or sanitary trap is fitted into the line close to the pump.

To connect the vacuum pump to the milking points, there is an air pipeline of a specified bore (25-32 mm). The pipeline is usually of galvanised steel pipe, except where it also forms part of the milking or circulation circuit. Then it will be either of glass or stainless steel. This pipeline is fitted with drain valves at its low points.

The interruption of the vacuum at the teat (pulsation) is achieved by a valve mechanism called a *pulsator*, which supplies intermittent atmospheric pressure and partial vacuum to the space between the teatcup shell and liner (pulsation chamber). When the pulsator opens the space between the shell and the liner to vacuum, equal pressures exit between the outside and inside of the liner and it takes its normal open shape. Milk flows at this phase of the cycle.

When air is introduced between the shell and the liner, the pressure increases on the outside of the liner causing it to collapse. However, the collapse is only partial, and the end of the teat is not completely sealed off from the vacuum, but milk flow ceases and the massaging effect of the collapsing liner keeps the blood circulating and prevents discomfort to your cow. Pulsators may be self contained, each with their own control mechanism or there may be one master pulsator which operates through a number of relay pulsators which transmit the pulse.

The Milking Unit

The milking unit is the complex of equipment which is required at each milking point and consists of the teatcup cluster with connections for the vacuum and pulse lines and a milk pipe to convey the milk into a bucket, jar or pipeline.

The *cluster* comprises a clawpiece and four teatcups, each made up of a shell, a rubber liner and connecting tubing. The shells are made of stainless steel and are cylindrical, with the ends adapted to suit the shape of the liner. There is a small tube in one side which connects the pulse to the pulsation chamber.

The liner is made of rubber which is either wholly or partially synthetic, since natural rubber absorbs fat and quickly loses its shape and resilience. Each liner comprises a mouthpiece, a barrel and a short milk tube. The mouthpiece should fit the teat tightly enough not to admit air but not so tightly as to cause discomfort.

The claw piece, which is usually of stainless steel, connects the four short milk tubes and the four short pulse tubes to the long milk tubes and pulse tubes. The claw piece incorporates a small milk chamber, which must be accessible for cleaning, and an air admission hole which assists the removal of milk from the cluster. The pulsator may close all four liners of a cluster at the same time (simultaneous pulsation) or close them in pairs (alternate pulsation).

Procedures in Machine Milking

Believe it or not, machine milking is regarded as the more natural method of milking when compared to hand milking since the action of the machine is thought to simulate the suckling action of the calf.

Cows are creatures of habit, and any change or upset will disturb their conditioned reflexes and milk letdown (ejection), and hence their milk production. It is therefore essential that your milking procedures be held constant as much as is possible in order to reduce the possibility of any disturbance and to enhance the possibility of obtaining the highest proportion of available milk. Remember, this is the aim of good milking routine.

The procedures in milking begin with the initial preparation for milking. This involves your bringing in of the milking animals from grazing (pastures) about two hours prior to the actual commencement of milking. This ensures that your animals are quieted down through getting adequate rest. Here the animals should have access to clean fresh water. Under some management routines the animals are fed their allocation of concentrate during this period while in others the preference is to feed the animals while they are in the process of being milked. Whatever the preferred routine, you must maintain consistency in your approach to milking.

Upon entering the milking parlour your cow's udder should be washed. Udder washing is included in a milking routine as a stimulus for milk letdown (ejection) and because the production of milk with minimum contamination requires your cow's teats to be clean at milking time. Udder washing is particularly necessary under tropical conditions where soiled teats are almost inescapable given the nature of the grazing conditions to which your animals are exposed. Udders are best washed with running water containing disinfectant and dried with a single service paper towel. (Use the paper towel one time! Saving money on paper towels will cost you more in disease, infection and the resulting decreased production.) Drying is desirable in order to avoid cow to cow transfer of bacteria. The risk of transfer remains when you wash udders *only* (and not dry them off) because this may concentrate bacteria at the ends of the teats.

It has now become a statutory requirement (a requirement by law) to remove foremilk before initiating the actual process of milking through the placement of the clusters unto the teats. This removal should be done into a strip-cup. This is a cap-like device within which is situated a platform, black in color, or a fine meshed strainer which forms the platform, with the bottom being painted black. In both cases the black color pattern serves to provide a contrast against which abnormal milk (mastitis infected milk) can become discernible by displaying the characteristic flakes normally associated with milk having such consistency (abnormal). The strainer serves a similar purpose preventing the flakes from going through, thereby displaying their presence.

Handling the teats during fore milking spreads pathogens from cow to cow. Therefore, it is recommended than smooth gloves be worn by the operator(s) of the milking machine. Their hands should be frequently dipped in a solution made from an appropriate proprietary disinfectant.

Should the milk appear normal in the fore milking process described to you above, then the vacuum control valve related to that particular cluster is turned on and the cluster attached to the teats. Simultaneously, your animals should be fed, if feeding at this time is the preferred routine. Feeding further enhances milk letdown.

The process of milk letdown is under hormonal control. *Oxytocin*, the responsible hormone is produced by the posterior lobe of the pituitary gland and has a transitory effect, the maximum effect lasting for only a few minutes (8 to 9 minutes). Therefore, to realise maximum milk withdrawal, effort should be made to complete milking within that 8 to 9 minutes.

When milking is completed, manifested by a significantly reduced milk flow or the complete cessation of milk flow as maybe observed through the milk tubes leading from the clusters, the clusters are removed from the udder. Overmilking should be avoided. Care should be taken to remove the cluster only after the vacuum has been shut off so as to prevent any reverse flow of milk which can be a source of contamination.

