CHAPTER 4

REQUIREMENTS OF ARTIFICIALLY REARED BEEF CALVES TO AGE 6 MONTHS
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Summary
The feeding and management requirements of artificially reared calves aged 4 days through to 6 months are described.

Critical features of 4-day-old calves are that they:
• Must have had adequate colostrum at birth. Tests indicate many 4-day-old calves have had less than adequate colostrum, which is critical to their good health through to weaning
• Ideally, weigh 40+ kg and never less than 35kg. Light calves grow slower than heavy calves
• Have digestive systems similar to those of monogastric animals until they have developed their rumen. Rumen development, therefore, is the key to enabling young calves to eat grass
• Can be fed on restricted milk diets, but with good access to good quality pasture and meal, thereby costing less to rear and wean successfully
• Can be weaned at 63kg at about 6 weeks of age (Friesian and Friesian cross breeds) and should reach 100kg at about 12 weeks of age
• Most commonly suffer deaths and ill health due to scouring and subsequent dehydration. Calves that are reared in good facilities and have had good colostrum within 24 hours of birth seldom get scours.

From 12 weeks to 6 months of age, the young calf must be offered high quality pasture with ready access to good water. A carefully organised animal health management plan should keep animal health problems to a minimum. Well-fed young animals are more able to withstand disease.

Introduction
Calves for beef production are derived from two sources:
1. Calves reared ‘artificially’ on whole or reconstituted milk and meal from 4 days of age and weaned at approximately 8 to 10 weeks of age. These
calves are sourced almost entirely from the dairy industry and are, typically, Friesian or Friesian cross bull calves weighing about 100kg.

2. Calves reared on breeding cows or other suckling cows and typically weaned at 150 to 250 days of age, weighing 200-300kg.

This chapter discusses the feeding and management requirements of artificially reared calves from 4 days of age. Much of the information presented on the management of these animals through to weaning has been derived from research and extension material based on work carried out by Paul Muir and Alistair Ormond of Poukawa Research Station, AgResearch, Hawkes Bay, New Zealand.

For suckled calves, their starting point is taken as weaning at 150-250 days of age. Rearing of suckled calves to weaning is an integral part of the management of breeding cows and is treated as a separate topic not covered in this book.

Requirements of the artificially reared calf from birth to weaning

The newly born calf and colostrum
The newborn calf must drink at least 2 litres of colostrum from its dam, or from another freshly calved cow, within 48 hours of birth and preferably within 24 hours. This is because it has a “naive” immune system. This period of immune naivety lasts for the first 6 to 7 weeks of the calf’s life. In the natural situation, protein antibodies delivered from the cow to the calf via colostrum cover this period of naivety. For the first 48 hours of a calf’s life, its digestive tract is able to absorb these large protein molecules undigested. This provides passive immunity for the calf for the above 6 to 7 week period until the calf’s own immune system becomes fully functional. Calves which do not drink enough colostrum at this stage, will be much more susceptible to infectious diseases, such as scours and pneumonia, and are less likely to survive, or grow rapidly, than normal calves.

Never assume that purchased newborn dairy calves will have had adequate colostrum. A recent meat company survey of slaughtered bobby calves found that 40% of calves had inadequate colostrum. If in doubt, calves can be blood tested for immuno-gamma-globulin levels.

The calf’s requirements for liquid feed after these first one to two days of life can be satisfied by various other feeds including fresh whole-milk, stored colostrum, acidified milk or milk substitutes, or reconstituted milk powders.

The rumen of the new calf
The newborn calf has only a very small rumen of approximately 1 to 2 litres capacity compared to the 25 to 30 litres capacity that it will have in later life.
Effectively at this early stage, it is a monogastric much the same as a pig and human. However, the calf’s rumen can enlarge very rapidly in the first few weeks of its life given the correct feeding management. Ensuring this happens is the objective of most artificial calf rearing programmes. The sooner the calf is able to graze forage rather than needing expensive milk and meal, the cheaper it will be to rear.

