Farm management
Breeding youngstock

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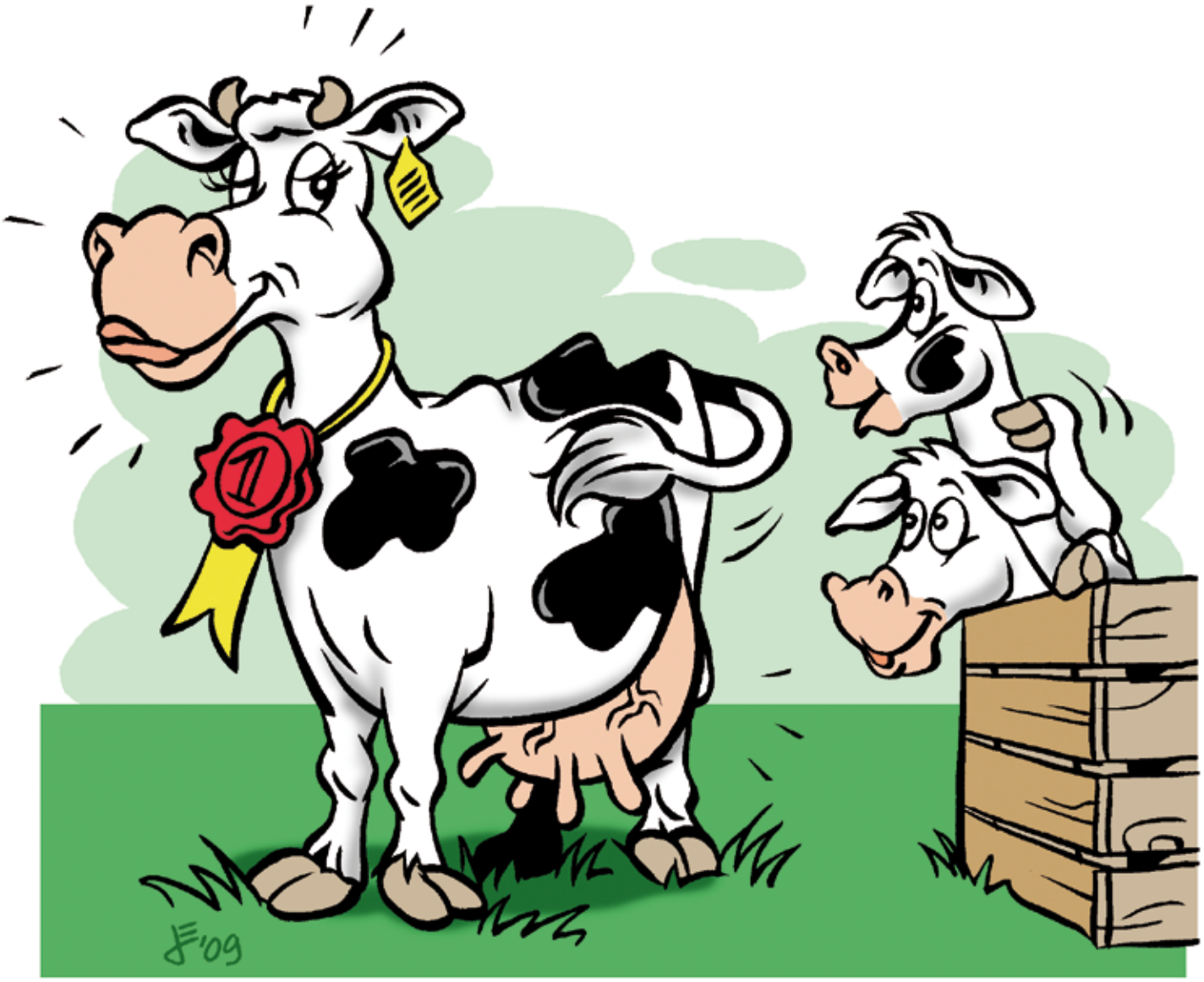

Introduction

Anyone in pursuit of a sustainable cow with a high lifetime production and long life must first optimize the rearing of young cattle. After all, this is the basis for the dairy cow of tomorrow. During a period of two years, dairy farmers do everything they can to raise their young calves to become highly productive cows. This is what is known as investing in the future.

This brochure on calf rearing is Lely's contribution to the optimization of rearing young cattle. This book is brimming with management information, choices and, above all, many practical tips for improving the rearing of young calves. It starts, of course, with a good milk period and an automatic calf feeder that guarantees the optimal growth and development of these young animals. The aim is: a mature heifer that calves at the correct weight, produces easily, processes substantial roughage and, due to her strong exterior, can fend for herself. Only then will she live a long and productive life. And the more milk she produces in her lifetime, the lower the costs of calf rearing will ultimately be. This is how good calf rearing lays the foundation for a profitable business.

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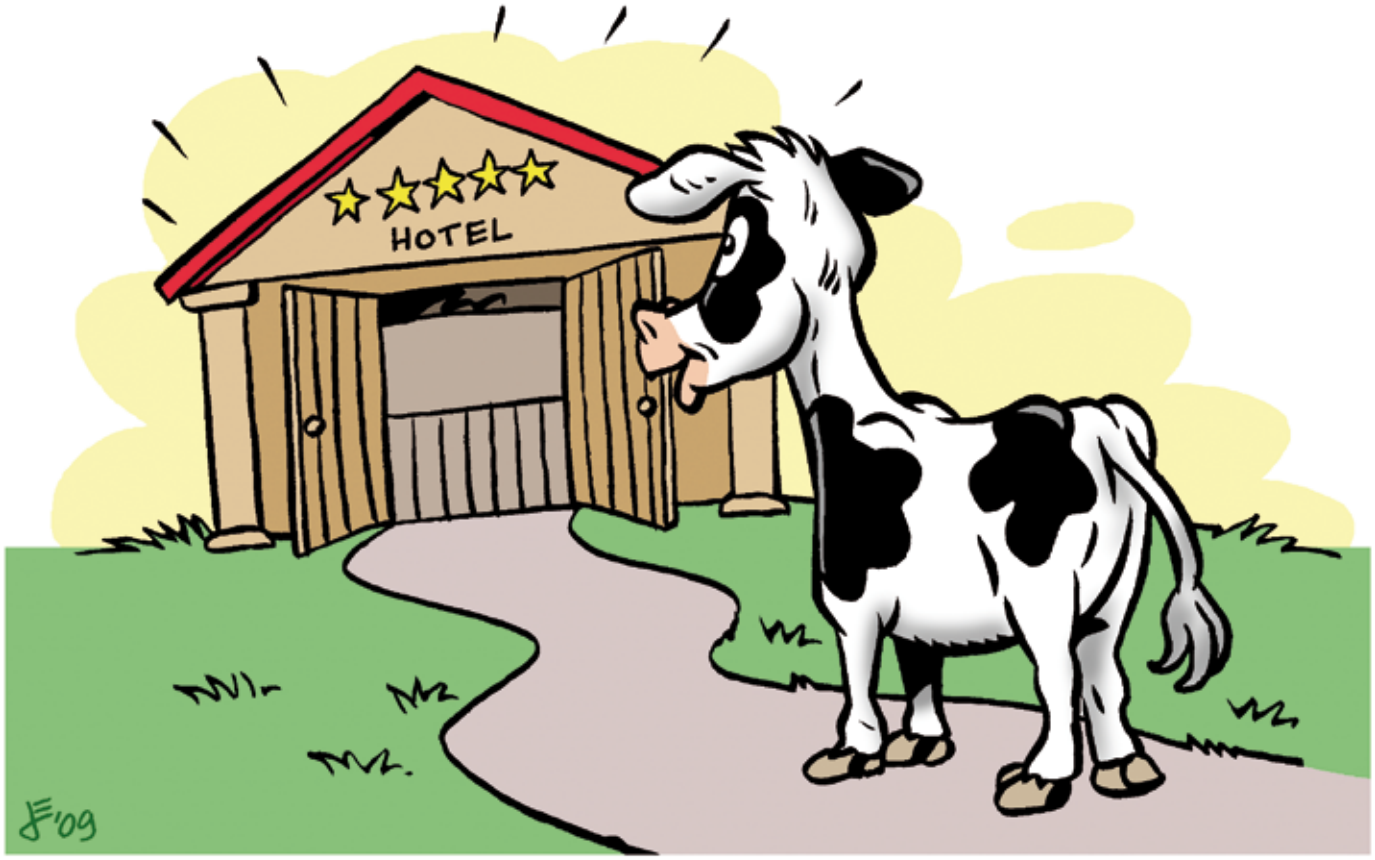


1 Calf rearing – from calf to sustainable dairy cow

1.1 Invest in the future

Calves are the dairy cows of tomorrow, and yet in many farms not enough attention is paid to young calves. Their feed is often of a poor quality, there is insufficient or the wrong kind of concentrate provided, or the younger generations find themselves in a tight corner due to high work pressure. This is not surprising considering that the primary focus of attention is on the dairy cows, however, in the long term, correctly-reared young cattle will guarantee a good return. Statistics show that the mortality rate among calves (approximately 12% up to 6 months of age) is relatively high. This is why the rearing of young calves is a very important part of the business on dairy farms, and it calls for attention.

1.2 The costs of rearing young calves

It takes an average of two years, and money, of course, to rear a calf from birth to the stage of pregnant, lactating heifer. When taking everything into account, excluding the buildings, dairy farmers end up investing approximately € 1,500 per reared heifer. Depending on the size of the farm, this works out at 4 to 5 euro cents per litre (0.26 gallon) of milk, which is a significant investment. It would, therefore, be more profitable to allow the heifer, and at a later stage, the cow, to produce for as many years as possible. With a high lifetime production, the depreciation of rearing (minus the remaining value of the cow) is spread out over many litres, making it cheaper per litre of milk.

Table: **the costs of rearing young cattle (in euros per raised heifer) in existing buildings and with your own roughage supply.**

Direct costs

Feed costs	**177**
Of which milk powder	45
Of which concentrates	132
Health costs	43
Insemination	36
Litter	45
Death loss	1
Crop and processing costs	590
Labour	423
Other non-added costs	74
Total cost per delivered heifer	**1,566**
Total cost per 100 kilograms (220 lbs) of milk	4.9*
Outsourcing of rearing	1,161
Total cost of outsourcing per 100 kilograms (220 lbs) of milk	3.5

* on the basis of lifetime production

Source: Netherlands; Animal Sciences Group, 1991

Outsourcing

When there is a tight supply of food or labour, outsourcing could be a solution. Also when new buildings are necessary, it could still be cheaper to look for a good calf rearing company. Raising young cattle is a specialized job that demands the proper attention and the required energy. An increase in work pressure on the farm encourages many farmers to outsource their calf rearing operations to professional calf rearers. Housing restrictions, feed supplies, environmental licenses, manure regulations and other directives could be a reason to outsource the rearing to another company.

Add to that the costs that have to be invested in the rearing of young cattle, and also taking into consideration the costs of housing, manure disposal and labour. With a daily rate of between € 1.50 to € 2.00 (in Western Europe), the rearing takes place at another location. The costs then amount to between € 1,100 and € 1,400 per raised heifer. When converted into kilograms of milk, outsourcing costs approximately 3 euro cents per litre (0.26 gallon) of milk produced when taking a lifetime production of 30,000 kilograms (66,139 lbs) of milk into account. The more a cow produces in her lifetime, the lower the costs per kilogram of milk for the rearing, and thus the more efficient the rearing.

1.3 The objective of rearing

The most important objective of rearing is to have a heifer that usually calves at 24 months, weighs approximately 630 kilograms (1,389 lbs) before calving, 570 kilograms (1,257 lbs) after calving (this can be monitored in the milking robot) and is built to live a long and productive life. This is all easily described in one sentence, but in practice it is an entirely different matter. Nevertheless, to a great extent, rearing determines the success of the dairy farm. Heifers that are lighter (and often younger) after calving, produce less milk during their first lactation; they are more prone to failure and lag behind in their lactation cycles. The average Dutch dairy cow has 3.4 lactations and produces more than 30,000 litres (7,925 gallon) of milk. In the United States and Canada the cows have an average of 2.8 lactations. The average useful lifespan of a cow is 58 months.

On average, heavier, well-developed heifers become pregnant earlier, produce more milk during their first lactation, have a longer lifespan and perform better in the herd. An extra body weight of 50 kg (110 lbs) at the start of the first lactation cycle means approximately 850 litres (225 gallon) more milk during the entire lifespan of the heifer.

To a great extent, the quality of the legs and udder potential are determined during rearing. Wrong nutrition results in a fat udder when the animals are only halfway through the rearing phase. In short: only heifers that are correctly built develop into active cows, capable of fending for themselves. These are cows that can compete in a herd; they have a high milk production and sufficient vitality to seek out the milking robot on their own initiative, for example. The rumen must also be optimally developed in order to handle a substantial amount of roughage. All in all, the rearing of young cattle is an important basis for trouble-free milking.

Dairy farmers need to take a closer, critical look at their young cattle. They need to measure and weigh a number of them and look critically at the whole development of the animals, their housing and their nutrition. Can it be improved? Have I enough time to do it? Improving the rearing of young cattle is repaid with interest the moment the heifer begins to produce milk; especially significant when the heifer, as a result of the improved rearing program, produces a calf one or two months earlier. This extra milk production is immediate profit.

Table: **rearing costs per kilogram of milk in relation to lifetime production.**

Lifetime production milk (kg/lbs)	Rearing costs (euro cents) per kg milk (lbs)
5,000 / 11,023	24 (10.88)
10,000 / 22,046	12 (5.44)
25,000 / 55,116	4.8 (2.18)
50,000 / 110,232	2.4 (1.09)

Source: Netherlands; Animal Sciences Group, 1991

Table: **the relationship between calving age of the heifer and milk production in the first and second lactations.**

Calving age (months)	Milk production 1st lactation	Milk production 2nd lactation
23.9	6,593	8,038
24.6	6,317	7,743
26.2	5,961	6,879
27.8	5,832	6,374

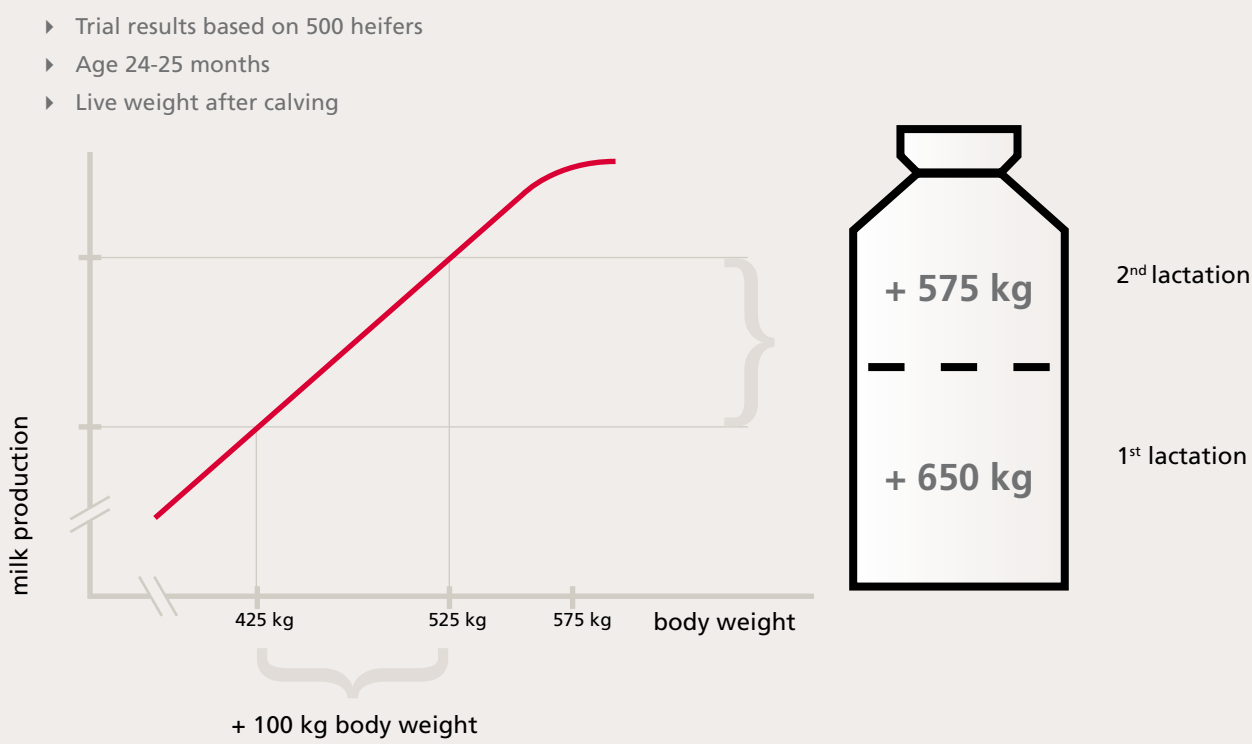
Source: van Gaasbek, Boers, Hoogeveen, 1996