Bacterial transfer on teatcup liners can be much reduced by dipping the milking machine clusters in disinfectant or flushing with running water before each cow is milked. Of course, the best method is to dip the clusters in the appropriate solution and strength of disinfectant. In actual practice it is impossible to eliminate all hand contact with the udder during milking, and difficult to make practical, completely effective teatcup disinfection. Therefore, it is inevitable that some bacterial transfer to the teats will occur.

To reduce this contamination it is mandatory that teat dipping after milking should be practiced. An ideal disinfectant teat dip would destroy all pathogens on the teat skin at the end of milking, give a residual protection to deal with further contamination during the milking interval, avoid damaging healthy teat skin and assist in healing teat lesions. This can be achieved with the use of the appropriate iodine or chlorine based proprietary disinfectants.

3.11.3 Milk Hygiene and Mastitis Control

Let's take a look at how to handle milk and avoid mastitis ruining your production.

3.11.3.1 Milk Hygiene

How milk is handled is a decisive factor in the supply of a good finished product. The milk of a healthy cow contains few bacteria on leaving the udder. If good hygiene is practiced, contamination outside the udder can be kept to a minimum.

The main source of contamination of milk, apart from dirty teats and mastitis is the build-up of milk residues in the milking installation. To control this build-up requires the conscientious application of a thorough daily cleaning routine. To achieve this, you must thoroughly clean the milking equipment with chemicals and hot water.

In milking parlours and other milking facilities using pipelines, cleaning is done in-place. The equipment is dismantled only when periodic replacement of parts is required. Care must also be taken to ensure that no milk deposit accumulates on the metal and rubber of equipment used in the milking process. Since rubber absorbs fat, both the teat-cups and the rubber must be thoroughly cleaned after each use, *first with cold water and then with hot water*. **If they are cleaned immediately with hot water, the milk proteins begin to coagulate and are then difficult to remove**.

In relation to in-place cleaning there are two practical methods: Circulation cleaning, which involves three rinses, and a single stage cleaning process using *acidified boiling water*.

3.11.3.2 Mastitis Control

Mastitis is a prevalent and costly dairy cattle disease. It is generally defined as an inflammation of the udder resulting from the injection of certain micro-organisms *(Streptococcus agalactiae,* Streptococcus organisms, etc.).

The consequences of this disease are tremendous, as demonstrated by:

- **The loss of milk production due to a destruction of secretory tissue**
- **Milk that must be discarded**
- **Excessive culling rates**
- **Time loss in handling infected cows and**
- **Cost of medication**

Treatment

The control of this disease basically involves three major areas. The first and most immediate area is *treating the cow with clinical mastitis*. **Define clinical mastitis.** In this case, it is necessary to treat the cow to minimize the destruction of secretory tissue. In most cases, antibiotic therapy involving penicillin or penicillin-based products is used. The treatment of clinical mastitis with antibiotics gives good results in reducing or eliminating the clinical symptoms of the disease. However, the penicillin-based products are not effective in eliminating *Staphylococcus* organism from the udder. Penicillin-based antibiotics are relatively effective against *Streptococcus agalactiae*, and these organisms can be eliminated from the dairy herd by treatment of infected quarters and selling cows that do not respond to treatment. **Selling cows where? to other dairy farmers or for meat?**

Prevention

The two other strategies concerned in mastitis control are preventive, ***i.e.,*** reducing the exposure of cows to the pathogens and decreasing the susceptibility of the cow to the organisms. Environmental factors may play an important role in susceptibility. However, specific factors have been impossible to define. The general opinion is that there is very little that you can do in decreasing the susceptibility of the cow.

Since the environment contains most of the mastitis causing bacteria, it is impractical to try to produce milk under sterile environmental conditions. Owing to the fact that the major source of pathogenic bacteria is the udders of infected cows, considerable progress can be made by reducing the spread of mastitis-causing bacteria from an infected cow to a non-infected cow.

As already mentioned, the *major* sources of transmission are the hands of the milker and the milking machine clusters. ***Therefore, strict adherence to the appropriate sanitation regime outlined in this section should considerably reduce the possibility of transmission.***

Another important element in the control of mastitis is the ***application of an appropriate dry-cow procedure*** involving the use of an available proprietary dry cow treatment. These are antibiotics which are long-acting, thereby conferring protection against mastitis throughout the cow's dry period.

Activity L

Please turn for further reading to:

Anderson, N.G. and Cote, J.F. January 1990. *Dry Cow Therapy,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 90-003, AGDEX 410/662.

Anderson, N.G., Rodenburg,J., Stiles, R., October 1983. *Mastitis in the Dairy Cow,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 83-079, AGDEX 410/662.

Rodenburg, J., May 1990. *Mastitis Prevention: Environmental Control.,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 90-104, AGDEX 410/662.

Ward, G.G., Anderson, N.G., Rodenburg,J., Stiles, R., January 1984. *Mastitis Prevention: Milking Management Procedures,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 84-003, AGDEX 410/662.

Do's & Don'ts!

- NEVER approach a Dairy cow from behind. If you wish to inspect the udder, milk it, or attend to the mammary gland in any way, always approach from the side.

- PLEASE DO NOT hit, shout or kick the cows when they enter or leave the milking area.

Highlights

There are so many important points made in this unit that it would be unwise of us to highlight for you what we think is important. As every reader has a different background, we would like you to list for yourself what you think are the highlights of this unit.

Conclusion

Please make up a list of your own conclusions.

Worksheet -

Problem: Persistent Mastitis [**PROBLEM TO BE INSERTED!!!!]**

Questions for Study

1. Indicate the major factors affecting yield and composition of milk and, outline the specific effect of any one of these factors on yield composition.
2. What are the salient features of proper machine milking procedure?
3. List the important considerations in milking parlor design.
4. Outline procedures for effecting proper mastitis control.