Rumen development, therefore, is the key to successful calf rearing. There are two critical factors governing rumen development. Firstly, the calf must start using and developing its rumen at as young an age as possible and secondly, what the calf eats when it is starting to use its rumen must be easily digested. Roughage is the key to establishing a large rumen as quickly as possible. It should be offered along with high quality, readily digestible concentrates, which should have at least 20% protein content in them and have an available energy density of more than 12 to 13 MJ ME/kg DM.

Calf rearing systems, rumen development
Calves for beef production may be successfully reared artificially in a large number of different ways using a variety of feeds and feeding levels. The particular system used is usually governed by factors such as the cost of feeds and the availability of labour. Milk and milk substitutes are expensive and so are often fed at restricted levels. This also encourages the calf to eat solid feeds thereby developing its rumen.

The feeding of liquid feeds can also be labour intensive. This provides an incentive to wean early onto pasture, sometimes with the aid of a transitional period on concentrates. Calves fed restricted milk at between 4 and 5 litres per day, but with good access to good quality pasture, will wean slightly lighter than those calves which are fully fed milk right from the start. However, the intake of pasture will be inversely related to milk intake so that while calves on restricted levels of milk grow a little more slowly, they are also less likely to show a check in growth rate at weaning, than those that are fed milk to appetite.

The reason for the above weaning check is usually related to rumen development. Calves fed on ad-lib milk or high-milk rates will have an underdeveloped rumen at weaning compared to their restricted-milk contemporaries. The undersized rumen does not have the capacity to digest large quantities of grass. Therefore, when these calves are taken off milk, they suffer post weaning stress, leading to weight loss and an increased susceptibility to diseases such as pneumonia and coccidiosis. A calf on a restricted milk regime during the first few weeks of life is encouraged to eat roughages, which develop its rumen and get it off to a much better start at weaning time. The aim is to provide enough milk energy to sustain growth, aided by high-energy concentrates, and yet keep the calf hungry enough to encourage the intake of
roughages in sufficient quantity to adequately develop the rumen prior to weaning. See details below.

The development of the calf’s rumen occurs through growth of rumen papillae on the rumen wall. These papillae are leaf-like structures on the internal surface of the rumen and they increase the surface of the rumen and hence its ability to absorb the end products of microbial digestion, particularly volatile fatty acids which are the energy fuel of adult ruminants grazing pasture.

Straw and stalky hay are the best roughages for rumen development because of their physical stimulation of the developing rumen wall. Spring pasture is acceptable, but is not the ideal roughage source for calves, as it has too little fibre, is high in water content and has a low energy density (on a wet weight basis) for the young calf. Until their rumen capacity is larger, young calves just cannot eat enough pasture, unless it is very high in quality. Hence the need for access to ad-libitum high protein, high energy concentrates or meal. Roughages therefore, stimulate rumen development, while concentrates, usually grain derived, supply the feed nutrients for growth.

**Essential nutrients for calf growth**
The three most essential nutrients for calf growth and development are water, energy and protein. Fibre, minerals and vitamins are also important but play a smaller role.

**Energy** is needed to maintain body temperature and support normal body functions otherwise known as maintenance energy requirements. Any energy consumed which is surplus to the basic need of the animal, is available for growth, that is, for the laying down of muscle, bone and fat and expressed as liveweight gain.

**Proteins** are required by the calf to maintain biological processes on a daily basis, as well as repairing tissues and forming blood. They are also an integral part of growth such as the laying down of muscle. Young calves are growing rapidly relative to their body size and so have a high demand for protein: hence the need for high protein concentrates in their diet, if adequate protein is not available from restricted milk.

**Water** is essential for all animals and it is good husbandry to provide calves with as much fresh water as they need. When calves start eating solid feeds such as concentrates or dry feeds like hay or straw, they require continuous or regular access to fresh water. In turn, this helps increase their intake of solid feeds, which further speeds up rumen development. Calves will drink 3 to 6 litres of water for every kg of dry feed consumed.
Under the right conditions, rumination, or cudding can occur in the calf at about 2 weeks of age. It is a good indication that rumen development is underway. Solid feeds and rumination both stimulate saliva production and this supplies chemicals such as ammonia and sodium bicarbonate to provide a well-buffered environment in the rumen, which is required for optimal growth of rumen microbes.