Table: **calving age heifers, lifetime production and total number of lactations.**

Calving age (months)	Lifetime production	Total number of lactations
21	21,330	2.4
22	31,230	3.1
23	38,345	3.7
24	36,154	3.2
25	32,085	3.2
26	21,465	2.3
27	19,960	2.1

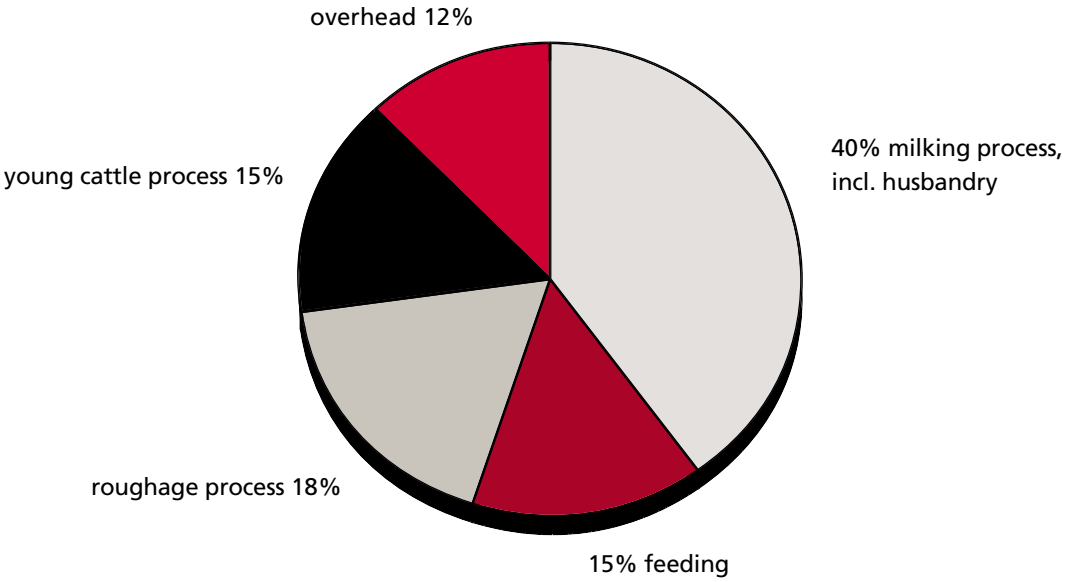
Source: van Amburgh, Top Agrar Fachbuch, 2000

Graph: **relationship between body weight and milk production in the 1st and 2nd lactation.**



Source: Netherlands; Animal Sciences Group, 1991 (1kg = 2,205 lbs)

Graph: **time allocation on dairy farms, including rearing youngstock.**



Source: Bestra Consultancy

Procedure calf rearing

- Statistics show that the average calf mortality (approximately 12% up to 6 months) on dairy farms is relatively high, and it calls for attention.
- The objective of rearing young cattle is to obtain a fully-grown heifer that calves at the correct weight, produces easily, consumes a lot of roughage and, with her strong exterior, is capable of fending for herself.
- The costs of rearing a heifer are, on average, approximately € 1,500, excluding buildings.
- Due to shortage of space, labour saving or other reasons, young cattle can also be outsourced.
- Heifers that are lighter during calving produce less milk in the first lactation, have a higher loss percentage and, on average, have fewer lactations.
- Young cattle reared in optimal circumstances provide a quick return on investment; the heifer reaches the desired weight earlier and will actively, and on her own initiative, seek out the robot.

2 Calving management

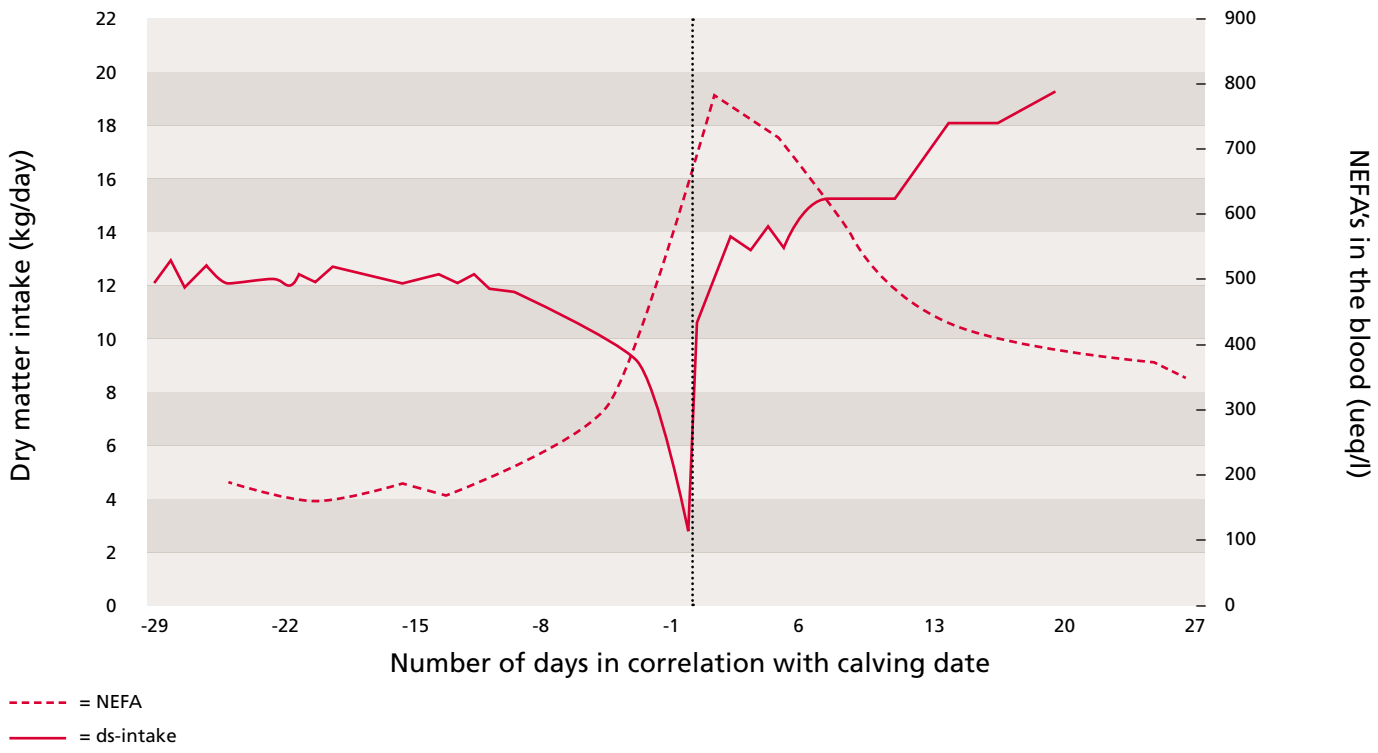
2.1 Dry cow feeding

A good start to the rearing period begins with the smooth birth of a healthy calf. Prior to that, an optimal management program and proper dry cow nutrition is crucial. If the cows are able to maintain their body condition during the dry period and the number of heavy births can be reduced, the quality of the colostrum will improve. Poor cow management three weeks prior to calving will quickly lead to more sick calves and a higher calf mortality rate within 24 hours (including stillbirths). A good dry period will encourage good feed intake immediately after calving, resulting in a minimal negative energy balance in the cow.

Problems with the metabolism

Why is good management and nutrition for dry cows so important? Because nearly 80 per cent of all health problems around calving are a direct result of the dry period. At the end of the dry period, the dry matter intake decreases to 10 to 12 kilograms (22-26 lbs) of dry matter and the cows enter into a negative energy balance prior to calving. The dry matter intake on the day of calving determines the cow's dry matter intake 21 days into lactation. The more the dry matter intake decreases, the more energy the cow will draw from the breakdown of her own body reserves. Body Fat is then degraded, allowing free fatty acids (Non Esterified Fatty Acids, or

Graph: **relationship dry matter intake and NEFA's in the blood.**



Source: Burhans et al

NEFA's) to enter the bloodstream. A high level of NEFA's (see graph) in the blood increases the risk of fatty liver syndrome, heavy births, retained placenta, milk fever or ketosis, displaced abomasum and mastitis. Cows with milk fever have a shortage of calcium in their blood. The cause is often an excess of cations – especially sodium and potassium – in the diet. Cows with milk fever eat less and have weaker muscle contractions, resulting in heavier births and the likelihood of retained placenta. The risk of stillbirth increases when the calving process takes too long.

Close-up cows

It is advisable to give cows in the early dry period a different ration than to cows in the so-called close-up dry period (two to three weeks prior to calving). The early dry period is intended for the drying up of the udder and the restoration of the rumen wall. A low energy diet and plenty of cell wall-rich materials will then encourage the cows to spend more time ruminating the feed and, as a result, the pH in the rumen will increase and the rumen wall will recover. In addition, a structure-rich ration will ensure that the rumen retains sufficient volume. The close-up cows must be encouraged to eat in order for them to maintain their condition and to prepare them for the ration during lactation. Feed close-up cows a ration containing more energy and a lower proportion of cell wall. Feeding a well-balanced, appetizing diet with sufficient structure will increase the chance of a normal birthing process. It is important not to change the feed in the various rations too much in order to avoid compromising the cow's rumen environment.

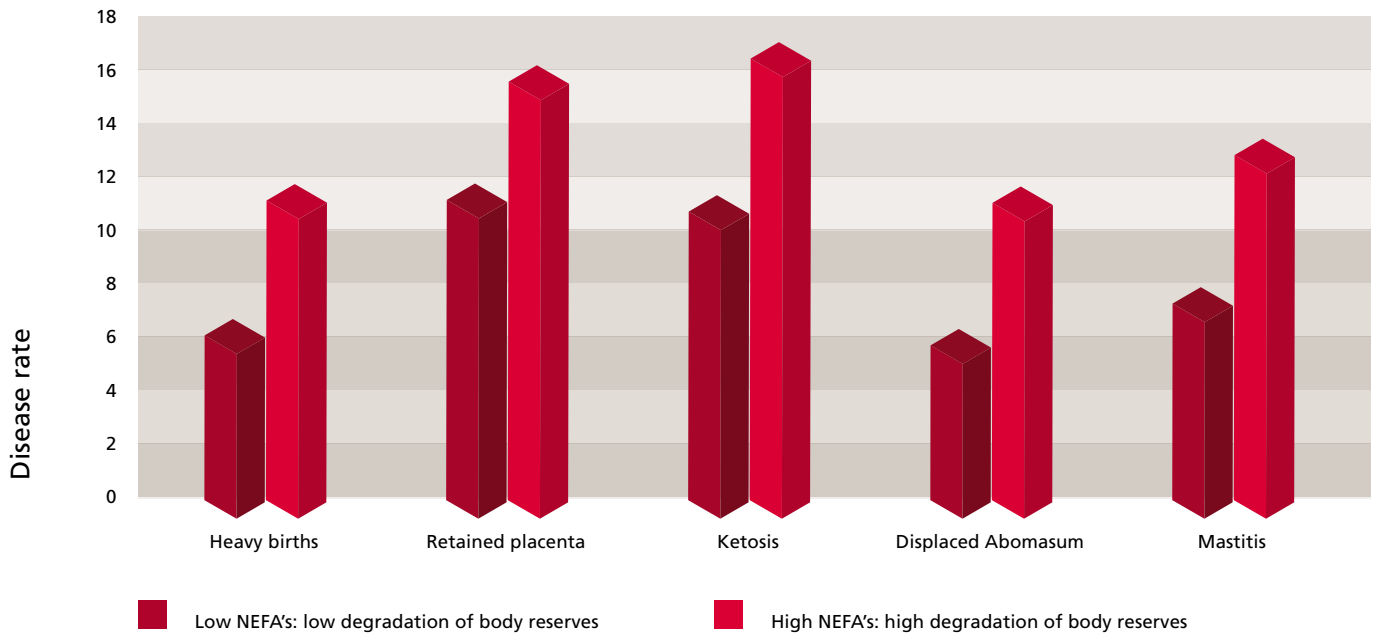
Compound feed that contains anionic salts will lower the cation-anion balance, thus can prevent milk fever and occurrence of oedema. Glucogenic energy in the diet will, in particular, prevent fatty liver syndrome and ketosis. An appropriate supply of minerals, vitamins and trace elements will increase the cow's resistance. This will lead to less colostrum (5 to 8 liters (1.3-2.1 gallon) in the first milking is ideal) but the quality will be greatly improved (more antibodies and a good balance of fat and protein for the calf). Good colostrum (see also Chapter 2.3) will increase the resistance and the survival chances of the calf when attention is focused on good management of the

Management of dry cows

- In the dry period, feed cows a low energy ration and plenty of cell wall materials.
- Maintaining body condition is important during the dry period; feed a well-balanced and appetizing ration with a higher level of energy and a lower proportion of cell wall.
- Do not make any sudden changes in ration ingredients to maintain a stable rumen environment of the cow.
- Anionic salts in the close-up ration could help prevent milk fever and occurrence of oedema; pay attention to dry matter intake due to reduced palatability.
- Adding glucogenic energy to the ration after calving is important in achieving a good start to the lactation.
- Healthy cows are active and activity is an important condition for an optimal utilization of the robot.

cows during calving, the farmer has won half the battle. Cows in a good condition remain healthier, are more active and get off to a better start. Sufficient activity of the cow is always important for adequate feed intake. When milking with robots, healthy, active cows are an important factor in keeping the number of daily milkings sufficiently high and putting the capacity of the Milking robot to good use.

Graph: **effects of low and high concentration of NEFA's on animal health.**



Source: adapted from van Dyk, 1995

2.2 Optimal calving circumstances

Comfortable calf birthing stall and hygiene

In addition to maintaining body condition, the prevention of stress during calving is important for a good calving process. Pamper highly pregnant cows and leave nothing to chance. A few days prior to calving, bring the cow to a calving pen with a soft surface and sufficient grip, such as straw, for example. The calving pen must be sufficiently spacious and clean. Sufficient space is required for a birth attendant to be able to provide assistance if necessary.

Cows calving down tend to remain calmer when they can see and hear other cows. Comfortable surroundings and the supply of appetizing feed and sufficient water will ensure that dry cows continue to eat sufficiently and it will lower the stress hormone levels. Allow the cow to walk into the calf birthing stall, or in a special start-up group (for example, straw box behind the robot) for fresh cows, until the placenta is expelled. This will allow better monitoring of the individual animal for start-up problems. Do not house a fresh cow in a group of sick cows.

Prevent the transfer of illness by cleaning and disinfecting the calf birthing stall thoroughly after each birth; after all, calves are born without antibodies and the risk of infection is large. Furthermore, the cow's hygiene is important. Before a birth attendant offers assistance to a cow in the calf birthing stall, first clean the cow's hindquarters and udder with water and a disinfectant. Use only clean and disinfected delivery material. Do not offer birth assistance too quickly as this could lead to stress with some cows and will delay the birthing process. Take action only after the amnionic sac has been broken for at least two hours and the birthing process has stopped. The birthing process will take longer with heifers. When assisting with the delivery, work hygienically and use a lubricant to lubricate the birth canal. After a heavy birth, it is advisable to cool down the birth canal with cold water to prevent excessive swelling. Research has shown that it is advisable after the calving process to provide the cow with lukewarm water and possibly an additive (glucogenic energy source). This will allow the cow to recover more quickly after calving.

Removing the calf from its mother

Removing the calf from its mother as quickly as possible after the birth has a number of important advantages:

- The risk of disease transmission from cow to calf is reduced. Cows carry a number of viruses and/or bacteria which could be dangerous for the calf but will have no impact on the cow.
- In particular, the transfer of paratuberculosis (via manure) decreases when the mother cannot lick the calf.
- The cow has less stress when the calf is removed immediately before it has been licked.
- There is more control of colostrum intake.
- The cow is not distracted by the calf, resulting in a higher dry matter intake.