Activity L

The L activities from this section need to be all properly done. If you have not done so, please do so now, or at yor next study period.

Activity P

Activity E

References

ANON (1983): Feeding of Animals in the Caribbean: An SFC-CARDI Sponsored Workshop, 11-16 April, 1983. Editors; F. Neckles, W. Cateau and D. Walmsley.

ANON (1983): *Livestock Manual for the Tropics,* Jamaica Livestock Association, Kingston, Jamaica.

ANON (1984): *Alberta Dairy Production Course,* Alberta Agriculture Dairy Production Branch in Cooperation with Homes Study, Alberta Agriculture, Alberta, Canada.

ANON (1985): *Dairy Housing and Equipment Handbook,* Fourth Edition, Mid West Plans Service, Iowa State University, Ames, Iowa.

ANON (1991): *Cattle Nutrition Course*, Alberta Agriculture Beef Cattle and Sheep Branch and Home Study Programme, Alberta Agriculture, Alberta, Canada.

Beth, D.L.; Dickinson, F.N.; Tucker, H.A.; and Appleman, R.D. (1985): *Dairy Cattle, Principles, Practices, Problems, Profits,* Lea & Febiger, Philadelphia, Pennsylvania, U.S.A.

Jarriage, R. (Editor) (1988): Ruminant Nutrition: Recommended Allowances and Feed Tables. INRA, John Libbey, Eurotext, London and Paris.

Nelson, R. (1986): *Stockman's Veterinary Handbook,* Livestock Development Company, Georgetown, Guyana.

NRC (1989): *Nutrient Requirements of Dairy Cattle,* National Academy Press, 6th Revised Edition, Washington, D.C., U.S.A.

Payne, W.J.A. (1990): *An Introduction to Animal Husbandry in the Tropics,* ELBS, Longman, London and New York, Fourth Edition.

Accompanying Reading

Anderson, N.G. and Cote, J.F. January 1990. *Dry Cow Therapy,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 90-003, AGDEX 410/662.

Anderson, N.G., Rodenburg,J., Stiles, R., October 1983. *Mastitis in the Dairy Cow,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 83-079, AGDEX 410/662.

Rodenburg, J., May 1990. *Mastitis Prevention: Environmental Control.,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 90-104, AGDEX 410/662.

Ward, G.G., Anderson, N.G., Rodenburg,J., Stiles, R., January 1984. *Mastitis Prevention: Milking Management Procedures,* Factsheet, Ontario Ministry of Agriculture and Food, Order No. 84-003, AGDEX 410/662.

UNIT 4 -- CALF REARING

4 Fundamentals of Calf Rearing

Quick Start h

Proper calf rearing is essential to maintaining the integrity of your dairy herd in as much as it provides a basis through which good replacement heifers can be produced.

The Learning Objectives of this unit are for you to know the essentials of how to rear an infant calf and the various feeding methods available.

At the end of this unit, you should be able to mix a substitute for colostrum, to hand feed a calf and to teach a calf to drink.

The Lesson /

Given below are some of the essentials of successful calf rearing.

4.1 Prenatal Nutrition

The first essential for rearing a good calf is prenatal nutrition. Ideally calves should be full of vigour at birth, and provided they are, should be <u>above</u> average liveweight for their breed. Liveweight and vigour at birth largely reflect the plane of nutrition experienced in the uterus during the last nine (9) to twelve (12) weeks or so before birth [the last trimester of pregnancy]. The plane of nutrition *in-utero* should be satisfactory in your dairy cow provided that she is receiving a diet that is not sub-optimal in energy, protein, vitamins and minerals. **If you don't remember, go back to Module 2 and review.**

4.2 Attention to Your Cow Before Calving

Attention at calving time is another pre-requisite. Where possible, approximately a week before calving, your cow should be separated from the rest of the herd and placed by herself in a suitable enclosure to calve. Where this is not possible due to a limitation in space, your cow can be placed in a clean paddock along with other cows in a similar state of gestation. With respect to the area of parturition (birthing), cleanness is emphasised because of the risk of serious disease-causing organisms gaining entrance by way of the reproductive tract. In addition, pregnant cows kept in unsanitary paddocks and pens before calving can succumb to mastitis even before they calve. So we will emphasize **cleanliness** again. Also, the danger of early infection of calves is reduced. The need for an attendant at the time of actual calving is important since it is never known on what occasion help is likely to be required. This is particularly so for first calvers. If your heifer is in labour for more than two hours then you should call your veterinarian for assistance.

4.3 Attention at Calving

If the newborn calf is not dried by its dam (by licking) shortly after calving, the attendant should dry the calf using a ***clean***, dry towel.

Also, shortly after calving (15 minutes), the calf should nurse and if unable to do so, should be assisted. It is important that the calf gets the colostrum or first milk because it has a laxative action (inducing normal functioning of the stomach) and is rich in vitamin A and antibodies which help to build up resistance to disease.

The antibodies confer passive immunity to the animal so as to protect it against the invasion of the intestinal tract by *E. coli* and other bacterial organisms. To further guard against infection, the calf's navel should be dipped in a suitable disinfectant, usually concentrated iodine. A tincture of iodine is < 10% iodine and is unsuitable., If no colostrum is available, the following mixture, which has approximately the same chemical composition as colostrum, can be made up and fed:

Artificial Colostrum

3 litres milk	1 teaspoon Cod Liver oil
1 litre warm water	2 teaspoons Castor oil
1 raw egg	

This mixture has no antibody content and you should obtain the advice of your veterinarian regarding the use of antibiotics until the calf is about 10 days of age, when it begins to produce its own antibodies.