**Restricted milk feeding regimes for calves**

Restricted milk feeding programmes, as described above, are designed to encourage the calf to eat solid feed and develop its rumen at the youngest age possible. Every time milk is fed to a calf, the calf lies down and sleeps while it digests the milk. The more often or the greater the amount of milk fed to the calf, the longer the calf is left feeling full and therefore less likely to be interested in consuming dry feed. The once-a-day milk feeding system is the greatest asset available to assist the early consumption of dry feed. The amount of nutrients supplied in a single feed of milk can be calculated so that it supplies enough nutrients for maintenance and modest growth, but leaves the calf feeling hungry later in the day. This is the time when calves will seek out solid feed to satisfy their appetites. The use of a smaller amount of milk at a greater concentration also encourages intake of solid feed. This is the basis of restricted-milk calf rearing systems including the “Poukawa Research Centre Milk Feeding System” described below.

**A cost effective calf rearing system**

The following is based on Poukawa Research Centre’s recommended system for rearing calves developed by Paul Muir and others (see “Further Reading”). It involves feeding concentrated milk-replacer once a day for five weeks as shown in Table 1.
Table 1: A recommended programme for feeding milk replacer (litres) to calves based on results from Poukawa Research Centre. Note: \(2 \times 1 = 2\) feeds per day each of 1 litre; \(1.5 = 1\) feed per day of 1.5 litres. The milk replacer is mixed at 200g/litre.

<table>
<thead>
<tr>
<th>Age (Days after arrival)</th>
<th>Calf size</th>
<th>weight range at 4 days old</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small (&lt;37kg)</td>
<td>Medium (37-43kg)</td>
</tr>
<tr>
<td>1 - 2</td>
<td>(2 \times 1)</td>
<td>(2 \times 1)</td>
</tr>
<tr>
<td>3 - 5</td>
<td>(2 \times 1)</td>
<td>1.5</td>
</tr>
<tr>
<td>6 - 9</td>
<td>(2 \times 1)</td>
<td>1.75</td>
</tr>
<tr>
<td>10 - 12</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>13 - 16</td>
<td>1.75</td>
<td>2.25</td>
</tr>
<tr>
<td>17 - 20</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>21 - 24</td>
<td>2.25</td>
<td>2.5</td>
</tr>
<tr>
<td>25 - 35</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>36 - 42</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>43 - 49</td>
<td>2.5</td>
<td>Weaned</td>
</tr>
<tr>
<td>Total milk replacer per calf (kg)</td>
<td>21.8</td>
<td>19.1</td>
</tr>
</tbody>
</table>

Additional features of the programme include:

- High protein calf pellets fed to appetite up to a maximum of 1.5kg per calf per day at 12 weeks of age. Calves should not be weaned off milk until they are consuming at least 1 kg DM/day of calf pellets.
- Calves must be allowed access to pasture from a minimum of 4 weeks of age.
- Calves should have access to clean water and barley straw or similar roughage at all times.
- **Note that 500g of calf milk powder is equivalent to:**
  - a. 2.5 litres of colostrum or,
  - b. 3.5 litres of wholemilk or,
  - c. 2.5 litres and 75g of milkpowder per litre.
Calf live weight appears to be a better indicator than age or meal consumption as to when to wean a calf off milk. Calves can be weaned from milk at 63kg, irrespective of age, and will then be able to achieve a **target liveweight of 100kg at 12 weeks of age**. Heavier crossbred calves tend to perform just as well as Friesian bull calves of similar liveweight. Transporting 4-day-old calves a long distance prior to arrival at the rearing site can cost the calf up to 1.5kg liveweight on average. This is a large stress on these animals. Purchase only those calves that weigh more than 40kg if possible, as calf weaning weight is influenced by birth weight.