Allowing cows to eat well after calving is important in order to prevent health problems. The provision of a drink with energy that is easily absorbed will stimulate activity and feed intake of the cow directly after the birth of a calf. Housing a calf in a clean, dry, draught-free and warm igloo, or single pen directly after birth ensures a good control of feed intake, water, manure consistency and possible illness. It also reduces the risk of transmitting diseases. Make sure there are sufficient pens available to allow sufficient time for cleaning, disinfecting and drying prior to the next calf using the igloo or pen. The width of a single pen must be at least the shoulder height of a calf (80-90 cm / 31-35 inch). Healthy and active calves are capable of using the automatic calf feeder after a few days.

Management around calving

- Avoid stress to the cows during calving (stress inhibits the birthing process).
- A hygienic and clean calf birthing stall is important in order to prevent problems during and after calving.
- If birth assistance is required, work quietly and hygienically and wait two hours after the amnionic sac has broken before assisting.
- Removing the calf from its mother early reduces the risk of disease transmission and improves the dry matter intake of the cow after calving.
- Providing lukewarm water (with an energy drink, if necessary) after the birth promotes the recovery of the cow after calving.

2.3 Colostrum management

Resistance and colostrum

Calves enter the world without resistance; they have no antibodies in their blood. The placenta of the mother is impermeable to large proteins. The newborn calf must get its resistance from the colostrum. Antibodies in the colostrum ensure that pathogens are less likely to make the calf ill. To improve the quality of the colostrum, it is possible to vaccinate the cow against, inter alia, Rota and Corona viruses. After vaccination, the cow secretes the antibodies against these viruses into its colostrum. The calves then automatically receive more protection against these common diarrhoea-causing diseases. The absorption capacity of the intestines for antibodies is highest immediately after birth. Twelve hours after birth, the absorption capacity has already decreased by 50 per cent, and 24 hours after birth practically no antibodies are absorbed.

This is why it is important to provide colostrum quickly, often and in plentiful quantity. Try to provide 4 liters (1.06 gallon) of colostrum in the first hours after birth. After each hour, the absorption capacity of the intestines for the antibodies is reduced by almost 10%.

The amount of colostrum depends on the quality, but the following rules apply in general:

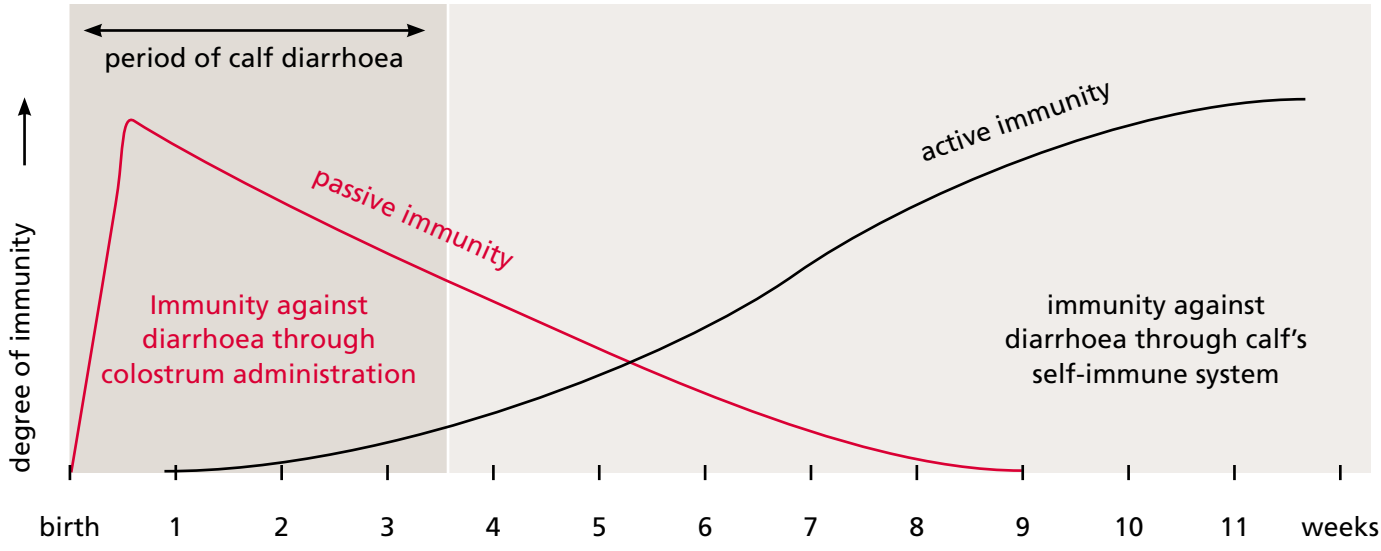
Quick: Make sure that the calf absorbs a minimum of 3 to 4 liters (0.8-1.1 gallon) of colostrum in the first hours after birth. In the first twelve hours it is important that the calf has had 5 to 6 liters (1.3-1.6 gallon) of colostrum; in the following 12 hours this should be replenished with at least 1 liter (0.3 gallon).

Often: Provide colostrum regularly, up to 4 liters (1.1 gallon) the first hours after birth. This higher frequency promotes the total absorption of colostrum.

Plenty: The antibodies absorbed in the first sixteen hours will protect the calf three to four weeks against infections. After this period, the calf will start to produce its own antibodies. The amount of colostrum intake is, therefore, crucial.

Colostrum must be given under hygienic circumstances. Always collect and feed colostrum in clean, disinfected buckets. It is preferable to use clean, separate boots and clothing in the calf rearing area.

Figure: **The importance of immunity through the colostrum when the self-immune system is insufficient. When the cow has been on the farm longer than 6 weeks, the antibodies in the colostrum are specific for that particular location. The level of antibodies in the colostrum is highest in the body of the calf 24 to 36 hours after birth.**



Source: Intervet Schering-Plough

Pasteurization

Do not feed the calves colostrum or milk from cows with mastitis, unless this milk is pasteurized. The intestinal tract of calves is permeable to bacteria and other inflammatory cells which hinders the absorption of antibodies. Mastitis milk also contains antibiotics. Administering antibiotics to a young calf is not desirable. There is a risk of calves carrying antibiotic-resistant bacteria at a later stage. Pasteurization of the milk kills pathogenic bacteria which makes it more suitable for the calves. Research has shown that pasteurization of colostrum for half an hour to an hour at 60 degrees Celsius (140 F) had no effect on the quantity of immune globulin IgG and the viscosity of the colostrum.

Quality of the colostrum

Good quality colostrum is important for a good start to the newborn calf. The resistance of the mother cow and the amount of colostrum produced by her has the most effect on the quality of the colostrum. Milk the cow completely out as soon as possible after calving for the best quality colostrum. Ensure that the udder is clean to reduce the risk of transmitting paratuberculosis. Colostrum from cows that produce an abundant amount (>10 kg/day) is of a lower quality. The concentration of antibodies is lower due to a greater dilution.

When can milk be called colostrum? The first milk yield after calving is called colostrum and it contains the most antibodies. The second and third milk yield after calving is called transition milk. Colostrum provides the calf with passive immunity and important nutrients.

Table: **composition of colostrum, transition milk and milk.**

	Milkings			
	1	**2**	**3**	**milk**
Dry matter (%)	23.90	17.90	14.10	12.90
Protein (%)	14.00	5.10	5.10	3.10
IgG (mg/ml)	48.00	2.05	15.00	0.60
Fat (%)	6.00	5.40	3.90	4.00
Lactose (%)	2.70	3.90	4.40	5.00
Minerals (%)	1.10	1.00	0.80	0.70
Vit. A (ug/dl)	295.00	190.00	113.00	34.00

Source: Adapted from Foley and Otterby, Journal of Dairy Science 1978, 61:1033-1060

Colostrum contains:

- Antibodies (IgG, IgM and IgA) [Immune globulin, also known as Ig, is another word for antibodies. The letters G, M and A indicate a particular type of antibody in the colostrum].
- High-quality energy nutrients.
- Minerals and vitamins.
- Substances that promote the first manure (called Meconium) are expelled.
- A-specific antibacterial factors.
- Enzymes (lactoferrin).
- White blood cell = leukocytes.

Nutritionally, the composition of milk the first three days after calving is different to that of normal milk. The concentration of fat, protein, minerals, vitamins, hormones and enzymes is much higher. The lactose content is lower. The cows can be vaccinated against pathogens such as E-coli bacteria and Rota or Corona viruses. These cows give more antibodies against these diarrhoea-causing pathogens to their calves through the colostrum. Vaccination usually consists of a basic vaccination and a revaccination. It is also good to know that older cows have a higher concentration of IgG (85% of the total number of antibodies) in their colostrum than younger animals. When freezing colostrum for emergency supplies in the event a cow has insufficient colostrum for its calf, it is preferable to take it from older cows.

Table: **average concentration of IgG (mg/ml) in the colostrum of cows with various parities.**

Lactation number	IgG concentration (mg/ml)
1	42.8
2	42.8
3	50.8
4	56.6
>5	55.5

Source: Hendrix-UTD

Measuring colostrum quality

The quality of colostrum varies greatly among cows. Research shows that the concentration of IgG in colostrum averages 48.2 mg/ml with a range of 20 to more than 100 mg/ml. Poor quality colostrum means little resistance for the calf, which increases calf mortality. The quality of colostrum can be easily measured through the use of a colostrum meter. The evaluation is based on the relation between the concentration of antibodies and density. A higher density means the concentration of antibodies is higher. Always measure the quality when the temperature of the colostrum is between 25-30 degrees Celsius (77-86 F), because the temperature affects density.

Application of the colostrum meter

1. Use collostrum from the first milk yield only. Ensure that the collection bucket is clean and dry. The udder must also be clean, to enable a 'clean' evaluation.
2. Place the colostrum in the plastic measuring cylinder. Make sure that the colostrum has a temperature of approximately 25 degrees (77 F). Deviations will render the evaluation less reliable.
3. The measuring cylinder should be filled to the top. Make sure there is no longer any foam. Remove dirt and foam on the outside.
   Tip: Overfilling the measuring glass will automatically ensure that there is no foam.
4. Lower the colostrum meter carefully into the colostrum. Be careful not to release the colostrum meter too suddenly. The colostrum meter must float in order to make an accurate reading of the scale.
5. Once the instrument is floating in the glass, evaluate the quality of the colostrum on the basis of the colour of the colostrum meter.

Storing colostrum

Colostrum can be stored frozen in case a cow has no, or insufficient, colostrum. Colostrum can be refrigerated for a maximum of three days. Frozen colostrum can be stored for one year. The temperature of the freezer must be lower than -20 degrees Celsius (-4 F).

- Freeze only good quality colostrum.
- It is preferable to freeze colostrum taken from older cows. This colostrum has a greater variety of farm-specific antibodies, because the cows have already been in contact with more farm-specific pathogens.
- Freeze portions of 2 to 4 liters (0.53-1.06 gallon) and 100-200 ml (3.38-6.76 ons). The portions of 2 to 4 liters (0.53-1.06 gallon) can be used as a complete diet if the mother cow has mastitis, paratuberculosis or if she has died. The small portions can be used as a supplement to the (artificial) milk to increase intestinal immunity.

Thaw out the frozen colostrum by placing it in a bucket of warm water (40 to 45 degrees Celsius / 104-113 F) in a sealed plastic container. Never thaw out colostrum in the microwave or in water that is too hot. The local temperature is too high and will destroy the antibodies (proteins).

Colostrum supplements and replacer

With colostrum supplements (freeze dried colostrum or whey), a low quality colostrum can be supplemented to increase the IgG concentration. Other sources are serum from the blood of cows and eggs. Most supplements contain 25-45 grams (0.06-0.10 lbs) IgG per dose. The IgG intake of colostrum supplements is low. Products derived from serum do increase the IgG intake.

Colostrum management has a major impact on calf mortality on the farm. Calves with low resistance have an increased risk of morbidity and mortality. Try to restrict calf mortality (including stillbirth) in the first year to less than 10%.

Table: **indication colostrum meter.**

Quality	Colour	Density	Conc. IgG (mg/ml)
Good	Green	> 1.047	> 50
Moderate	Orange	1.036 – 1.046	22 -50
Poor	Red	< 1.035	< 22

Source: Biogenics; Waterman, 1998

Artificial colostrum can, of course, completely replace natural colostrum. In addition to antibodies, artificial colostrum also contains nutrients (energy) that the calf needs within the first 24 hours. Artificial colostrum is comprised of freeze dried colostrum or serum. One dose contains 125 grams (0.28 lbs) IgG. Feeding natural colostrum is always preferable to the use of artificial colostrum. Using artificial colostrum can reduce morbidity and mortality in calves when:

- There is no colostrum available.
- The quality of the colostrum is poor.
- The colostrum contains undesired pathogens.

If supplements or artificial colostrum are used, these must be free of pathogens such as BVD – Bovine Virus Diarrhoea and paratuberculosis.

Watch out for paratuberculosis (also known as Johne's disease)

Paratuberculosis is a chronic and contagious intestinal inflammation. Infected cows spread the disease through their manure, milk and colostrum. Young calves are extremely susceptible to infection. The younger the animal, the greater the risk of infection. The bacterium can survive outside the body for a long time, for example in the ground and in silage. The transmission of infection from adult animals to calves can be reduced through:

- A clean cow and a clean calf birthing stall at birth.
- Removing the calf from the mother directly after birth.
- Feeding the calf colostrum free of these morbidities.
- Feeding pasteurized colostrum and, following the colostrum period, only artificial milk or pasteurized milk.
- Housing calves up to the age of 12 months separately from cattle of two years and older.
- Avoiding manure from older animals getting into the stalls of young stock.
- Working from young to old and wearing different working clothes for these two age categories.
- Preventing pollution of drinking water (separate drinking water circuit and no surface water).
- Keeping calves inside during their first year and feeding them on good quality roughage that has not been contaminated with manure.
- Not grazing young calves (the grass may be contaminated with paratuberculosis).
- Not feeding waste to young stock.
- Avoiding contact with other stock, such as goats.

Management around the newborn calf

- Make sure the calf has an intake of 3 to 4 liters (0.79-1.06 gallon) of colostrum during the first hours after birth.
- Colostrum ensures passive immunity of the calf, therefore, the quality of the colostrum is of great importance. Through vaccinating cows against Rota and Corona viruses or E-coli, the cow produces antibodies that are secreted in the colostrum which increases the quality of the colostrum.
- The level of antibodies (immune globulin) in colustrum can be measured with a colostrum meter.
- Colostrum supplements or artificial colostrum can replace or replenish natural colostrum.
- Paratuberculosis is a contageous intestinal inflammation. Observing good hygiene measures will reduce the incidence of this disease.

3 The milk period

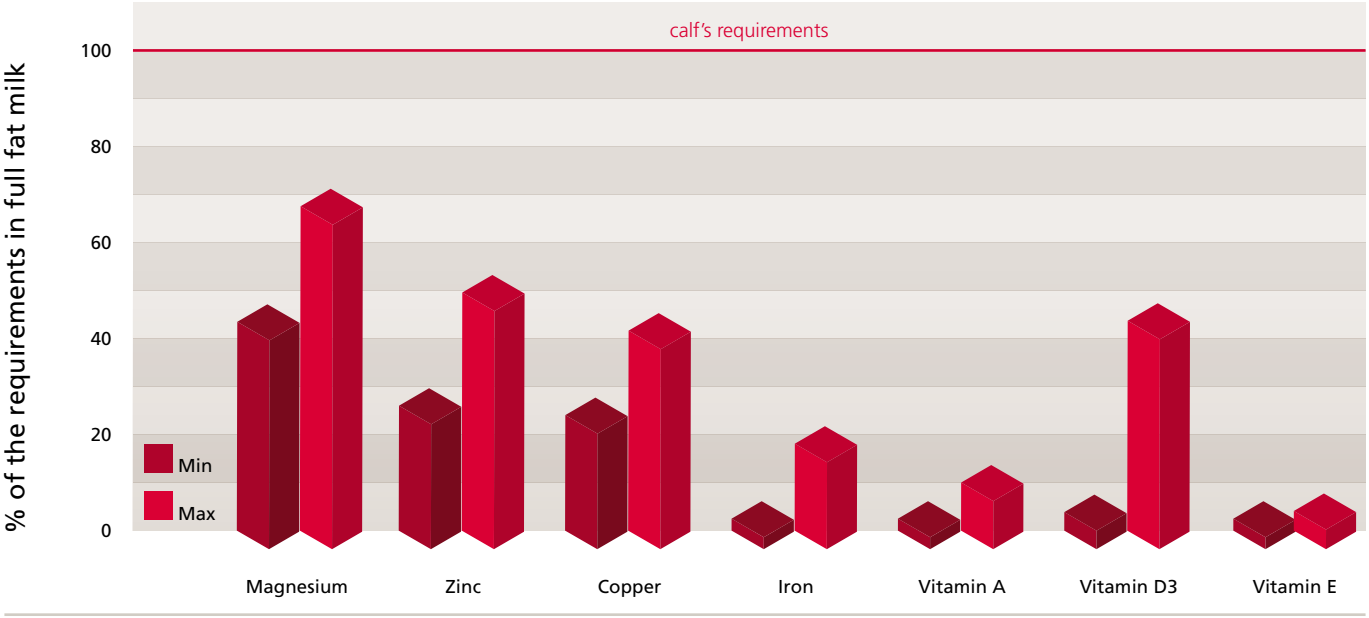
3.1 The first steps towards a long and sustainable life

A newborn calf deserves every attention. Even though it will take another few years, the first steps towards becoming a highly productive, sustainable cow are taken in the first few days of the calf's life. Colostrum is the first requirement: plenty, fresh, quick and often, is the motto. A minimum of 3 to 4 litres (0.79-1.06 gallon) of colostrum in the first few hours after birth should be given. A catheter could be helpful in administering this first vital milk to the calf. It would be useful to keep a portion of colostrum in the freezer for when the cow has no colostrum herself. Colostrum should be thawed out in hot water (if the water is too hot the antibodies will be destroyed; the temperature should be approximately 40 degrees Celsius / 104 F) and administered at a drinking temperature of 35 to 40 degrees (95-104 F).