4.4 Leave the Calf with Its Mother

Your calf should be left with the cow for two or three days where it should have access to its mother's colostrum which will form the basis of its diet for that initial period. Separating them at this age is ideal because of the following reasons:

- It reduces the chances of the calf overeating or acquiring infection and contamination from the place of birth.
- It is much easier to teach the calf to drink at this stage.
- It prevents the development of that usually strong maternal bond between cow and calf which could adversely affect milk letdown and consequently milk production, if encouraged.
- Milk being the primary economic product, it is important that the production of saleable quantities be maximised.

4.5 Teaching the Calf to Drink

One of the easiest methods of teaching the calf to drink from a bucket is to simply put one's finger in its mount, bringing head and fingers into the bucket containing the milk and then gradually withdrawing the fingers. Throughout this process, the calf should be properly restrained. If success is not obtained at the first attempt, the procedure should be repeated.

4.6 Housing the Calf

Place the calf in an individual pen or calf rearing crate after removal from its mother. The housing environment is probably the biggest drawback there is to successful rearing of infant calves. The individual pens should be dry and draught free but must have a circulation of fresh air.

The individual calf pen can range in size from 15 to 25 square feet. Solid-wall pens are optional, plywood panels usually making excellent walls. The height of the wall should be at least 36" or preferably 42" to prevent larger calves from going over the side.

In the calf pen you should have a receptacle for loose hay, as well as one for grain, and a water receptacle (cup or bucket). Where you place these items is a matter of choice or convenience but preferably, you should put the grain and water receptacles in front – inside or outside, with the hay at the rear of the pen. This should prevent contamination of water and grain by the hay. The floor should be slatted to prevent accumulation of urine and faeces in the pen.

4.7 Feeding Methods

After the calf is 3 days of age, several different feeding methods are satisfactory. The methods in common use are:

- Ü Nurse cow (multiple suckling)
- Ü Whole milk, grain, hay or green feed
- Ü Commercial milk replacer, calf starter, grain, hay or green feed.
- Ü Skimmed milk, grain, hay or green feed.
- Ü Limited whole milk, calf starter, grain, hay or green feed.

The particular system of calf rearing adopted on any dairy farm should be dictated largely by economic considerations. You, as the dairy farmer, are therefore well advised to compare calf rearing costs of all the systems available and decide on whatever is most economical under your conditions.

Let us look at the essential features of the above mentioned methods:

4.7.1 Nurse Cow Methods

This is nature's method of rearing calves. It represents the method by which, in general, the problems of stunting and disease are hardly encountered. There are many variations of this method. It could involve the separation of the calf at nights where single suckling is used, putting the calf back with the mother after milking in the morning, with the mother being milked once per day. Another approach is to utilize the residual milk after milking where the calf is allowed to suckle after each milking (Restricted Suckling).

A cow and calf system is in order where the main business of your farm is the production of pedigree stock. But where the sale of milk is your main objective it is not economically prudent to use such a method. <u>The method can be modified to become more attractive</u>

economically by adopting a multiple suckling variant. Essentially, this involves the selection of a low producing cow with good mothering ability or a group of such animals, on which groups of up to 4 calves each can be suckled.

4.7.2 Whole Milk Method

With this method of hand feeding, there is less trouble from digestive disturbances than other methods of hand feeding and it is through this method which calves tend to perform best. It involves feeding specified volumes of milk equivalent up to the calf's daily requirement (7% - 10% of body weight) twice per day for the first two weeks, and once per day subsequently, until weaning. From week 3 grain should be introduced increasing on a weekly basis. Clean, fresh water should also be introduced at this time.

4.7.3 Commercial Milk Replacer Method

This involves replacing milk entirely in the calf's ration, usually from week 2 up to the time when the calf is weaned from milk. The choice of using this method is a matter of economics, conditioned by the price of milk that is saved and sold and the cost of milk replacement. According to the product used, the manufacturer's directions should be followed. You should feed the calf the other supplements as is indicated under the whole milk method.

4.7.4 Skimmed Milk Method

Where skimmed milk is available, you may substitute it gradually for whole milk. The only difference between whole milk and skimmed milk is that the fat has been removed (or skimmed) from the skim milk. Calves can be successfully reared on either skimmed milk or whole milk. The feeding system in which you use skimmed milk powder would be the same as that for whole milk. However, you should give your calves being reared on skimmed milk, in addition to the milk, liberal amounts of good quality hay, some grain, minerals and regulated supplies of clean, fresh water.

4.7.5 Limited Whole Milk

This feeding system involves feeding your calf a limited amount of whole milk for about 3 to 4 weeks, and then shifting gradually to dry calf starter. Begin feeding the calf starter twice daily in such quantities that it will eat, increasing the amount fed with each succeeding week. Also, at week 3 you should make available regulated supplies of clean, fresh water to the calf. When your calves reach the age of approximately 7 to 8 weeks, a portion of the starter should be replaced by concentrates and the process continued gradually until the starter is entirely replaced.

4.7.6 General Management Factors

Regardless of the method used in rearing, you must consider carefully certain management factors if disappointments are to be avoided. Good quality in the feeds, regularity in feeding routine, thorough cleanliness of feeding utensils and calf pens, freedom from draughts and excessive humidity, and protection from heat and flies while on pasture are but a few of the factors that play an important role in your success at calf rearing.

Efforts should be made to reduce sucking. This habit may seriously distort the udder in the formative stage and has been known to persist even after the calves have developed and come into production. An individual calf pen can be used as a corrective measure but if not possible, the calf can be tethered for a short time after pail feeding.

Horn growth can be stopped when the calves are young by applying one of the caustic preparations available or by using electric dehorners on the developing horn buttons. Identification by tagging or tattooing should be recorded at an early age to avoid errors in recordkeeping. Extra teats are easily removed on calves and excessive foot growth should be trimmed off. A bad infestation of lice may be the cause of unthriftiness. You should examine a calf with a dry shaggy coat for external parasites. If the herd is operating under a vaccination programme, have your calves vaccinated when approximately 4 months of age.