Feeding concentrated milk powder mixes is risky and is only successful in larger calves. Hence, the milk powder regime as shown in Table 1.

Scouring has often been observed to occur in these artificially reared calves around 10 days of age, “the five-day blues”. This scouring is often due to Cryptosporidia infection and is treated by removing calves from milk and administering electrolytes for 2 to 3 days.

Pellets available for calf feeding vary in protein content. It is very important that high protein concentrates be fed to young calves on restricted milk. These concentrates should have a crude protein content of at least 18%.

The provision of shelter is critical once the young calves move out onto pasture at 1 to 2 weeks of age.

**Calf health**
The most common cause of calf deaths and ill health is scouring and subsequent dehydration. The biggest cause of scours is stress and or lack of colostrum in the first 48 hours after birth (see comments above). Scouring causes depletion of critical vitamins and important electrolytes in the calf, and stress scours will often occur in the first ten days of a calf’s life. Damage done to the intestinal walls of the calf mean that it is unable to utilise the food it consumes and the results are a poor calf. An essential feature of a successful calf rearing programme, which minimises disease, is close observation. A sick calf is inactive, and often lies down for long periods of time with its head extended. Its eyes may be sunken, the calf otherwise looks dehydrated with a dull coat and it is generally unresponsive. People responsible for looking after calves should be trained to recognise these symptoms, especially when calves are moved away from their place of birth on to other farms.

Calves suffer from two major forms of scours, viral diarrhoea, which compromises the ability of the intestine to absorb nutrients, and bacteria (usually *E. coli*) or white scours, which does not. Scours can also result from incorrect feeding of milk powder, either too much in each feed or inadequate quality, particularly of protein. The risk of scours is increased if calves are subject to stress, for example by movement or following a sudden change of diet.
Calf scours occurs at anytime up to four weeks of life, by which time the rumen is sufficiently innoculated with benign bacteria to prevent it being colonised by bacterial pathogens. Calves can be protected (via dam vaccination pre-calving) against certain forms of *E. coli* scours, but the most important means of protection is ensuring that the calf has adequate intake of colostrum in the first 24 hours of its life.

The major viral pathogens are rotavirus and corona virus. Calves with viral diarrhoea are not able to re-absorb water in the gut because of damage to the gut wall so dehydration is the major problem.

Dehydration can be averted by recognising the symptoms early and providing oral re-hydration therapy. Scouring calves will lose up to 20 times more fluid than healthy calves. The first step in the treatment of moderate or severe scours is to stop feeding milk (on which scour bacteria live) and provide a complete balanced fluid replacer, which contains both electrolytes (mineral salts) and energy (glucose). This energy source needs to be something such as glucose. This is a form of energy that the bacteria cannot survive on, but which the calf can utilise.

A simple electrolyte replacement mixture to combat stress and scours is shown in Table 2. Numerous ready-made mixes are also commercially available.

**Table 2:** An electrolyte recipe for treating calves with scours

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salt</td>
<td>1/4 teaspoon</td>
</tr>
<tr>
<td>Baking soda</td>
<td>1 tablespoon</td>
</tr>
<tr>
<td>Glucose/Dextrose</td>
<td>4 tablespoons</td>
</tr>
</tbody>
</table>

Make up to approximately 2 litres and give two feeds per day providing 4-6 litres of mix per day. Apply the treatment for 2 days. This allows all milk to leave the calf’s digestive system, which in turn results in the death by starvation of the scour bacteria, and allows some recovery of the intestinal tract of the sick calf.

**Common causes of scours**
- Stress – Transport, change of diet, overcrowding.
- Milk volume – an excessive volume of milk can over-fill the fourth stomach (or abomasum), and be pushed through into the intestine before it has clotted. Scouring will result.
- Quality of feed – poor milk powders. Either too low in fat, or overheated during production.
• Bacteria – These are not considered a major cause of calf scours. Once a calf begins scouring, the conditions in the intestines are “ripe” for an invasion by harmful bacteria such as salmonella and certain strains of *E. coli*, causing damage to the intestine walls and therefore preventing the calf from absorbing nutrients and fluids. This causes fluids to be passed from the body into the intestines and out in the scour causing dehydration, which can kill the calf.