3.2 Milk replacer or cow's milk?

On the third or fourth day after birth, the switch can be made to milk replacer or normal (pasteurized) cow's milk; either may be given. We know that many dairy farmers give their surplus milk to calves and that this is an easy way of working, however, milk replacer better meets the nutritional needs of the calf. In addition to the necessary nutrients, milk replacer also contains vitamins and minerals, which are important for a healthy growth. Furthermore, milk replacer has a consistent taste and composition and there is no risk of transmitting infectious diseases, such as paratuberculosis. The correct dosage and a feeding schedule are accurately described on every bag of milk replacer.

Graph: **Full fat milk does not meet the calf's requirements in vitamins and minerals.**



Source: Hendrix-UTD

The Lely Calm automatic calf feeder provides both fresh milk and milk replacer. An important criterion for milk replacer is that it can be mixed at a specific temperature (43 degrees Celsius / 109 F). There are various types of milk replacer on the market; milk powder with and without a portion of skimmed milk powder. Research has shown that milk powder without skimmed milk powder is very suitable as a food source for calves and that the same growth rates can be achieved. It should be noted, however, that during the first two weeks of their lives, calves have difficulty digesting non-milk proteins. For this reason, it is recommended to switch over to milk powder without a portion of skimmed milk powder only after this age.

3.3 From abomasum to the development of the rumen

The stomach system of young calves is small and undeveloped. The abomasum (where the milk is digested) has a volume of 1.5 to 2 litres (0.40-0.53 gallon) in newborn calves. The rumen has a volume of just 0.75 litres (0.20 gallon). At the age of 8 weeks, both the rumen and the abomasum can contain 6 litres (1.59 gallon). The growth rate of the rumen at 3 to 8 weeks is greater than the growth rate of the calf herself. At the end of the milk phase the rumen has enlarged to a volume of 14 litres (3.70 gallon), while the abomasum can contain 7 litres (1.85 gallon). In adult cattle, the ratio rumen:abomasum is 90:10. Despite the lack of volume in the abomasum, 4 litres (1.06 gallon) of colostrum can easily be given. The surplus runs over into the rumen which, since there is no bacterial life present, does not present a problem.

Start of the rearing period

- Make sure the calf receives at least 3 to 4 litres (0.79-1.06 gallon) of colostrum during the first few hours after birth.
- Milk replacer better meets the nutritional needs of the calf.
- Milk replacer with or without skimmed milk powder can be fed to the calves; however, during the first two weeks of their lives, calves have difficulty digesting non-milk proteins.

Roughage stimulates rumen development

In addition to milk, calves soon adapt to concentrates and hay, which should be coarse and of a good quality. Calves gradually learn to eat solid feed until they are eating 1,5 to 2 kg (3.3-4.4 lbs) a day after weaning. The rumen wall of young calves contains very little rumen papillae. The rumen is stimulated through the feeding of coarse roughage, the right kind of concentrates and energy. The more the animals absorb, the easier it is to reduce the milk phase. The transition to solid feeds is smoother if the rumen is well-developed and healthy. In addition, fresh water must not be overlooked. It is advisable to supply fresh water when the calf is 1 week old. Calves require 10% of their body weight in water every day. Especially on warm days, the need for water is greater than the few litres of milk the calves receive. In the winter period, the need for energy for calves in the milk phase is higher. Due to the cold, more energy is needed to provide the calf her basic needs.

3.4 Group housing

During the first few days of their lives, calves should be housed in individual calf units or in igloos, depending on the capacity of the farm and the climate. The farmer or animal attendant can then keep watch over the individual calves and they will immediately notice when a calf has not drunk her milk. If it is lethargic or has diarrhoea then there will be no doubt as to which calf is sick. Moreover, the chance that the animals infecting each other is greatly reduced.

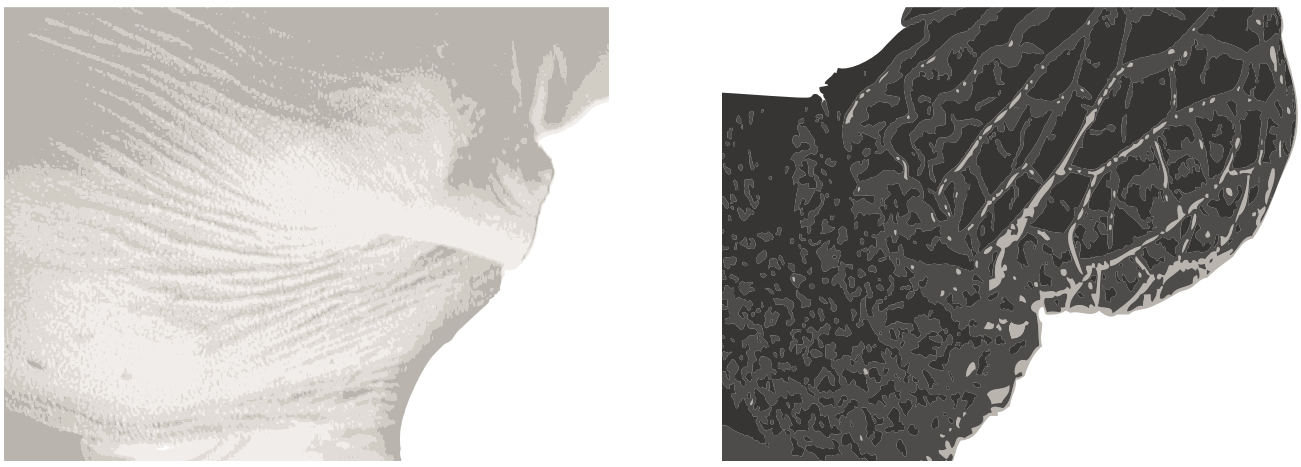
After 3 to 10 days in the single pen, the calves are able to fend for themselves and can be moved into the group (with a minimum of 1.5 m^2 space per calf). This is where the animals learn to socialize and, above all, they have more room to develop their frame and muscles through running and jumping. In group housing, calves can easily be fed through a Lely Calm automatic calf feeder. This keeps the animals healthy because they are fed several times a day, and the quality of the milk is constant and at the right temperature. Housing calves in groups requires less work (labour-saving and relief), but it requires more skill of the farmer. The eye of the master watches over the health of the animals, where monitoring of the milk and feed intake form a very important part. Furthermore, it is difficult to ascertain which calf has diarrhoea, for example. When calves are unable to compete with the others in the group or are ill, it is advisable to (temporarily) house them separately.

3.5 Automatic calf feeder encourages better growth and health

For calves housed in groups, a Lely Calm automatic calf feeder is the perfect solution. Depending on the type of automatic feeder, it can provide 25-30 calves with predetermined portions of milk several times a day. This way of feeding is particularly suited to the biorhythm of the animal. The calf drinking station prepares each portion in the same way.

- Distribution to a natural pattern over the day.
- Fresh preparation of each portion.
- Correct temperature of 39 degrees Celsius (102 F) for the calf's digestive system.
- Accurate distribution of milk powder.
- Milk quantity per visit may depend on the age of the calf.

Figure: **rumen of a calf fed on milk and hay (left) and the much greater rumen development in a calf fed on milk/hay/concentrate (right).**



Source: Pennstate University

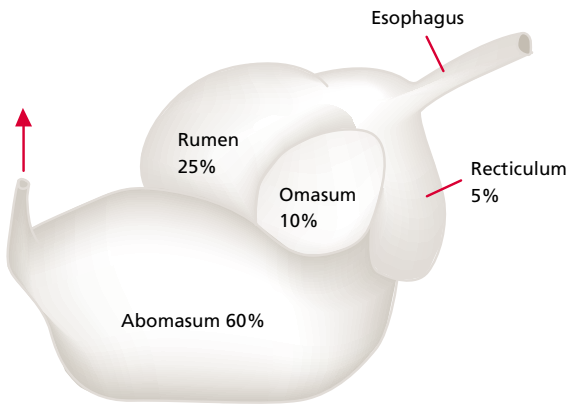
This results in a better health and growth. Loss is limited during the rearing stage. The Calm provides milk at a constant temperature, at the same concentration and in portions that are precisely adapted to the calf's needs. It is also quite easy to feed the animals four times a day and then gradually reduce the milk yield so that weaning takes place slowly. The animals will then have more time for the intake of roughage which will stimulate rumen development. The calves will be trained to the stage of ruminant more quickly and will have less weaning problems.

With the Lely Calm, the work of the dairy farmer is limited to monitoring. However, that too is a very important task! The automatic calf feeder should be checked and cleaned on a daily basis. Calibration is a monthly chore during which the amounts of water and milk powder are calibrated. This can be done very simply through, for example, determining when one bag of milk powder is empty. For example, if 20 calves consume 5 litres (1.3 gallon) of milk a day, the milk replacer will be used up after two days (200 litres / 52.8 gallon of milk).

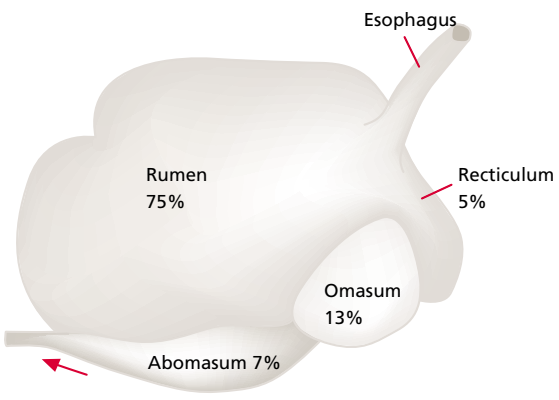
Development of the young calf

- The feeding of good quality roughage and concentrates stimulates the rumen development of the calf.
- Depending on the climate and the capacity of the farm, individual housing during the first few days of the calf's life is preferable.
- After 3 to 10 days, the calves can be housed in groups with an automatic feeder; socialization of the calf can then begin.
- House sick or problem calves separately until they are sufficiently recovered and can compete in the group.

Figure: **rumens of the young calf and the mature cow**

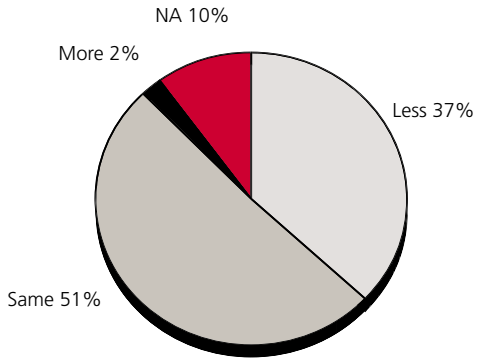


Approximately 3 litres
(0.79 gallon)



Approximately 100 litres
(26.42 gallon)

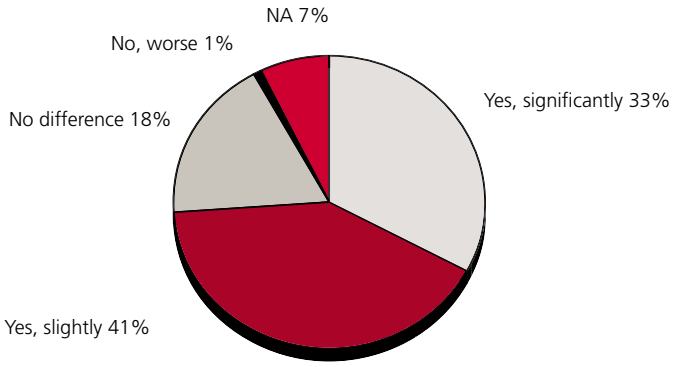
Diagram: **calf mortality with automatic feeders.**



According to 88% of Lely Calm feeder users, calf mortality is less, or at the same level than with the old traditional feeding systems.

Source: Lely Industries N.V.

Diagram: **improvement of calf's health.**



According to 74% of Lely Calm feeder users, the calf's health status has improved when compared to the old traditional feeding systems.

Source: Lely Industries N.V.

3.6 Less work and more flexibility

The Lely Calm offers farmers between 60 and 70% labour-savings and also flexibility of work. With 50 calves this is a saving of 2 hours a day, which means 700 hours a year. Moreover, peak labour periods on dairy farms are in the mornings and in the evenings, which coincide with the peak hours of the family. With the outsourcing of the milking to the robot and the feeding of the calves to the Calm, the peak is removed from these periods. Farmers can just as easily monitor the automatic feeder at 11.00 or 15.00. Monitoring once a day is a 'must', twice is recommended. On farms rearing 60 calves per year the Calm will pay for itself in three years. Moreover, the rearing costs will be lower given that the heifers will reach their insemination weight quicker.

Flexible robot use

The Lely Calm is the perfect way of preparing for a milk producing life with a milking robot. The animals learn from a young age to get their milk; this makes them assertive and, above all, they become accustomed to automatic feeders and all the noises that they make. The dairy farmer will profit from this when a heifer walks into an automatic milking system for the first time.

Standard feed program

A standard feed program provides the calves approximately 60 days with milk. During this period, they will have an intake of 415 litres of milk and 62 kilos of milk powder. On average, the concentration over the entire period is approximately 135 grams of milk powder per litre.

If the concentration of milk powder is required to be 130 grams per litre, this means that the system has to be set to portion 150 grams, since the powder is dissolved in one litre of water (1kg). In other words, 150 grams of milk powder to a total amount of 1,150 grams equals 130 grams per litre. The portions vary between 0.25 and 0.5 litre; per visit, the calves absorb between 1.5 litres to a maximum of 2.5 litres.

An example of a feed program could be as follows (read the program on the bag of the milk replacer):

- The first 5 days: 3 to 4 litres per day.
- Day 5 to day 9: 5 to 6 litres per day.
- Day 9 to day 32: 6 litres per day.
- 14 days prior to weaning: reduce from 6 to 2 litres.