As the calf gets older, it is important to make maximum use of forages in the feeding programme. Aim to keep your calf growing, avoiding extreme thinness on one hand and, excessive fatness on the other. You should keep water before your calves at all times. This should be fresh and clean and in a clean bucket or other container.

The age at which calves can be put out to pasture depends on the quality of the pasture, the amount of supplements that will be fed and the method of weaning practiced (early or late). Weaning can range anywhere from between 5 weeks to 4 months.

You should note that calf rearing in a dairy situation is an expensive proposition. Therefore, it is important that only those calves with promise of developing into satisfactory cows for sale or for retention for replacement should be reared.

Do's & Don'ts!

- **Try to avoid housing calves in wooden crates.**
- **Daily observation of the calf's stool, when the animals are individually housed is important for the early detection of digestive disorders and diarrhoea.**
- **Always monitor the calf's daily intake of milk and feed.**

Problam/Case: Sudden Death in Calves

Activity P

1. List the essentials of feeding, housing, and health care of dairy calves:

    a) at birth

    b) birth to weaning

2. Why is colostrum essential for dairy calves?

References

ANON (1983): Feeding of Animals in the Caribbean: An SFC-CARDI Sponsored Workshop, 11-16 April, 1983. Editors; F. Neckles, W. Cateau and D. Walmsley.

ANON (1983): *Livestock Manual for the Tropics,* Jamaica Livestock Association, Kingston, Jamaica.

ANON (1984): *Alberta Dairy Production Course,* Alberta Agriculture Dairy Production Branch in Cooperation with Homes Study, Alberta Agriculture, Alberta, Canada.

ANON (1985): *Dairy Housing and Equipment Handbook,* Fourth Edition, Mid West Plans Service, Iowa State University, Ames, Iowa.

ANON (1991): *Cattle Nutrition Course,* Alberta Agriculture Beef Cattle and Sheep Branch and Home Study Programme, Alberta Agriculture, Alberta, Canada.

Beth, D.L.; Dickinson, F.N.; Tucker, H.A.; and Appleman, R.D. (1985): *Dairy Cattle, Principles, Practices, Problems, Profits,* Lea & Febiger, Philadelphia, Pennsylvania, U.S.A.

Jarriage, R. (Editor) (1988): Ruminant Nutrition: Recommended Allowances and Feed Tables. INRA, John Libbey, Eurotext, London and Paris.

Nelson, R. (1986): *Stockman's Veterinary Handbook,* Livestock Development Company, Georgetown, Guyana.

NRC (1989): *Nutrient Requirements of Dairy Cattle,* National Academy Press, 6th Revised Edition, Washington, D.C., U.S.A.

Payne, W.J.A. (1990): *An Introduction to Animal Husbandry in the Tropics,* ELBS, Longman, London and New York, Fourth Edition.

UNIT 5 -- THE ST. STANISLAUS MODEL AND DAIRY CATTLE TARGET PERFORMANCE COEFFICIENTS

5.0 The St. Stanislaus Dairy Farm Model - Guyana

Quick Start h

This unit attempts to describe the management requirements of and a model of an intensive dairy farm for the wet humid tropics in which natural or improved pasture **[the most productive and adaptable forage species which is / are available at any given location]** is the main source of feed. The unit also attempts to present you the learner with a reasonable set of target performance coefficients for Dairy Cattle in the Wet and Humid Tropics . These targets are achievable, but there is still room for improvement.

5. 1 Introduction

This unit will focus on the **St. Stanislaus College Dairy Farm Model** which was developed by Dr. Hector Munoz of the Inter American Institute for Co-operation in Agriculture [IICA]. The St. Stanislaus College Farm, which was administered by a Farm Committee and located at Sofia, Georgetown, Guyana was established in 1975 with the following objectives:

to provide practical training for students in Agriculture and

to generate an income from its commercial operation.

At the beginning of the 1980's, the achievement of these objectives was affected by the general economic austerity measures which the government of Guyana had to undertake. Foreign exchange became expensive and the price of locally produced milk became attractive to the producers. In 1983, the Farm Committee solicited the intervention of IICA to revitalize the Farm with emphasis on dairy production. This emphasis was in keeping with the Government's policy to increase milk production and IICA established a Dairy Production Demonstration Unit at the Farm in 1984. Over the past ten years, close collaboration between **IICA and the Caribbean Agricultural**

Research and Development Institute [CARDI] resulted in the testing and promotion of the Dairy Production System on the Farm by replication of the practices developed at St Stanislaus on other farms. Reports have indicated increased farm profits as well as an unprecedented level of beneficiaries**. The National Dairy Development Project [NDDP] of Guyana** also became involved in the promotion of this Dairy Farm Management Model and this has resulted in the improvement of and increase in domestic milk production in Guyana. A joint effort between NDDP, CARDI, IICA and the St Stanislaus Farm has extended the technology to farmers. More than 20,000 acres were established with antelope grass, *Echinochloa pyramidalis*, and hundreds of farmers are using partially or completely the St Stanislaus Model technology. The methodology used in developing the approach comes from the experiences of Dr. Hector Munoz, Dr. Manuel Ruiz and Dr. Gustavo Cubillos formerly of IICA and **CATIE** in Costa Rica. It builds on the Farming Systems Model approach to Dairy Development which was developed and attempted by them in Guatemala and was reported on by Cubillos (1992) in *Dairy Development in the Caribbean Region*. CARDI, IDF and CTA, Editor Don Walmsley, 1992.

Learning Objectives

At the end of this unit you would be able to describe the management requirements of an intensive dairy farm.