• Naval infection – Bacteria entering through the naval into the bloodstream cause problems. Calves can develop swollen knee joints and jaws, and also sores in the mouth. Generally animals with this problem have to be culled.

• Viral + Protozoal infections – scours caused by rotavirus (viral) or cryptosporidia (protozoal) infection constitute most of the scours in calves less than three weeks old. Antibiotics are not effective in treating these. Therefore, treat with electrolyte replacer and take the calf off milk for several days as described above.

• Salmonella scour – Salmonella cause bloody, putrid, diarrhoea-containing mucus. Calves develop fever and become dehydrated very rapidly.

• Coccidiosis or blood scours – caused by protozoa infecting the calf from three weeks of age. Affected calves show blood stained scouring with a lot of mucus. Coccidiosis is a stress related disease and usually affects calves that are reared in crowded, unhygienic conditions. Many protein calf meals contain a coccidiostat for prevention of this condition.

**General comments about artificially rearing calves**

• Early accommodation – the best bedding for calves is bark, wood chips, post peelings or sawdust shavings. Preferably all of these should be non-tanalised. The minimum area per calf is 1.5m².

• Calves should be housed for the first 2 to 4 weeks and then put out onto fresh pasture (weather permitting), preferably with shelter available or away from the prevailing weather direction. Shivering, and loss of blood from the stomach to the muscle and the brain tissue will occur at the temperatures shown in Table 3.

**Table 3:** Temperatures at which calves show cold stress.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Friesian</th>
<th>Jersey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry coat, no draught</td>
<td>3°C</td>
<td>8°C</td>
</tr>
<tr>
<td>Dry coat, with draught</td>
<td>8°C</td>
<td>13°C</td>
</tr>
<tr>
<td>Wet coat, with draught</td>
<td>13°C</td>
<td>18°C</td>
</tr>
</tbody>
</table>
If the temperature drops below the values in Table 3, the chances of a calf getting scours increases greatly. The normal body temperature of a calf should be about 39°C. Check by inserting a thermometer up the calf’s rectum for 1 minute.

- Do not overcrowd the calf-rearing shed. Use an “all-in, all-out” rearing system with stringent cleaning between batches of reared calves.

- Spray the pen surrounding the calves with disinfectant before the calves go into the rearing sheds, or alternatively, apply a mix of 100gms of washing soda per litre of water.

- The calf’s navel should be sprayed with iodine within 24 hours of birth if possible. Check navels at 3 days of age. If bigger than your little finger, infection has probably occurred and the calf should be checked by a vet.

- Always provide fresh, clean water to calves in their pens. Always feed young calves before older calves if using the same feeders for both calves.

- If calves do not feed, or look sick, take them off milk immediately and feed electrolytes.

- If calves are not eating sufficient amounts of dry feed and are not scouring, reduce their daily milk volume and if necessary increase the milk concentration.

- Ensure that when weaning calves off pellets onto pasture that the process is gradual. Ideally, they should be offered green leafy pasture of approximately 1800 kg DM/ha pre-grazing mass and shifted frequently.

- On average, medium calves (37 to 42kg at 4 days of age) consume around 19kg of milk replacement powder, and 22kg of high protein calf pellets up to weaning at 63kg. From weaning until 10 to 12 weeks of age, they will consume a further 53kg of low protein calf pellets.

**Target weights for artificially reared bull calves**

Table 4 summarises target weight information provided in the sections above. These targets relate to Friesian bulls. For other breeds, alter the targets in proportion to differences in mature weight (Chapter 8).