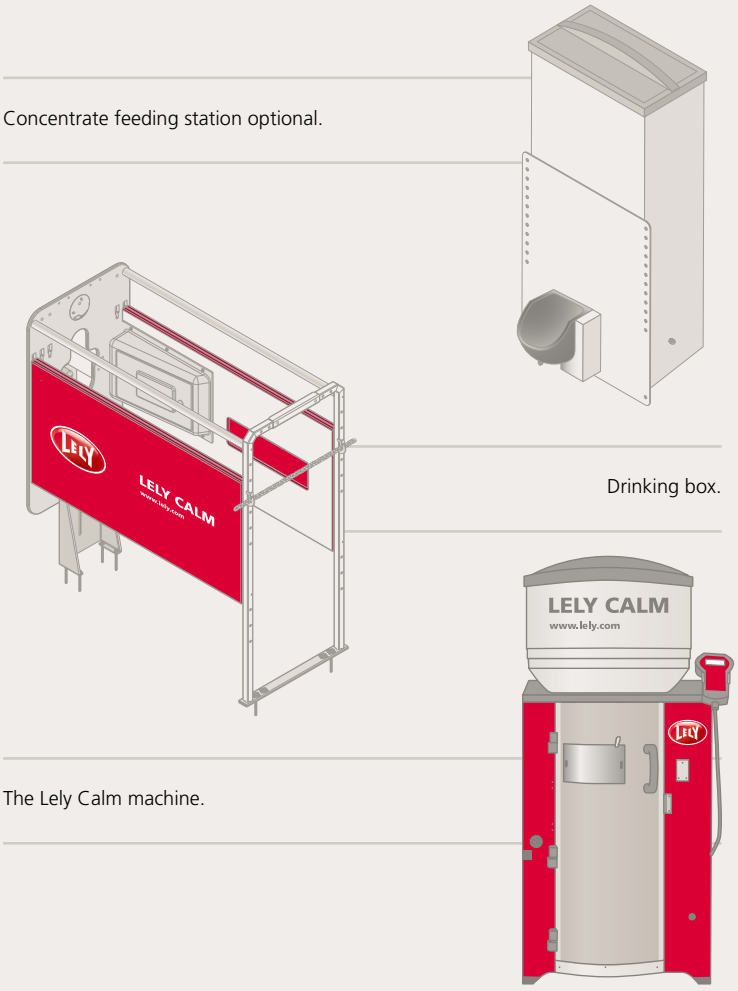
(1 litre=0.26 gallon / 100gr=0.2205 lbs)

In this period the calves should have unlimited good feed and fresh water at their disposal. After weaning, it is advisable to maintain the same conditions. Therefore, avoid rehousing, dehorning and vaccinating in the first week after weaning. Check the growth of the calves after weaning. This program is merely an example.

Circumstances make it necessary to adapt this program, for example, when the weather is colder. At a temperature of -4 degrees (24.8 F), the calves require 33% higher energy. At -18 (-0.4 F) they require as much as 75% energy. In preparation for the cold days during the year, Lely has introduced the calf coats. The calf coat helps the calf to keep warm, so that she spends less energy on heat regulation and more on her growth process.

This is how the Lely Calm works

The Lely Calm automatically mixes a measure of milk powder and hot water (the drinking temperature is 39 degrees / 102.2 F) to one portion of milk. The milk powder should be suitable for automatic feeders. The automatic feeder recognizes the animals from the transponders around their necks. As a result, the Calm knows exactly how much milk the calf should have, and not a drop more or less. Due to this individual recognition, calves of different ages can be held in one group, but it is also possible to have one feeder operate for two separate groups. When calves do not come to the feeder, the Calm will make an attention list of the animals that did not feed and in this way these animals will demand the attention of the farmer.

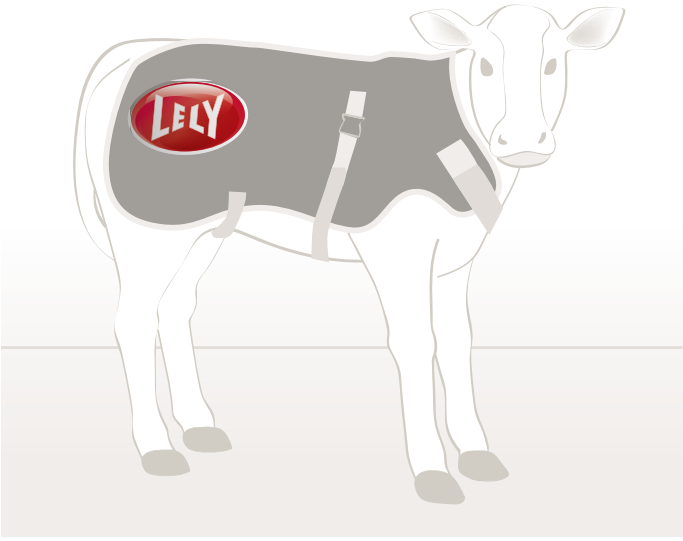


The most important advantages of the calf coat are:

- Optimal growth.
- Improved health (less chance of illness through draught, for example).
- Shorter rearing phase through improved growth results.
- Improved animal welfare.

In addition to the intake of milk, the intake of concentrates is very important for a good rumen development. Good development of the papillae in the rumen is achieved by feeding concentrate and hay, in addition to milk intake. The calf is then better adapted to digest the feed and grows at a faster rate. In East-European countries and in America, special TMR rations are being mixed for young stock in order to provide optimal energy and protein requirements.

Lely promotes feeding milk in combination with a concentrate feeding station. Connecting a concentrate feeding station to an automatic drinking station is an excellent way of controlling and monitoring the growth process.



Alpuro specialist Kai Kikkers “Without a good feeding program everything comes to a standstill”

Buy an automatic calf feeder, connect it to water, throw in a bag of milk powder and Bob’s your uncle. That, according to Alpuro Breeding calf specialist Kai Kikkers, is how it does not work.

“Without a good feeding program everything comes to a standstill”. After housing the calves in single pens, it is a question of slowly building up the maximum yield of approximately 6 litres (1.6 gallon) a day. “The feeding program should be fine-tuned to the calves, the farm and the farmer." Gradual reduction of the milk phase also takes approximately 2-3 weeks. That is one of the great advantages of the automatic calf feeder, according to Kikkers. “The rumen is given the opportunity to gradually take over because each day, the calf receives a few hundred millimeters less milk. You can’t achieve that with bucket feeding. During this period, the rumen grows by a factor of 3.”

“A great advantage of the automatic calf feeder is the constant temperature, quantity and concentration of the prepared milk". Kikkers mentions monitoring as being the most important task of the dairy farmer. “When you feed in buckets, you immediately notice when a calf is not feeling well; they do not come to you.” Working with an automatic calf feeder demands a different method. Monitoring of residual milk is essential. A calf that does not drink her milk is not healthy. “Is the calf lively? Is she breathing normally? Are there any peculiarities?" These are the attention points that Kikkers mentions, while emphasizing that the farmers should walk among the calves. “That is not done enough.”

He mentions the monthly calibration of the automatic calf feeder as another important monitoring aspect. “We calibrate the automatic calf feeder so that the correct temperature, amount of water and milk powder is apportioned", he says about the service that Alpuro Breeding supplies to its customers free of charge. If the milk is too thin, for example, it will go into the rumen because it looks like water. Clostridium and other diseases lie in wait, which could lead to the acute death of the animals.”

Stress is reduced and rearing improved by weaning the calf on the basis of weight and concentrate intake. In the Calm several feed programs can be preset to customize the feed system to the rearing strategy. As soon as the concentrate intake increases, the quantity of milk is reduced, reducing the costs for milk powder.

In addition to feed intake, water is essential for the development of a calf. From the age of 1 week, a calf should be able to avail freely of sufficient fresh, clean drinking water. In several countries spring water may be used to give to the calves. It is advisable to check the quality of this water at least twice a year since it has a major impact on the health of the herd.

3.7 Weaning without stress

Slowly reducing the milk yield will ensure that the calves automatically increase their intake of roughage. When the calves have reached an intake of 1.5 to 2.0 kilograms (2.6-4.4 lbs) of concentrate per day and weigh almost 80 kilograms / 176 lbs (depending on the breed and circumstances), they are ready to be weaned off milk. Their age is then between 7 and 10 weeks. It may seem young, but with a healthy growth, weaning is possible at 7 weeks of age. They can remain in the group even after weaning. The switch to other accommodation or another group can then be delayed and stress is reduced by the farmer; stress leads to less resistance and a higher susceptibility to morbidity and loss of growth.

The Lely Calm automatic calf feeder

- An automatic feeder can provide an average of 25 to 30 calves (per drinking pen) with the correct portion of milk and can supply further portions during the course of the day.
- The Lely Calm offers labour-savings of 60 to 70% and on farms rearing 60 calves a year, it will pay for itself in 3 years.
- The Lely Calm works perfectly in combination with concentrate feed stations; this is an excellent way of preparing calves for the milking robot.
- Calves should be able to avail freely of sufficient fresh, clean drinking water and sufficient roughage and concentrates (from the age of 1 week).
- When calves have reached an intake of 1.5 to 2.0 kilograms (2.6-4.4 lbs) of feed a day, they can be weaned off milk (they are then between 7 and 10 weeks old).

Wilco van Ginkel, Scherpenzeel (NL): “Collar on and ready”

“Together with the robot, the automatic calf feeder is the best investment that we have made on our farm." At the end of 2006, besides a Lely Astronaut, Wilco van Ginkel also bought a Lely Discovery mobile barn cleaner and a Lely Calm automatic calf feeder.

“Currently we milk 120 cows, and we have as many calves. It was just too much work”, according to the dairy farmer who farms in partnership with his father Gert in Scherpenzeel. Now he no longer needs to haul buckets. “At the moment we have 20 calves in one pen. Just imagine how much work that would have been with all that milk.”

Further, Wilco praises the health of the calves. “Occasionally our calves have suffered from diarrhoea, and we easily lost a couple within a few days. With the automatic calf feeder they are extremely healthy and, above all, they are growing faster. Feeding milk several times a day is much better for calves.

After they are born, the calves are placed in individual calve units or igloos for about 10 days. They are given colostrum and at first, normal milk. When the calves start to drink for themselves and are lively, they are placed in a group and put on Calm. “A collar on and that’s it”, says Wilco very easily. “We help them the first time and after that they are able to feed themselves." The milk amount is increased to 6 litres a day and afterwards very slowly reduced so that the calves are weaned off milk at 10 weeks old. “This takes place so gradually and automatically that the calves have more time for the intake of concentrates and roughage, which makes weaning a smoother process and less stressful. We no longer have any calves crying for milk.” In addition, the machine is very consistent and does not make mistakes. “As a carer, you sometimes give them a bit extra or you forget something. The Lely Calm does not do that; it is very dependable.” The weaned calves remain in the group a number of days longer, but they no longer receive any milk. “When they are able to fend for themselves, we remove the collar and they are ready to be moved to the first laying box. Changes are made gradually, so that we do not have any stress during this difficult period. The work for Wilco and his father remains limited to checking and calibrating. “Once a month we check whether the quantities of water and milk powder are still correct. Our work now consists of checking on the system, which costs less time. You can do it whenever you like, which is more pleasant."

4 Growing: from weaning to calving

4.1 Optimizing maximum growth

After weaning, the next step is to optimize maximum growth of the calves. Up to one year of age, calves may grow as fast as they like. In fact, in order to achieve the goal of calving at 24 months, it is necessary to optimize growth in young calves as much as possible This means an intensive diet of high-quality protein (17%) and a high level of energy (900 VEM 'feed evaluation unit for dairy cows'). In addition, it is essential for the development of the rumen to have a diet that is sufficient in fiber. This diet could, for example, consist of course roughage or alfalfa which stimulates rumen muscle movement, resulting in good rumen development. This is the best way to train young calves to become dairy cows so that, at a later stage, they can process a substantial amount of roughage. TMR rations are used in Eastern European countries in particular, and also in Canada and America, in order to meet the requirements of young cattle. To limit feed transitions as much as possible, another option is to apply the so-called complete feed system. Until 6 months of age, the animals receive as much concentrate feed in a dry feeder, supplemented with unlimited hay. This system results in higher concentrate feed costs, but it saves on labour.

Proteins and energy

To balance the transition from the milk to the 'solid' rearing period, during weaning the animals should have an intake of 1.5 to 2.0 kilograms (2.6-4.4 lbs) of concentrate and sufficient roughage. For the youngest animals, a crude protein level of 17% is desirable.

Graph: **desired and realized weights in the first year of life.**

Source: De Heus Brokking Koudijs

From approximately 8 months old, this protein percentage can be reduced to 16% and ultimately to 15% when the animals have reached the period of insemination at 15 months. Particularly during the rearing period, this percentage of proteins is often lacking. A normal basic feed is often insufficient. Protein is required for building bones and muscle; in short, the skeletal growth. During the first year, the calf builds up its skeletal structure, which will increase the following year. The energy content in the young growth should, therefore, be at a high level.

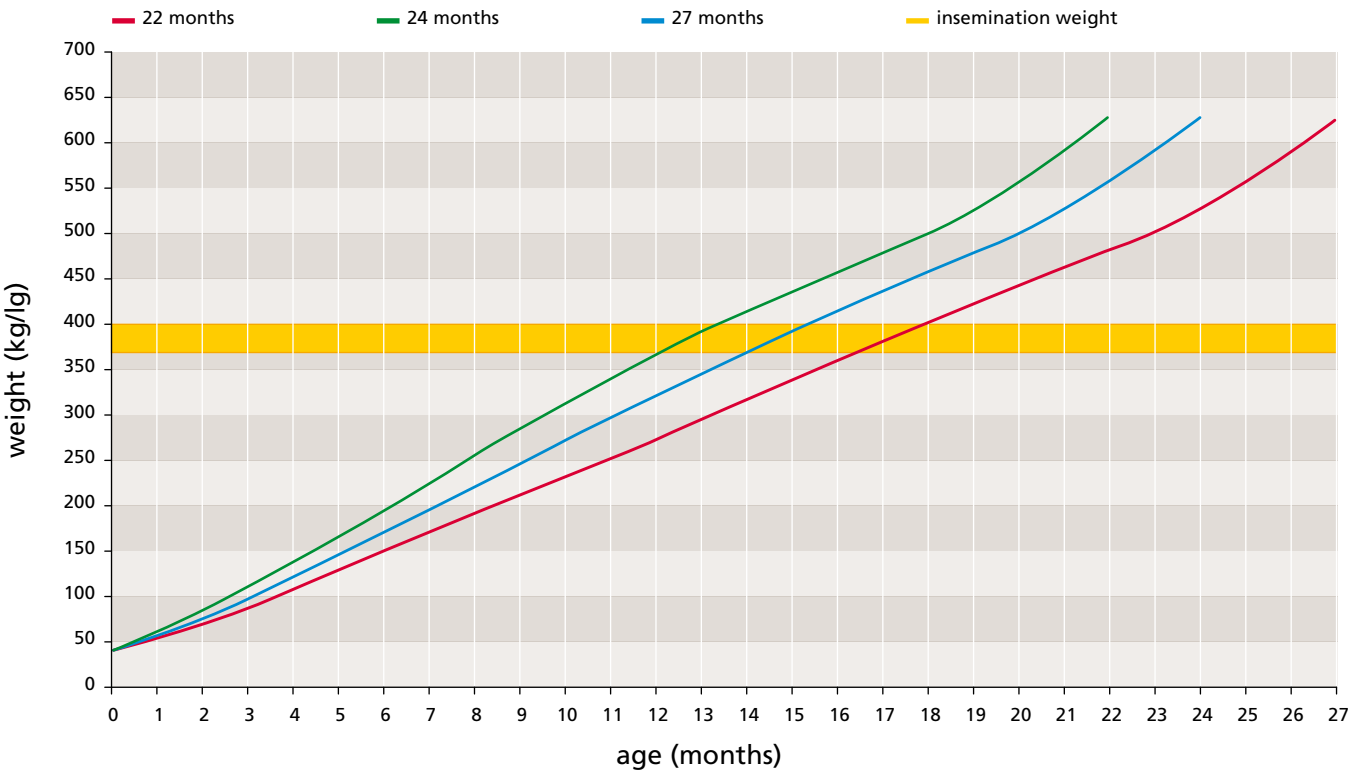
Growth is especially high in the first year of the cow's life; often up to 900-1,000 grams (1.98-2.21 lbs) per animal per day, however, a growth in development is also desirable. The animals may not turn to fat, which is a sign of an incorrect energy-protein ratio. Too little protein is the cause of round, podgy animals. After insemination, the growth will decline to approximately 500 grams (1.10 lbs) per day. The protein supply can be meager, and the feeding of too energy-rich feed, such as corn, makes the animals fat in this period. Good, structure-rich roughage is of vital importance to the continuing development of the rumen. Hay, supplemented with concentrate, is a good option. Also, a TMR ration attuned to the needs works well in the optimal development of young cattle.