You would also be able to describe and explain the St. Stanislaus College Dairy Farm Model.

You would also be able to state suitable Target Performance Coefficients for dairy production in the humid tropics.

The Lesson /

5.2. The Actual Description of the Farm as it is today

The Farm is 6.8 hectares (16.8 acres) in size, of which 5.1 hectares (12.6 acres) are being used to produce grass and the rest of the area is occupied by buildings, trenches, dams and a fish pond. The 5.1 hectare are planted with improved pastures of Antelope Grass (***Echinochloa pyramidalis***): 3.5 hectares (8.7 acres) of pasture are being used during the day on a Rotational Grazing Cycle by milking cows, dry cows and heifers and 1.6 hectares (4.0 acres) are dedicated to calves and afternoon grazing of the milking cows. The remaining 0.1 hectares (0.3 acres) if grass is used as a Cut-and-Carry System for a Sheep Production Unit.

In 1983, the Dairy Herd consisted of three (3) cows, two (2) heifers and one (1) bull calf. Up to December 1993, the animal inventory of the farm was composed of twenty (20) cows, two (2) heifers, nine (9) heifer-calves, one (1) breeding bull and one (1) bull-calf.

The Basic Physical Model of the *St. Stanislaus College Dairy Farm*

Table 1 shows that the physical makeup of the farm is 75% improved or adapted pasture.

Table 1 The Basic Physical Model of the St. Stanislaus College Dairy Farm Model

PHYSICAL FEATURE	AREA (ha.)	AREA (ac.)	% of TOTAL AREA
IMPROVED PASTURE	**5.1**	**12.6**	**75%**
[Paddocks for Rotational Grazing of Milking cows, Dry cows and Heifers]	[3.5]	[8.7]	[35 %]
[Paddocks for Rotational Grazing of calves and afternoon grazing of Milking cows]	[1.6]	[4.0]	[46%]
[cut and carry for sheep]	[0.1]	[0.3]	[2.3%]
BUILDINGS, DAMS, TRENCHES POND and ROADWAY	**1.7**	**4.2**	**25%**
TOTAL	**6.8**	**16.8**	**100%**

The Technology Behind the Model

The technology behind the model consists of three (3) components as follows, **Feeding, Herd animal Management,** and **Production Infrastructure.**

Feeding

Feeding is based on the controlled grazing of improved pasture of Antelope [*Echinochloa pyramidalis*] grass **the most adapted and productive grass suited to that area.** <u>If you were developing a system for another area you would choose the grass or combination of forages [grasses and legumes] which are best suited to the area you are developing.</u>

Remember: ***a forage species which may grow well in one region will not always perform as satisfactory in another region.***

The animals are grazed on a 25 - 28 day rotational grazing cycle with the use of local by-products to supplement animal feed (e.g. wheat middling or rice bran). The arithmetic behind the model of the grazing system is presented in Table 2.

Forage conservation is also practiced by making silage for use in the dry or during the very wet seasons.

Table 2: THE MODEL OF THE GRAZING SYSTEM

ITEM	#	AREA [ha.]	AREA [ac.]	% of TOTAL AREA
PADDOCKS				
[28 paddocks grazed 1/day on a28 day cycle; + 4 Paddocks for Conservation and other]	**32**	**5.1**	**12.7**	**75%**
AVERAGE SIZE PER PADDOCK		**0.16**	**0.40**	**2.4%**
AVERAGE # OF ANIMAL UNITS	**28.6**			
TOTAL PASTURE		**5.1**	**12.6**	
STOCKING RATE [Animal units / unit area]		**5.6**	**2.3**	
STOCKING RATE OF EACH PADDOCK [Animal units/ area/ day]		**170**	**71**	

5.3 Herd Animal Management

The animal herd management system involves the use of a milking machine for more hygienic and uniform milking; twice-a-day milking with no calf stimulation; a health and fertility testing program; a record system to monitor performance of each animal and the herd; and calf rearing with bucket-feeding with weaning at 8 weeks.

5.4. Production Infrastructure

The production infrastructure consists of the following:

Solar electric fence to control grazing of pasture;

Milking parlor;

Cow and Calf pen;

Milk room;

Silos for forage conservation.

Electric Fencing Equipment is available out of the NASCO Farm and Ranch Catalogue. You could also read any suitable publication on Electric Fencing. one such publication is Anon (1976): Electric Fencing Ministry of Agriculture, Fisheries and Food ; Bulletin # 147, Her Majesty's Stationary office , London.

The solar electric fencing system is an inexpensive way for you to manage paddock sizes for controlled grazing without the need for putting down expensive fence posts and fencing infrastructure.

FEEDING	HERD ANIMAL MANAGEMENT	PRODUCTION INFRASTRUCTURE
- Improved pasture Fence	- Twice a day milking	- Solar Powered Electric
- 25 to 28 day grazing	- Herd Health Program	- Milking Machine
cycle	- Fertility Testing Program	- Milking Parlor
- Annual Stocking rate:	- Record Keeping System	- Maternity Pens
6 animal units per hectare	- Bucket Feeding of Calves	- Calf Pens
- Supplementary feeding	- Weaning at 8 weeks	- Milk Room
to high milkers	- Sale of bull calves 3-7 days old	- Silos for Conservation
- Forage conservation for	- Natural Service or AI	
dry season		

Figure 1. ...The Technology behind the St Stanislaus Dairy Farm Model

The Usefulness of the Model in Guyana

The Model Dairy has been successful in demonstrating the economic benefits from the use of simple, appropriate dairy production technology. Over the past ten years, the St. Stanislaus Dairy Demonstration Unit has achieved significant improvement in production and productivity. The information collected at the Farm indicates that production, reproduction and productivity of the Dairy Unit have been improved. **Table 4** shows some parameters that were improved over the last ten (10) years.