**Table 4: Target weights for artificially reared bull calves**

<table>
<thead>
<tr>
<th>Age (weeks)</th>
<th>Target weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>40 (approx.)</td>
</tr>
<tr>
<td>6</td>
<td>63 (wean off milk replacer)</td>
</tr>
<tr>
<td>12</td>
<td>100 (wean off meal)</td>
</tr>
</tbody>
</table>
Requirements of artificially reared weaner calves up to 6 months of age

General comments

This section covers the management of healthy weaner Friesian bull calves from 100kg liveweight at 10 to 12 weeks old through to 6 months of age.

The three main issues facing the young weaner calf are animal health, social and management stress and nutritional stress. By adequately dealing with these, animal health problems become a minor issue for this stock class. In addition, animal health problems can be minimised by following a carefully organised animal health management plan, which should be worked through and updated with a veterinarian. See also Chapter 7.

For social and management stress, the issues include the handling of the animals, mob size and their management. Nutritional stress relates to feeding – both quantity and quality, especially in the summer. Young animals are more susceptible to problems than older animals because their immune system is still developing and the survival aspects of their behaviour are still not properly learnt.

Optimum mob size for young Friesian bulls has not been clearly defined although farmer experience suggests 70-100 is an acceptable figure. Before the animals reach puberty, mob size may not directly contribute to social stress. However, in a bigger mob, individual animals are less likely to be noticed.

Access to water is often an issue. Good clean trough water, where an individual does not have to compete to get access, is required. Dams and streams can pose problems. It should be remembered that weaner calves are young inexperienced animals. They appear not to be easily able to determine how to get to water in isolated streams or swamps. They become stressed easily and in desperation, can become bogged or have some other mishap.

If the water source is a stream or a dam rather than a trough, ensure that animals are able to get in and out from the drinking source without spoiling it for other animals. For environmental reasons also, a trough water source is preferred compared to a natural water supply. The provision of good quality water, is imperative (Refer Chapter 10).

Nutrition and pasture quality

Well-fed young animals are more able to withstand disease. Many diseases are encouraged by poor nutrition. High quality pasture with a high ME content (greater than 11MJ/kg DM) is an essential feature of successful rearing of cattle to 6 months of age. This quality of feed is not always readily available in New Zealand sheep and beef pastures during summer months. Crops can provide high quality feed at this time but it is important to ensure they are profitable (Refer Chapter 6 and 12).
It should not be assumed that young weaner calves purchased from a rearing property will be totally independent by the time they arrive on the next property. Some rearers encourage high liveweight gain in their calves, by continuing to feed high energy and protein supplements or high milk-content diets right up until the day they are sold, or transferred, to the next grower. Their rumens may still not be fully developed as a result (refer above). In this case, a weaning check, stress and a pre-disposition to disease could be a feature of the newly arrived weaners. If there is a suspicion that this is the case, then continue feeding them on calf meal and slowly reduce the quantity to fully wean them on to pasture over the next few weeks. This extra meal feeding is likely to be more important for calves below 100-110kg liveweight.

**Figure 1:** Differences in the quality of pasture typically obtained on warm, summer dry North Island farms vs. pasture from a well managed feed quality situation. Feed quality is expressed as the concentration of ME in the pasture DM.

![ME content (MJ ME/kg DM)](image)

Figure 1 demonstrates that for typical properties the provision of high ME – content pasture for these calves is not as easy as it looks, particularly over the summer period. Yet, pasture quality differences can have enormous impacts on liveweight of the animals later on (Chapter 6). For these weaner calves to grow at 1kg/day (as required by the target line in Figure 2), they require a pregrazing pasture cover in excess of 2200kg DM/ha, with greater than 11.4MJ ME energy content in the pasture. Therefore, managing feed quality (Chapter 6) must be a vital part of a farming system to keep these animals growing at target weights.
The rules for these young animals are simple:

- Do not expect them to clean up pastures
- Move them onto new pasture as soon as feed quality drops
- Provide supplements to the animals if they are below target weights on arrival at the property, or if pasture quality or quantity are below target feeding levels
- Remove animal health as an issue by working to a strictly monitored animal health programme (Chapter 7).

Further reading