Table: **Overview, growth, weight and chest circumference according to age**

Age (months)	0	2	4	6	8	10	12	14	16	18	20	22	24
Growth (gr/day)	600	850	900	950	900	825	750	675	625	575	500	400	250
Weight (kg)	40	77	128	183	241	296	347	392	433	472	507	537	562
Chest width (cm)	74	94	13	129	142	153	162	170	176	181	186	190	193

Source: Schothorst Feed Research (1 kg = 2.205 lbs / 1 cm = 0.39 inch)

Graph: **growth curves for different calving ages.**



Source: Hendrix-UTD (1 kg = 2.205 lbs)

Grazing season

It is advisable not to graze animals before the age of 6 months. Due to the risk of paratuberculosis and salomnella infection, grazing should begin at the age of 12 months. The grass intake of young calves is fairly limited. Young cattle up to the age of one year should receive additional feed in order to realize an optimum growth (for example, dry pulp or corn silage). From one year old, if there is a sufficient supply of grass, there is no reason to provide additional feed. The young stock are capable of consuming enough grass to maintain their bodies and to grow. It is recommended to house the animals timely before calving season begins. The animals can then be fed together with the close-up group of the dry cows.

4.2 Inseminating by weight

In practice, heifers often calve between 22 and 28 months. Research shows that the optimum age for heifers to calve is around 24 months. It is better, however, to assess the animals on weight and height. In order to produce enough milk and to compete in the herd, heifers should weigh approximately 570 kilograms (1,256 lbs) after calving. With this weight, they produce the maximum quantity of milk in their first lactation. Lighter animals will perform under the attainable level of milk production. The crotch height at calving is approximately 1.45 meters (57 inch) and the chest size 190 centimeters (75 inch). During insemination, a crotch height of approximately 1.32 meters (52 inch) is desirable and a chest size of 165 centimeters (165 inch). In order to achieve the calving goal, the young stock may be inseminated at a live weight of approximately 370 kilograms (816 lbs). These are standards that relate to HF animals.

Yearling bull or sexed sperm

The heifer requires a smooth start to its productive life. She must calve easily for a smooth transition into lactation. A yearling bull increases the chances of easy calving. Use bulls that have a good breeding value for ease of birth and also bulls that score well with calving so that, in turn, the daughters of these bulls have the right characteristics (crotch width and incline) to calf easily. Sexed sperm is also suitable for use on heifers. In 90% of the cases, a heifer calf is born; these are generally preferred and are somewhat lighter. According to dairy farmers who use sexed sperm, the fact that calving is easier is one of the advantages. The heifers are sprightly and full of life after calving which reduces the risk of disease and improves the fertility later on into lactation. The disadvantage of sexed sperm is that fertilization results are somewhat lower and the sperm is relatively expensive.

4.3 Accelerated rearing

The ideal calving age for heifers is approximately 24 months, or 2 years old exactly. There are, however, a number of rearing concepts that attempt to have the animals calve at a younger age, for example, at 22 months old. This results in the animals giving milk two months earlier, which means extra yield. Also, the rearing costs of the young calves decrease per kilogram of produced milk, assuming that the cows become at least as old. Accelerated rearing demands even more professionalism; at some stages the animals must grow one kilogram (2.205 lbs) a day in order to achieve the intended goal. This means smart growth plans and in particular the carer must stay on top of things at all times. There can be no setback at any stage and, as far as grazing is concerned, it appears that the objective is difficult to achieve because the circumstances vary too much and adjustment is often necessary. Every dairy farmer will select a calving age that best suits his personal qualities and business. It is important, however, to choose the desired calving age and to adapt the entire rearing period accordingly.

4.4 Measuring is knowing

Anyone with a natural aptitude for rearing young cattle will regularly take a measuring stick and measuring tape to the barn. However, the best thing would be to weigh the animals regularly since this is the most accurate method. There are at least three important stages in the life of a young calf when she should be weighed: after weaning, during the insemination period (at 15 months) and after giving birth. Combine these details with the condition score of the animals.

As with dairy cows, young calves have an optimum condition score. For a balanced growth, optimum fertility and healthy calves, the ideal condition score is between 2.5 and 3. Just before calving, the animals should achieve a condition score of 3.5 so that they have some body reserves at the beginning of lactation. The skeleton is plainly visible in growing animals; the ribs and the outline of the back can be clearly seen without appearing lean and the coat is short and glossy. A nice wedge-shape indicates a good rumen development and that the animals are able to process large amounts of roughage. Obese animals (too much energy, not enough protein) have more difficulty becoming pregnant; they have fatty udders and difficult births. At insemination obese animals already have a condition score of well above 3. Too thin animals do not gain the necessary kilograms and start their productive lives at a disadvantage. Use this information to readjust the management and the feeding program.

Growth during the first year of life

- Young growth must be fully utilized (900-1000 grams per day) for the calf to be able to calf down at the right moment (usually 24 months).
- A ration attuned to the needs is necessary to achieve optimum rumen development, carcass development and weight development of the calf.
- Protein is often the limiting factor in the rations of young cattle (a protein percentage of 16% can be fed up to one year old).
- Grazing of young cattle requires specialist knowledge and attention; young animals are not capable of consuming sufficient grass and there is an increased chance of transmitting diseases.

Jackie Moncton, Nantwich (UK) “I save 10 hours a week”

Farmer, mother of two children and a full partner in the dairy farm with 225 cows, Jacky Moncton from Nantwich in England had 1,001 daily chores to do, including bucket-feeding 35 to 40 calves.

“And that is something I wanted to do well, because calves are the dairy cows of tomorrow, of course. The healthier the calves, the lower the loss when they start producing milk.” It was, therefore, quite logical that she and her husband Martin decided at the end of 2006 to feed the calves via an automatic calf feeder. “In this way, I save 10 hours a week, say, 5 days of 2 hours. “Now, I no longer have to run ahead of myself." Her work is now limited to cleaning and checking up on the calves. “I do that consistently every other day. I replace the nipple every 10 days.” Jacky admits that this is perhaps too often. “But in this way you avoid transmitting infections; after all, 25 calves drink from one nipple and some suck on it more than 100 times a day.”

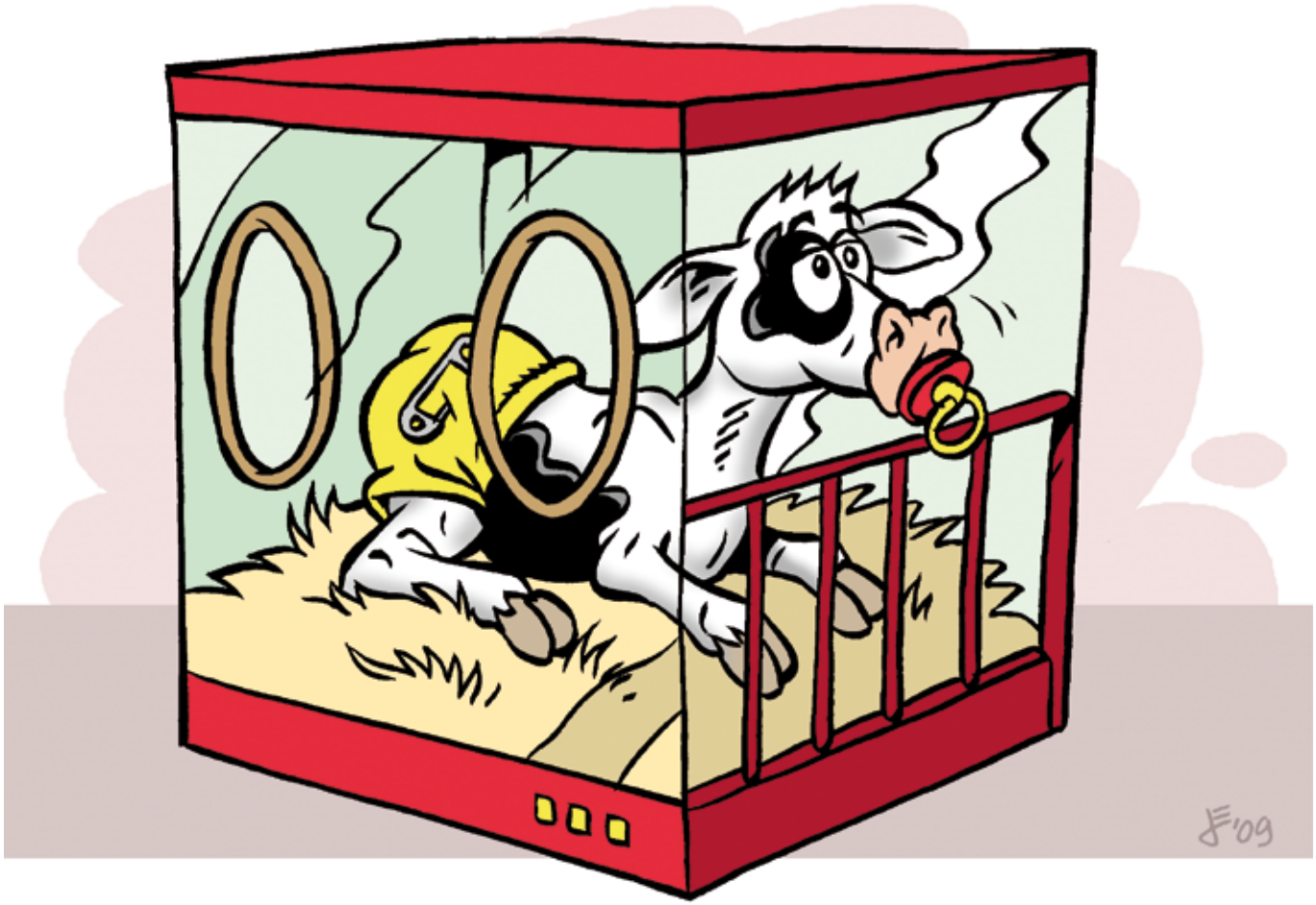
The calves are doing extremely well on the feeder. “With the first group, I noticed that they were becoming bigger and heavier.” What's more, the calves are much healthier. “This is because the feeder is reliable and consistent.” Particularly the feeding of several portions a day is considered by Jacky to be an enormous advantage. “This ensures a more balanced growth, which improves their resistance. We now have fewer losses.” We also have less sick calves. Another advantage of the machine is the alarm function. When calves have not (completely) drunk their portion, it is called to the attention of the dairy farmer,. “It can actually see when there is a sick calf quicker than I can.” Of the 125 calves that they rear each year, there were 3 during the last two years that did not want to drink initially. “I put them back in the single pen for a week and then I had success. They are just like babies; you have to treat them all differently." The only one who had to learn to adapt was Jacky herself. “I had to learn to trust the machine. Meanwhile, I can read and write with it and resolve potential problems myself".

Insemination of the young stock

- For insemination of young cattle a certain (body) development is desirable; weight approximately 370 kg (816 lbs), height approximately 1.32 meters (52 inch), chest size 165 centimetres (65 inch).
- The use of a yearling bull or sexed sperm can be used for the insemination; it is important that the heifer calves easily and that she enters into her first lactation smoothly.
- The optimum calving age for heifers is approximately 24 months based on the economic results (less rearing costs and a higher milk production).

Procedure for rearing young calves

- The decision as to which age heifers should calve is dependent on the type of dairy farmer and the specific circumstances of the company and the country in which it is located.
- Accelerated rearing lowers the costs per kilogram of milk with an equal life span and milk production.
- Measuring is knowing; take a tape measure and measuring stick or weigh the animals regularly.
- Also condition score plays an important role with young calves; obese animals will have difficulty in becoming pregnant and often have more problems during calving.



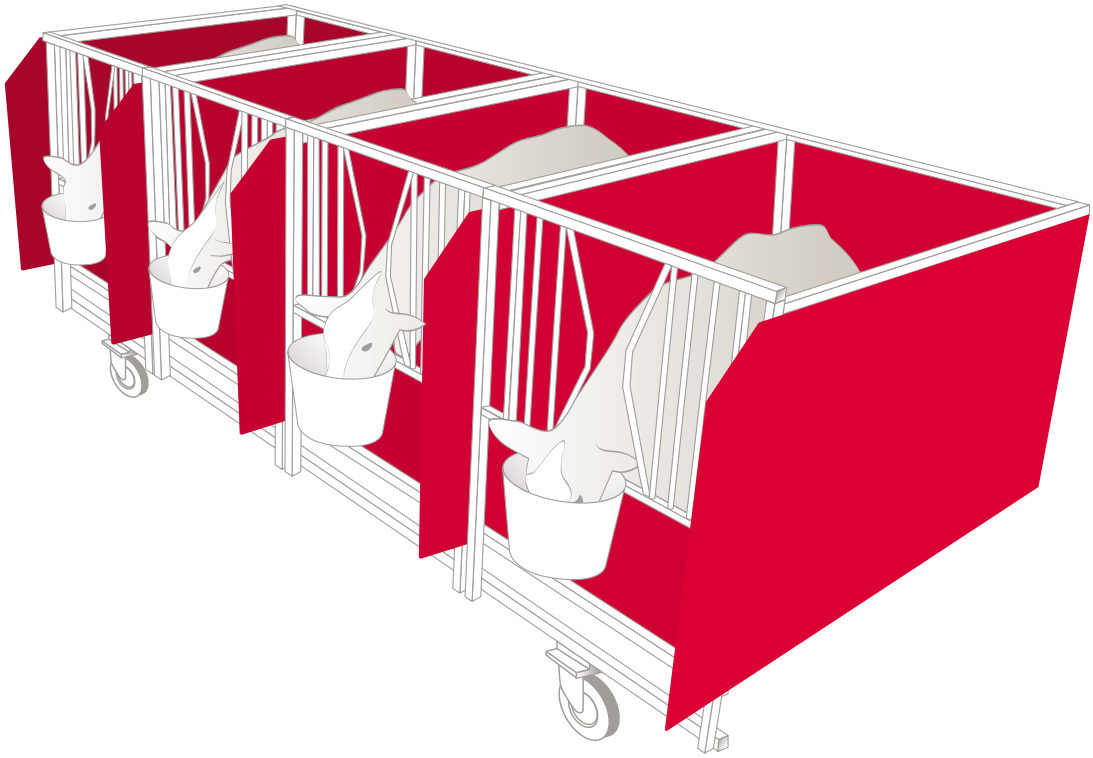
5 Housing and climate

5.1 Healthy rearing

Separate housing away from the older cattle is an import part of rearing young calves up to the age of one year. Young calves contract diseases easily when they are in contact with older calves or cows. Infections from E-coli, paratuberculosis and salmonella, which are present in the manure or milk of older cattle, are a direct threat to young calves. Respiratory infections are also easily transmitted to younger cattle by the older ones. Housing young calves separately, erecting a hygiene sluice and maintaining a work sequence from young to old will limit the transmission of diseases. A regular calving pattern will also reduce the burden of disease and will ensure a continuous and regular work process.

5.2 Individual housing

After the birth of a calf, it is advisable to remove the animal from its mother as quickly as possible to reduce the risk of disease transmission. In the first week of life, individual housing is preferable. Calves are less able to suckle or lick each other, thereby reducing the risk of umbilical inflammation and disease transmission. In addition the animals can be monitored more easily. Separating the heifer calves from the bull calves prevents the cattle dealer being in contact with the heifer calves when collecting the bull calves, reducing the risk of introduction to disease. With individual housing, calf igloos or single pens are normally preferred. Furthermore, it is important that the calves are kept warm and dry.



Calves in individual mobile units.

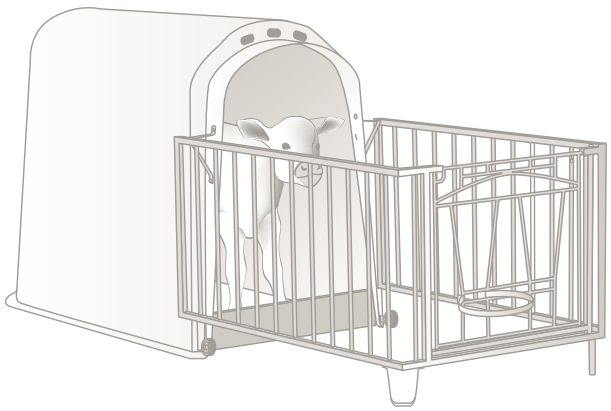
Straw, sawdust and, in certain cases, sand, make a perfect bedding. In cold weather, extra bedding should be used and calf coats can be used.

Draught-free housing is essential. Be careful with too much draft caused by the chimney effect when placing igloos between two barns or between silage plates. Place the igloos or pens close to the house or the milking parlour so that the carer regularly walks past during his daily routine. This makes it easier to check on calves several times a day. After a calf has been moved out of an igloo or single pen, these must be thoroughly cleaned and disinfected in order to avoid transmitting disease to the next calf.

Single housing

Individual calve units for calves can be placed both indoors and outdoors. Igloos function perfectly outdoors. Calves reared outdoors in igloos are placed immediately away from the source of infection. However, this means that the dairy farmer will have to go outside to feed, even in bad weather. Large companies often have special calf streets, in other words, a special area where all the calves are housed, for example, in igloos.