Principal areas of achievement of excellent animal performance under Guyana's harsh coastal grazing conditions may be summarized as follows:

Excellent performance of cows under coastal grazing conditions with an "Average Milk per Cow per Day" over 9.0 litres (2.0 gallons) with minimal input of supplemental feed (Guyana's national average is less than 1.0 gallon).

Total dairy farm milk production of over 131 litres (29 gallons) produced from an average of 15 cows milked daily, year-round.

Milk production per hectare per year of over 9,000 litres from a total of 5.1 hectares of Antelope grass pasture, a level of production which has more than exceeded the national average for native grass.

High stocking rate as much as 6.0 Animal Units per hectare compared to the traditional rate of less than 2.5 per hectare.

Improvement in individual animal herd performance due to vigilant monitoring with a good recording systems, a good herd health program, with an emphasis on the minimal use of drugs.

Excellent performance of heifers born and raised on the farm.

The improved dairy production technology generated by the IICA project has been used to train personnel in different production areas. The farm is utilized by farmers as well as students from secondary schools, universities and agricultural training institutions which need a functional commercial dairy farm for training in their respective programs. Training on the Farm also targets special groups such as personnel from agricultural credit and financial institutions, agricultural extension organizations, and entrepreneurs involved in supplying inputs for livestock development.

Using the St. Stanislaus Dairy Model, the IICA project has provided support to the National Dairy Development Program (NDDP) by transferring the technology to their technicians and farmers. Dairy farmers on coastal Guyana have completely, or partially, adapted the St. Stanislaus model to their farms. Many of these farmers presently utilize one or more of the components of the system as a result of exposure to the St. Stanislaus Dairy Production Model.

These components include Antelope grass pasture, rotational grazing system (with or without a solar-electric fencer), improved milking procedures (with or without a portable milking machine), a herd health management system, a simple pen design and record keeping.

An Animal Equivalent.

1 Animal Unit = AU = an 880 lb Cow = 1 Mature Cow

5.5. The St Stanislaus Model Universally Simplified

The farm situation would differ from place to place, the number of animals , the area of land available and other parameters. In order for the model to have some universality Table 3 was developed. It attempts to simplify the model for an area with the rainfall type available on the coast of Guyana. Adjustments would therefore have to be made for each location based on rainfall.

Table 3: The St Stanislaus Model Universally Simplified

ITEM	% OF AREA	#	ANIMALS [/ ha.]	ANIMALS [/ ac.]
IMPROVED PASTURES	75%			
OTHER	25%			
	% OF TOTAL			
HERD STRUCTURE				
- Cows in Milk	46.2			
- Dry and Pregnant Cows	15.4			
- Pregnant Heifers	12.4			
- Year Old Heifers	12.4			
- Heifer Calves	12.4			
- Serving Bull and Bull Calf	1.2			
- Total	100%			
STOCKING RATE				
[Animal Units / unit area]			5.6	2.3
STOCKING RATE:				
DAILY GRAZING OF				
PADDOCKS				
[Animal Units / unit area]			171	71
PADDOCK SIZE / 100 Animal Units			0.58	1.4

Table 4 St. Stanislaus College Farm Summarized Data 1983 - 1993

Parameters	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total Milk Production	2,430	16,901	24,331	24,516	31,718	38,588	40,060	42,851	43,966	50,409	47,909
Av. Lactation length/year (days)	426	232	256	249	236	233	294	290	351	308	286
Av. Milk/Cow/Lactation (l)	1,215	2,066	2,044	2,199	2,218	2,173	2,626	2,765	3,155	2,948	2,633
Av. Milk/Cow/Day (l)	4.5	8.5	7.3	7.8	8.6	9.0	8.8	9.0	9.0	9.7	9.1
Av. No. Cows Milked/Day	-	6	9	9	10	11	12	13	13	14	15
Milk Production/Ha (l)	714	3,930	5,688	5,701	6,219	7,566	7,855	8,402	9,237	10,502	9,394
Stocking Rate (AU/Ha)	1.1	2.7	3.8	4.0	4.8	5.2	5.2	5.8	5.7	5.9	6.5
Calving Interval (Days)	-	455	367	360	340	352	368	356	441	374	384
Open Days	-	158	101	78	72	57	102	103	155	95	82
Av. No. of Services/Conception	-	1.2	1.1	1.0	1.2	1.0	1.8	1.2	1.9	1.7	1.5
Total Animal Units (AU)	-	11.5	16.3	17.3	24.3	26.5	26.6	29.0	27.2	28.5	33.4

Source: Supporting the Development of Livestock Production Systems in Guyana - IICA Project

1 Litre (l) = 1.7 pts. milk 1 Animal Unit (AU) = 880 lb. animal

5.6. Whole Farm Expenditure Pattern

Table 5: Whole Farm Expenditure Pattern

EXPENDITURE ITEM	1996 % of Total	1995 % of Total
Fuel	2.6	1.7
Wages	39.8	31.8
National Insurance	2.7	1.7
Feed and Medication	16.4	28.4
Rates and taxes	0.0	0.9
Light and power	3.0	5.9
Maintenance Equipment	14.7	10.4
Maintenance Land and Building	2.3	6.3
Misc.	3.4	3.8
Bank Charges	0.0	0.0
Audit Fees	2.4	2.0
Depreciation	0.8	1.0
Bonus	2.9	5.4
Telephone	0.6	0.3
Livestock Maintenance	8.3	0.0
Total Value	$1,869,940.0	$1,670873.4
REVENUE		
Cows	$262,000.	$83,000.
Milk	$2,873,552.	$2,461,641.
Sheep	$102,300.	$0.
Total	$3,247,852.	$2,544,641.
REVENUE- EXPENDITURE		
Total	$1,377,912.0	$873,767.6
as a % of Expenditure	42.4%	34.3%

Table 6: Nature of Milk Sales and Revenue from Milk.