It is important that the housing facilities are easy to clean. Therefore, make sure that partition walls are of a smooth material. Individual calve units on castor wheels are very handy as they can easily be moved elsewhere or wheeled over to the cleaning area. The floor on which the individual calve units or igloos stand must preferably slope by 2% towards the drain behind or under the pen. Place the pen preferably 30 to 50 cm (12-20 inch) above the ground for sufficient drainage of the urine. Avoid draught from cellars, for example, by spreading straw on slatted floors.



Calf in calf igloo.

Advantages of individual calve units:

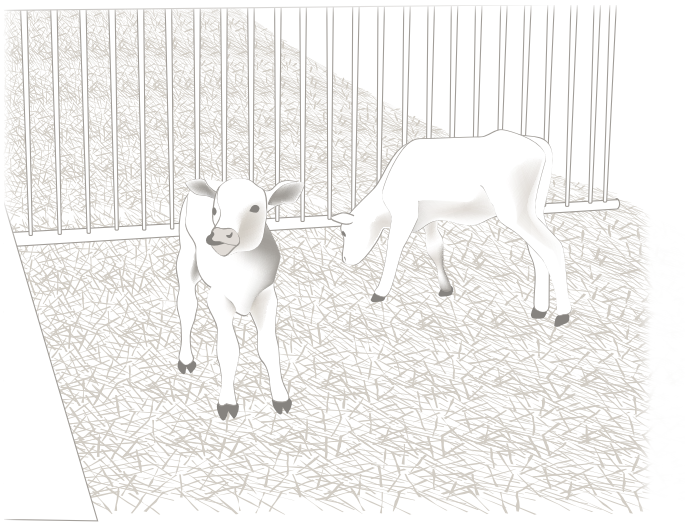
- Indoors, individual calve units can be placed in the vicinity of other calves.
- The climate outdoors is favourable.
- Milk, water and feed are easy to supply.
- No rising damp.
- Lower risk of infections due to thorough cleaning.

Disadvantages of individual calve units:

- The floor underneath the pen also needs to be thoroughly cleaned.
- Unoccupancy is preferable between two consecutive calves.
- Feeding takes place outside when the pens are outside.
- High straw consumption.

5.3 Group housing

Calves older than two weeks may not be housed in individual calve units in many countries. Group housing is, therefore, compulsory and has the advantage of being less labour intensive. When a Lely Calm automatic calf feeder is used, the calves are already in groups from week one on a bedding of straw. Because the risk of infection in group housing is greater than in individual housing, this demands extra vigilance. With diarrhoea, for example, it is more difficult to detect which calf is the sufferer. A change in the pattern of milk intake of calves is a clear signal that something is wrong. Calves that do not drink sufficient milk or do not pay enough visits to the feeder should be monitored.



Calves in straw pen.

Individual housing

- Young calves can contract various diseases through contact with older calves or cows; try to work hygienically and house calves separately until they are 12 months old.
- In order to limit the transmission of disease, it is advisable to remove the calf from its mother immediately after birth.
- For the purposes of monitoring and hygiene, it is advisable to house calves individually during their first days of life.
- Monitoring is important in order to quickly signal disease or abnormal behaviour of the calves; housing should be adapted accordingly.
- Larger businesses often have ‘calf streets’ where all calves are housed in one area.

Housing on straw bedding up to the age of 6 months is preferable to lying stalls. In straw pens, the calves always have a dry area in which to lie down. A damp, warm environment is an ideal source for bacteria; therefore, sufficient bedding and the avoidance of damp areas are of great importance. Prior to placing a new group of calves in the pen, the pens must be thoroughly mucked out, cleaned and disinfected.

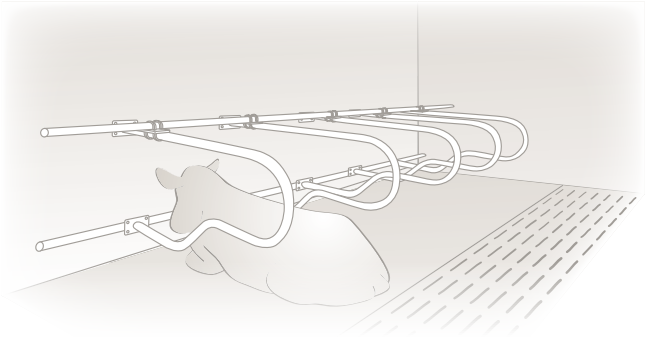
Group housing should have a floor with a 2% slope to enable the slurry to drain away. A disadvantage of pens with a full bed of straw is the higher straw consumption. In group housing it is also important to have groups of a uniform size to prevent the smaller and weaker animals from not receiving sufficient feed. When using feeders, try to use two drinking pens or make use of a swing gate. Each group must avail of fresh and sufficient drinking water, concentrates and roughage.

Partially slatted floors

Instead of a full bed of straw, calves can be housed up to the age of 6 months in a so-called two-floor stall. Part of the stall consists of a slatted floor and the other part of a sunken lying area with straw. To ensure ease of work, it would be useful when building the stall to create the possibility of mucking out the straw area mechanically. The calves can feed and drink in the slatted area. The advantage of this is that the lying area remains cleaner and dryer compared to full straw pens. This has a positive effect on the health of the calves. Housing calves on full beds of straw, or in two-floor stalls, is better than housing them too young in a lying stall, even if the latter is less labour-intensive.

Cubicles

It is preferable to house older calves in a free stall barn because mucking out is less labour intensive. Also, savings can be made on bedding costs. It is important that the size of the cubicles is adapted to the age and size of the calves. When cubicles are not the right size, there is every chance that the calves do not learn to lie down in the cubicle in the correct way. There are stall dividers for sale without legs that are easily adjustable, and thus suitable for various age groups. The cubicles must be foreseen of bedding. Young calves older than 12 months can be housed with the dairy cows in the barn. The housing of dairy cows younger than 12 months is not recommended due to the transmission of disease. More information on the various housing standards in the Netherlands is given in the appendix.



Older calf in cubicle.

How many places do I need for young calves?

The number of places required for the various age groups of young calves depends on the calving pattern and the amount of young calves needed to replace dairy cows

- **The calving pattern.** When many cows calve within a short period, many individual calve units and housing facilities for calves up to three months old are required. The table below provides an example of the number of places required for young calves with a reasonably spread calving pattern.
- **Replacement.** To replace livestock, each year it is necessary to retain approximately 35 heifer calves per one hundred dairy and calf cows (retention percentage of 35 per cent). However, farmers regularly keep all heifer calves (50 per cent). The table below is a summary of the number of places for different age groups and with retention percentages of 35 and 50 per cent.

Table: **the number of places required for young calves per age group with retention percentages of 35% and 50%.**

Retention %	35%			50%			
Age of animal (months)	Number of places young calves with number of cows			Number of places young calves with number of cows			Type of housing
	60	100	650	60	100	650	
0-0.5	9	15	90	9	15	90	Individual pens
0.5-3	9	15	90	12	20	130	Straw hutches
3-6	9	15	90	15	25	162	Straw hutches/ Free stall barn
6-12	12	20	130	18	30	195	Free stall barn
12-18	12	20	130	18	30	195	Free stall barn
18-22	6	10	65	12	20	130	Free stall barn

Source: Dairy Farming Manual 2006

Group housing

- Group housing requires less labour but more vigilance; the Lely Calm attention lists can offer support during monitoring.
- Up to the age of six months, housing on straw bedding is preferable.
- Pens with partial slatted floors have a lower straw consumption.
- When young stock is housed in free stall barns, the dimensions of the cubicles are important in encouraging good use and a normal lying position.
- The number of places required for young calves is dependent on the replacement percentage and the calving pattern.

5.4 Ventilation

Keeping young calves outdoors is the best way of guaranteeing sufficient fresh air. When young calves are housed indoors, the risk of respiratory problems through poor ventilation is much greater. An unfavourable stall climate has a negative effect on their resistance. A seemingly fresh stall can be much less pleasant at lying height of the animals than anticipated through ammoniac, draught or a temperature that is too low. Also, too small a section (surface and height) can provide a stuffy environment, resulting in respiratory infections. The stall content must be at least 6-8 m^3 per calf and approximately 15 m^3 per yearling.

Good ventilation means that gas, warmth and moisture are adequately filtered and sufficient fresh air is supplied. The amount of warmth that cattle produce determines, for a large part, the ventilation requirement. Good ventilation is also essential for reducing the transmission of pathogens from calf to calf. Most cowsheds are ventilated naturally.

The size of the inlet opening (in the side walls) and the outlet opening (in the ridge) determines the ventilation capacity (see table). Always build a cowshed transverse to the dominant wind direction, which ensures good natural ventilation. The use of open facades, for example using wind break cloth or curtains for closing off, has already greatly improved the ventilation of many cowsheds. With higher outdoor temperatures, it is advisable to support the natural ventilation with mechanical systems. A well-insulated roof also ensures a better indoor climate, both in hot and cold weather. Finally, it is important to avoid sudden drops in temperature, especially with young calves, for example by mounting air-controlled plates under air passages.

More information about optimal ventilation is given in the appendix (based on circumstances in the Netherlands).

Ventilation

- The risk of respiratory problems is greater with poor ventilation; therefore, ventilation should receive attention.
- Good ventilation means that gas, warmth and moisture are adequately filtered and sufficient fresh air is supplied.

Table: **surface area of inlet opening (cm²/animal) in young cattle and differences in height between inlet and outlet openings.**

	Difference in height between inlet and outlet opening			
Age (months)	3m	4m	5m	6m
1	250	220	195	175
3	400	350	315	285
6	700	600	540	495
12	1,010	875	780	710
18	1,360	1,175	1,050	960
22	1,650	1,425	1,275	1,170

Source: Handboek Melkveehouderij 2006 (Dairy Farming Manual 2006)

Table: **Ventilation capacity for young cattle**

Age (months)	Average weight (kg/lbs)	Ventilation capacity (m³/hour)
1	60 / 132	60
3	100 / 220	100
6	175 / 386	170
12	305 / 672	245
18	425 / 937	330
22	500 / 1,102	400

Source: Handboek Melkveehouderij 2006 (Dairy Farming Manual 2006)

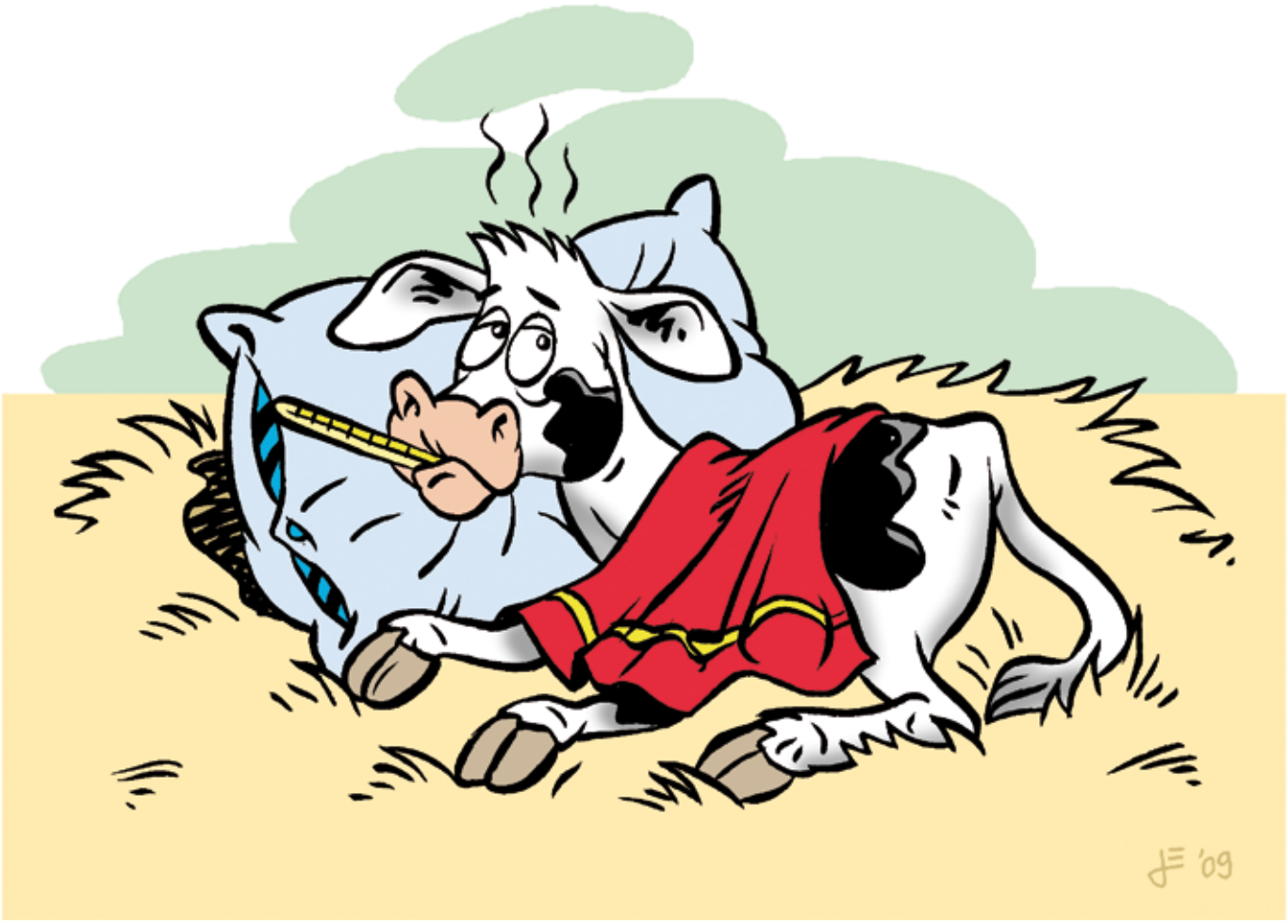
Klaas Swaag, Barsingerhorn (NL): “Less rearing costs and healthier cows”

When the brothers Klaas and Jan Swaag from Barsingerhorn built their farm, ease of labour was the first priority. Which is why, in 2006, besides a robotic milking machine, an automatic calf feeder was installed.

“We milk 120 cows, producing 1.1 million liters of milk, but because Jan has quite a lot of committee work, we have arranged it so that one man can run the company", explains Klaas. The calf feeder saves him approximately half an hour a day. “The work now consists of monitoring and cleaning”, he explains, adding that maintenance is quite easy. "We replace the nipple once every three months and clean the bottle with a detergent.” It is also better for the calves. “Three to four times a day they receive milk of the exact same concentration and at the same temperature. The calf benefits from this standard routine.” How warm should the water be, how much milk powder should you put in the measuring jug; everyone does it a different way, the dairy farmer indicates. “And now there is no longer that difference. The feeder prepares it the same way each time."

Klaas is convinced that the calves are growing faster and using less milk powder. “This reduces the rearing costs and we rear young calves that grow to be healthy cows."

In principle, the calves receive milk during exactly 70 days. “The feeder does not give a calf an extra week of milk when another calf in the pen is still receiving milk. As a carer, however, you do”, says Klaas as an example. “But when a calf is too light, it remains on milk replacer a few days longer. You have to remain flexible, which is quite easy." At approximately 10 days old, the calves are moved to the drinking box. “They are then strong enough to fend for themselves.” During the first few days, Klaas feeds them from the bucket. “First I bring a few attention cows to the robot and then I give the newborn calves feed and monitor them. I have a fixed routine in my work.” The brothers consider the investment to be profitable. “As a farmer you don’t always calculate your hours, however, due to the reduction of labour, you have more energy and that is good for your business, as well as your social life."



6 Sick calves – prevention is better than cure

6.1 Calf mortality rate too high

On dairy farms, approximately 12% of calves die before the age of six months. This is too high; it costs money and extra time. Something can be done about this; the best companies have a calf mortality rate of 3 to 4 per cent. With the proper care and management of young calves, many health problems can be avoided. Hygiene and feeding are crucial elements. Good colostrum management increases the calves' resistance, reduces the risk of pathogens and produces healthier calves. In addition, proper milk management during the first four weeks plays an important role in preventing diarrhoea. Supplying milk through an automatic feeder significantly reduces the risk of feeding errors. The Lely Calm automatic calf feeder simulates 'nature' as it were, through the distribution of four small portions of milk a day in the correct concentration and at the optimum temperature. The calves can then digest the milk properly, and diarrhoea occurs less frequently.

6.2 Infectious diarrhoea

During the calf's first month of life, diarrhoea is by far the greatest threat to its health. Newborn calves become infected through the manure of cows and older calves, which often contains all the agents of calf diarrhoea. Diarrhoea is not only the primary cause of death in calves, it also leads to considerable growth retardation. The calves often remain sensitive to infections. Diarrhoea is caused by food or infections. Calves can become infected with bacteria (E-Coli, Salmonella), viruses (Rota and Corona) and parasites (Cryptosporidium, Coccidiosis, gastric and

Infectious diarrhoea

- Diarrhoea is the primary cause of mortality in calves; approximately 12% of calves die before the age of 6 months.
- Calves can become infected with bacteria (E-Coli, Salmonella), viruses (Rota and Corona) and parasites (Cryptosporidium, Coccidiosis, gastrointestinal worms).
- Manure research can establish the cause of diarrhoea.
- Early treatment is necessary to prevent weakening and dehydration of the calves.
- In older calves, worm-induced diarrhoea can occur during grazing.

intestinal worms). The period during which diarrhoea occurs can be indicative of the diagnosis. Food induced diarrhoea mainly occurs from week 1 to week 3.

When a calf has diarrhoea it is important to act as quickly as possible. Calves lose moisture rapidly, which leads to dehydration. Check twice a day for signs of diarrhoea. In order to determine the exact pathogen, research of the manure is necessary. Collect a sample of manure immediately after noticing diarrhoea. You will need at least five manure samples. The calves can then be treated effectively and the sooner the better.

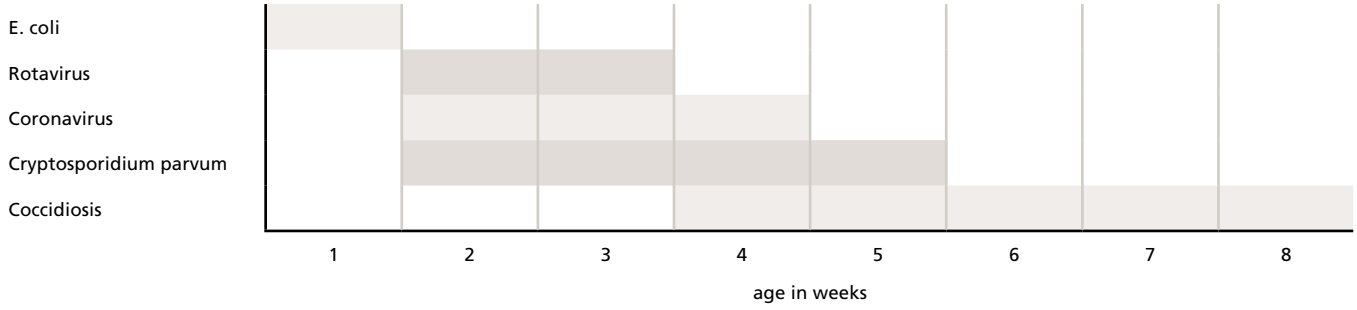
Worm induced diarrhoea

As soon as the older calves go outside, there is every risk that they will become infected with gastrointestinal worms. The worms are present in the abomasum or in the small intestine and cause a lot of damage, resulting in diarrhoea and growth retardation. The adgistment (or "custom grazing") of calves on hay afterwards from the month of June, or on a fresh pasture that has not been grazed in the current year, will reduce the risk of infection. Draw up a worming and grazing schedule, together with the veterinarian, and use manure and blood samples to evaluate worm management on a yearly basis.

6.3 Food induced diarrhoea

Food induced diarrhoea upsets the calf's intestines through incorrect nutrition. The calf receives too much milk at once or the consistency, concentration or temperature of the milk is wrong. The maximum quantity per portion in the Lely Calm automatic calf feeder is 2.5 kilograms (5.5 lbs) of milk per feed. Mixing milk powder in water that is too hot causes the so-called Maillard reaction, resulting in deterioration of protein digestion. Protein then lingers behind in the intestines. Due to the osmotic value of the intestine content, water is sucked from the blood to the intestines.

Graph: **diarrhoea during the first four weeks is mostly caused by: E-Coli, Rotavirus, Coronavirus, Cryptosporidian or food induced diarrhoea. Diarrhoea in calves older than four weeks is caused by: Coccidiosis, food induced diarrhoea, BVD, gastrointestinal worms.**



Source: adapted from De Gezondheidsdienst voor Dieren

Food induced diarrhoea

- Food induced diarrhoea is caused by a faulty diet; the mixture, concentration and temperature are all influential factors.
- The Lely Calm contributes to the accurate feeding and the required monitoring of the calves.
- With the Lely Calm, the natural drinking position of the calf is imitated, which encourages the oesophageal groove reflex.
- Food induced diarrhoea can be prevented through proper management of the milk stage of the calves.

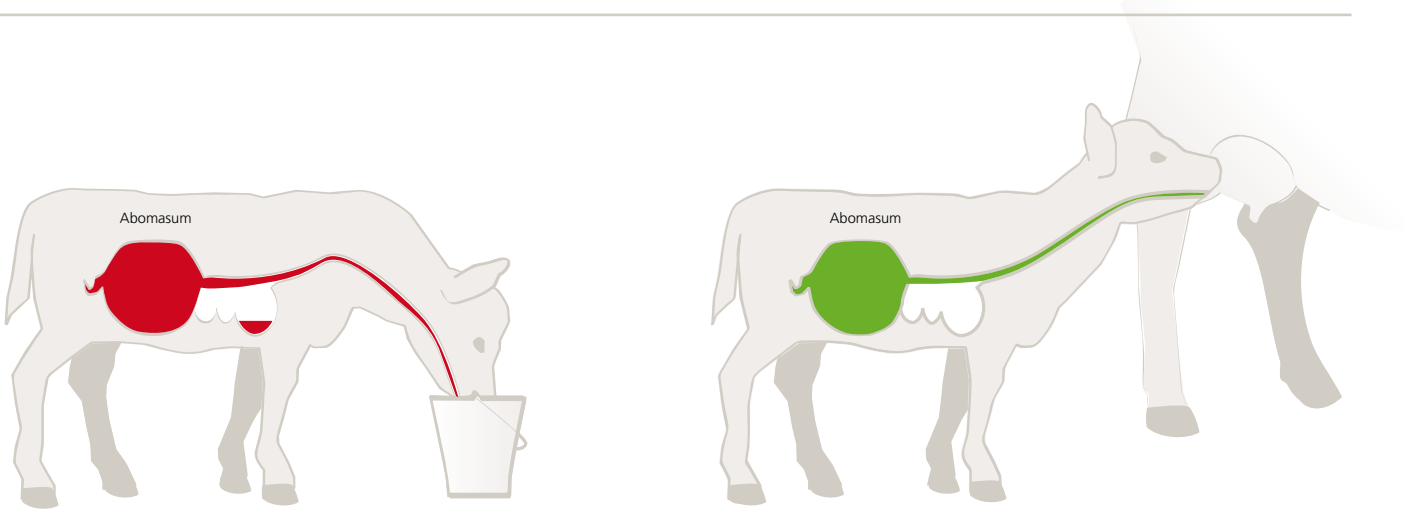
Hot water can also cause problems with fat digestion. It is also important to ensure the proper functioning of the oesophageal groove reflex, whereby the milk goes directly to the abomasum. The drinking behaviour of the calf, the temperature and the concentration of the milk is important in this respect. When the oesophageal groove reflex does not function properly, the milk enters the rumen where it ferments and hinders the uptake of important nutrients. These so-called ruminal drinkers can also suffer from abnormal gas production in the rumen, causing the rumen to swell. These calves are running up because of the gas accumulation. The remedy for food induced diarrhoea is the temporary reduction of milk (do not completely stop the milk supply) and the provision of electrolyte drinks to compensate for the loss of moisture.

Food induced diarrhoea can be prevented through proper milk management and the correct choice of roughage. Using a well-adjusted Calm automatic calf feeder prevents human errors during the preparation and distribution of milk. Illness through food induced diarrhoea is, therefore, less frequent than with calves given milk in buckets. Also, the natural dinking position with the Calm feeder plays a positive role in the stimulation of the oesophageal groove reflex and the prevention of ruminal drinking.

6.4 Airways

Respiratory infections are the second major cause of death in young calves. Approximately 15 to 20% of the animals on the dairy farm suffer from this. Calves between two and ten months old are the most susceptible to respiratory diseases. Lung problems in calves are mostly caused by a mixed infection involving the influenza virus in yearlings and various bacteria. Periods of changeable weather, high humidity (>80%), large temperature differences between day and night, and a bad climate in the barn increase the risk of lung problems. Prevention, therefore, consists of optimizing housing conditions and possibly vaccination. The primary concern is to keep the calves dry.

Figure: **the suction movement of the calf when drinking from the nipple: a raised head with a stretched neck strengthens the oesophageal groove reflex. With an automatic calf feeder, the drinking position is more 'natural' than with bucket feeding.**



Airways and parasites

- Respiratory infections also contribute to the high mortality rate among calves.
- Humidity, ventilation and the living environment affect the number of respiratory infections; fresh air is essential and the recommended humidity should be <80%.
- IBR, BVD and paratuberculosis greatly affect the health of cattle; the diseases could mean growth retardation and loss.
- A high health status of the company is essential; at the national level, various control programs are taking place.
- The control of parasites, flies, midges and other insects, mange and ticks is profitable; they cause unrest and growth retardation and they also transmit diseases.

That is to say, dry bedding, good draught-free ventilation, no overcrowding and an optimum diet to avoid diarrhoea. In addition, the shearing of the calf's back can help to eliminate excess heat and prevent sweating. Furthermore, lung problems in young calves that graze could be caused by lungworm. Characteristic of lungworm is a persistent cough. If not treated in time, this can lead to complications and death. Vaccination is the only effective method of prevention.

IBR, BVD and paratuberculosis

Outbreaks of IBR (Infectious Bovine Rhinotracheitis), BVD (Bovine Viral Diarrhoea) and paratuberculosis can also affect the health of young calves. It can result in growth retardation and more loss. Striving for the highest possible health status on the farm is recommended. Enquire at a national body (in the Netherlands the 'Gezondheidsdienst voor Dieren') and at the veterinarian for ways of preventing, combating and remaining disease free.

6.5 External parasites

Parasites, such as flies, midges and other insects, mange and ticks cause unrest and growth retardation. They also increase the risk of transmitting diseases. This is sufficient reason to combat external parasites. By using simple measures, insect nuisance can be avoided. Calves and yearlings, in particular, can be troubled by lice. There are biting and bloodsucking lice. They mainly cause itching, growth retardation and skin damage, and bloodsucking lice may cause anaemia. Fungal skin, or ringworm, can be recognized from the ring-shaped spots, especially on the head (around the eyes) in the neck and sometimes over the entire body. Young calves are the most affected. Animals build up resistance to fungal skin once they have been infected. Fungal skin infections can be stubborn and prevail on the farm for a number of months. A lot of effort is required to eradicate them. Be careful, you could also become infected by fungal skin.

6.6 Preventive measures

Farmers can take various measures to improve the health of young calves. The most important issues are:

- **Colostrum management:** Under the motto 'well begun is half done', the separation of cow and calf and good colostrum management are the first steps in the prevention of disease in young calves. Provide sufficient, good quality colostrum immediately after the birth of the calf. This provides the calf with the necessary antibodies to protect itself from disease during the first weeks (see paragraph 2.3 for further information). Check the colostrum management, if necessary, through determining the IgG levels of the colostrum or through blood samples of the calves.
- **Milk management:** To avoid diarrhoea, in particular food induced diarrhoea, it is necessary to prepare the milk replacer according to the instructions. Ensure proper drinking temperature; note the concentration of milk powder and the correct drinking position (pay attention to the nipple height). With an automatic feeder, after setting up the processor, most factors are executed flawlessly. Always include well-structured feeds (hay or alfalfa) in the diet and note the correct feeding program, taking into account that sufficient minerals, vitamins and trace elements prevent deficiency. Start in good time with the provision of concentrates for good rumen development. Depending on age, TMR rations can also be provided as feed for young calves.

- **Hygiene:** Working hygienically in the rearing pens, in the housing of calves and in the distribution of milk reduces the risk of infection. Ensure a high standard of cleaning, disinfection and drying of unoccupied rearing pens and single pens. Obtain 15% more single pens than necessary for the calves in order to make that possible. Do not place feed and water troughs on the ground, but hang them up to prevent contamination from manure. Isolate sick animals to prevent further spread of contamination.

- **Separation of age groups:** A good separation of age groups limits the transmission of diseases. Always work from young to old; first take care of the young calves and then the older animals and use separate clothing and boots for each age group. Try to move the groups up in their entirety. Avoid overcrowding of pens and departments to reduce infection pressure. Pay attention to the grazing schedules of young calves or do not graze young calves up to the age of 6 months to avoid lung and gastrointestinal worms (depending on climate and environment).

- **Vaccinations:** Consult the veterinarian about the required vaccinations of dairy cattle and young calves, and execute them consistently and at the right moment.

- **Becoming disease-free:** Participate in disease control programs (in the Netherlands 'Gezondheidsdienst voor Dieren') to combat infections and to become free of infectious diseases as much as possible. Infections that are not present on the farm cannot be directly transferred to the calves and the young cattle. A closed operational management is preferable to avoid the introduction of diseases. If cattle is conveyed, pay attention to the health status of the farm where the cattle came from.

- **Housing:** The importance of adequate ventilation has already been mentioned in preventing lung disorders. Furthermore, clean straw and the frequent spreading of new straw is a means of reducing the transmission of disease via manure.

Prevention

- The provision of good quality colostrum as quickly as possible after the birth of the calf contributes to its health.
- During the milk stage, the temperature, concentration and consistency of the milk is important; after being set correctly, this is automatically prepared by the automatic calf feeder.
- The ration during rearing is important for a balanced growth and good rumen development of the calf.
- Always work hygienically, from young to old and avoid overcrowding and a high infection pressure.
- If possible, participate in control and vaccination programs.
- Provide clean housing with sufficient ventilation.

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Appendix Housing

The Decree on Calves (Kalverbesluit) of the Dutch government dated 1 January 2004 specifies the requirements that must be met for the housing of young cattle. The Decree was established to improve animal welfare. The main requirements are:

- Het aanbinden van kalveren tot een leeftijd van 6 maanden is verboden.
- The tethering of calves before the age of 6 months is prohibited.
- Group housing is compulsory from the age of 8 weeks.
- The width of a single pen is at least equal to the shoulder height of the calf. In practice, this amounts to a minimum width of 81-85 cm.

The recommended minimum free space per animal is:

- < 150 kg 1,5 m2
- 150-220 1,7 m2
- > 220 kg 1,8 m2

The following table contains the guidelines for the various housing systems for young cattle.

Tabel: **Dimensions for the housing of young cattle**

Housing	Age category in months					
	0 - 2	0,5 - 3	3 - 6	6 -12	12 - 18	18 - 22
Single pens		81				
Pen width (cm)	81 - 85					
Pen length (cm)	130 -150					
Group hutch with straw						
Minimum area (m2/animal)		1,5	1,7	1,8		
Minimum pen depth (cm)		300				
Two-floor stall						
Walking-eating space grids (cm)		175	200			
Lying area with straw (cm)		250	250			
Depth lying area (cm)		30 - 40	30 - 40			
Eating width (cm)		50	50			
Free stall barn						
Cubicle width (cm)		60	70	80	90	100 - 110
Cubicle length-outside row (cm)		130	160	180	200	220
Cubicle length-inside row (cm)		130	160	180	190	210
Height shoulder barrier (cm)			75	85	95	105
Walking-eating space (cm)		175	200	220	275	
Walking space between two rows (cm)				175	200	200
Eating width per animal (cm)		35	40 - 45	45 - 50	50 - 55	55 - 60
Height drinking trough (cm)			60	70	80	100
Height drinking nipples (cm)	100	110				
Slit width of grids (cm)		3	3	3,5	3,5	3,5
Full grid with rubber						
Pen depth (cm)				200 - 300	300 - 320	300 - 350
Floor area (m2/animal)		1,5	1,7	1,8	1,8	1,8
Cow shed						
Standing width (cm)				80	90	100
Standing length open shed (cm)				120	140	150
Standing length slurry shed			110	130	140	150

Source: Handboek Melkveehouderij 2006 (Dairy Farming Manual 2006)

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