Milk Sales	1996	1995
Value of Sales @ $200.00 G$/ gall	$2,873,552.0	$2,461,641.0
Volume of Milk Sold[Gallons]	14,367.8	12,308.1
Milk Sales / day [Gallons]	39.4	33.7

5.7 Target Performance Coefficients

The target performance coefficients are presented in Table 7 below each coefficient where data has been available from either the St Stanislaus Farm (Guyana) or the Sugarcane Feeds Centre (Trinidad) the information is presented in brackets respectively as ( ) or [[ ]] respectively.

Table 7 Target Performance Coefficients for Dairy Cattle

DAIRY CATTLE	
PARAMETER	**Suggested** **(achieved St Stanislaus)** **[[Achieved SFC]]**
Age at First Calving	24 - 30 months **[[27]]**
Age at First Service	15 - 21 months **( ) [[ ]]**
Calving Interval	12 - 13.5 months **(13.6) [[ ]]**

Weight at First Service	550 LB (JH) 650 - 700 (HOL)
	( ) [[ ]]
Service / Conception	1.3 - 1.8
	(1.4) [[ ]]
Bull to Cow Ratio	1:30-40 (Mature)
	1:12-15 (Young)
Number of Days Open	60 - 90
	(100) [[ ]]
Calving Rate	85 - 90%
Mortality Rate	
Calves	10 - 12%
Yearlings	2%
Mature Animals	1%
Culling Rates	
Cows	15 - 20%
On First Lactation	20 - 25%
Percentage Cows in Milk	80 - 85%
Lactation Length	280 - 305 days
	(301) [[ ]]
Milk Production (litres / lact)	**(2483) [[ ]]**
Milk Production (litres / Ha)	**(7450) [[ ]]**
Milk Production (litres / cow / day)	**(8.3) [[ ]]**
Milk Production (litres / day)	
Wk. 1-13	
JH or Jersey	
CB Holstein	
Wk. 14-30	
JH or Jersey	
CB Holstein	
Wk. 31-40	
JH or Jersey	
CB Holstein	

Calf Birth Weight (kg)	
JH or Jersey	20-26 kg
CB Holstein	35-40 kg

Do's & Don'ts!

Do not just think that the model is repeatable everywhere as it is. The model has to be adjusted to suit the rainfall conditions of your environment as rainfall is the major constraint to forage production.

Highlights

The Model is being actively promoted throughout the Caribbean. Farmers, technicians and students in the Caribbean have returned home to apply the principles [which they had experienced at the Farm] to their own dairy operations. Following the construction of a new Dairy Training Centre on the farm, practical applications of this successful dairy model have continued to be transferred to farmers, agriculture students and technicians via in-service training, special demonstrations and farm visits.

Conclusion

The dairy technology promoted by the IICA Project and adapted by St. Stanislaus Farm has contributed to increased and improved production, as well as to the good financial status of the Farm and of the Farms of the Farmers who adopted the Technology. The success of the St. Stanislaus Dairy Model has contributed to the smooth and fast dissemination of the technology promoted by the IICA Project. The training of farmers, students, farm and technical personnel has been more complete and productive through the use of a real and on-going productive dairy system.

Questions for Study

What is an animal unit?

Of what use is this knowledge to the Dairy Farm Manager ?

Do you think that any information is missing from the Universal Model described ?

Design a Dairy farm Using the information provided in this unit and the rest of the module. You are to assume that the area you have available is 30 acres (12.2 ha.) of gently sloping land. Design it for the climatic regime and soil conditions for the area in which you live.

References

Anon (1983): Feeding of Animals in the Caribbean: An SFC-CARDI Sponsored Workshop, 11-16 April, 1983. Editors; F. Neckles, W. Cateau and D. Walmsley.

Anon (1983): *Livestock Manual for the Tropics,* Jamaica Livestock Association, Kingston, Jamaica. [Out of Print]

Anon (1984): *Alberta Dairy Production Course,* Alberta Agriculture Dairy Production Branch in Cooperation with Homes Study, Alberta Agriculture, Alberta, Canada.

Anon (1985): *Dairy Housing and Equipment Handbook,* Fourth Edition, Mid West Plans Service, Iowa State University, Ames, Iowa.

Anon (1991): *Cattle Nutrition Course,* Alberta Agriculture Beef Cattle and Sheep Branch and Home Study Program, Alberta Agriculture, Alberta, Canada.

Beth, D.L.; Dickinson, F.N.; Tucker, H.A.; and Appleman, R.D. (1985): *Dairy Cattle, Principles, Practices, Problems, Profits,* Lea & Febiger, Philadelphia, Pennsylvania, USA

Chamberlain, A. (1989): Milk Production in the Tropics, Intermediate Tropical Agriculture Series, Longman, Singapore.

Munoz, H., Davis, P and Mansaram, M. (1994): Supporting the Development of Livestock and Production in Guyana and Suriname. IICA Project - A Farm Profile: St. Stanislaus Demonstration Unit.

Nelson, R. (1986): *Stockman's Veterinary Handbook,* Livestock Development Company, Georgetown, Guyana.

NRC (1989): *Nutrient Requirements of Dairy Cattle,* National Academy Press, 6th Revised Edition, Washington, DC, USA

Payne, W.J.A. (1990): *An Introduction to Animal Husbandry in the Tropics,* ELBS, Longman, London and New York, Fourth Edition.

Accompanying Reading

Appendix #1: Michigan Dairy Breeding and Health Record System Card Template.

Appendix #2: Monthly Dairy Report used at the UWI Field Station by G.W. Garcia.