Replacement heifer rearing on modern dairy farms – part one

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Adult milking and dry cows are prioritised over replacement heifers on modern dairy farms far too frequently, which can result in too many replacement heifers failing to reach their first lactation. Brickell et al. (2009) found that 14.5% of heifers born alive failed to reach their first calving. Insufficient numbers of replacement heifers can have a huge impact on dairy herd health and performance due to restrictions on selective culling. In addition to this, a surplus of replacement heifers can be a good source of income for a farm.

Garnsworthy (2005) states that 'the objectives of heifer rearing are to obtain good animal performance with minimal losses from disease, death and infertility, whilst maintaining a high standard of welfare, optimum (low) input costs and minimum labour inputs'.

This article aims to discuss the challenges facing modern dairy farmers when it comes to rearing replacement heifers and how to overcome these challenges to optimise health, growth and future production.

The starting point

Some would say that the starting point for good replacement heifer rearing is ensuring adequate intake of good quality colostrum as soon as possible after birth, but others believe it is well before this.

Prenatal nutrition can have serious effects on calf health, for example iodine deficiency can result in the birth of small weak calves which have an increased risk of mortality. Lay et al. (1997) have shown that pre-natal stress can affect the capacity of calves to adapt to stress in later life.

Stress during delivery can have an impact on future calf survival and must be minimised. Minimising stress during delivery involves selecting an easy-calving sire and ensuring that the mother is not over-conditioned at calving to reduce the risk of calving difficulties, and ensuring that calving assistance, if required, is given with care.

Colostrum

Colostrum not only provides a calf with nutrients but also with passive immunity, which is essential in the first weeks of life before its immune system is fully functioning.

Absorption of antibodies from colostrum into the calf's blood circulation occurs across the intestinal epithelium and is only possible for approximately 24 hours after birth. After this the intestinal epithelium undergoes maturation resulting in 'closure' and an inability to absorb macromolecules without prior digestion.

In addition to this, for the first 12 hours after birth secretion of digestive enzymes is limited allowing antibodies present in colostrum to escape digestion prior to absorption. Therefore, calves should receive colostrum as soon as possible after birth, before gut closure and increased secretion of digestive enzymes occur, to ensure maximum absorption of antibodies.

As well as receiving colostrum as soon as possible after birth, it is also important that calves receive an adequate amount of colostrum and that the colostrum is of good enough quality. It has been suggested that colostrum ingestion stimulates maturation of the intestinal epithelium and gut closure, as there is little change to the gastro-intestinal tracts of starved or water-fed neonatal calves (Xu 1996).

Therefore it could be more beneficial for a calf to receive a full feed of colostrum slightly later on after birth than to receive a part feed immediately after birth followed by a full feed several hours later as the initial part feed could stimulate gut closure before the second full feed is given.

As a general rule calves should receive at least three litres of good quality colostrum in the first six hours of life. A calf can receive colostrum by being allowed to suck its mother or by being fed colostrum, either from its mother or pooled from other cows, using a bottle or an oesophageal feeder.

Suckles mother	
Advantages:	Minimises risk of disease spread. Low labour requirements.
Disadvantages:	Not possible to monitor volume of colostrum consumed. No control over quality of colostrum.
Fed colostrum from mother using a bottle or oesophageal feeder	
Advantages:	Minimises risk of disease spread. Possible to monitor volume of colostrum consumed.
Disadvantages:	High labour requirements. No control over quality of colostrum.
Fed pooled colostrum from other cows using a bottle or oesophageal feeder	
Advantages:	Allows good quality colostrum to be selected. Possible to monitor volume of colostrum consumed.
Disadvantages:	Moderate labour requirements. Increased risk of disease spread, for example Mycobacterium paratuberculosis.

Table 1. Advantages and disadvantages of the different methods by which a calf can receive colostrum.

The advantages and disadvantages of each method are summarised in Table 1. Besser et al. (1991) concluded that only 10.8% of calves fed colostrum by oesophageal feeder were diagnosed with failure of passive transfer compared to 19.3% by bottle and 61.4% by suckling. Good quality colostrum can be hygienically collected and stored frozen for when inadequate amounts are available.

Colostrum quality

The concentration of immunoglobulin in colostrum, or quality of colostrum, depends on various factors, including:

- Disease history – cows exposed to a greater number of pathogens produce colostrum with a greater concentration of immunoglobulin.
- Parity – multiparous animals generally produce colostrum with higher levels of immunoglobulin than primiparous animals.
- Breed – Jersey and Guernsey cows generally produce colostrum with a greater concentration of immunoglobulin G than Holstein cows, although this could be due to the yield effect.
- Yield – Pritchett et al. (1994) reported a negative relationship between volume of colostrum produced and immunoglobulin G concentration, which is likely to be due to a dilution effect.

A colostrometer can be used to estimate the immunoglobulin content, and therefore the quality, of colostrum, although it works by measuring the specific gravity of colostrum, which can be affected by other components of colostrum as well as immunoglobulins so its accuracy is questionable.

If there is insufficient good quality colostrum available, colostrum supplements and replacements can be considered but these are costly, may pose biosecurity risks and may not contain immunoglobulin specific for diseases present on the farm. A better option would be to store surplus good quality colostrum in the freezer so that it can be thawed when required.

The ZST test

Passive transfer of immunity can be assessed by measuring the concentration of immunoglobulin G in calf serum at 24-48 hours after birth using the zinc sulphate turbidity (ZST) test. The critical level for

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defining failure of passive transfer is usually immunoglobulin G <10g/L.

Breen et al. (2012) suggest that a target for failure of passive transfer of immunity is that <15% of calves should have immunoglobulin G <10g/l.

Calves with IgG levels <10g/L are at greater risk of diseases, for example pneumonia and diarrhoea, although development of diseases is not only affected by host immunity but also by pathogen challenge.

Feeding

Reinhardt (2004) suggests that under natural conditions a calf would be suckled by its mother for up to 14 months. In modern dairy farming, the majority of calves are suckled by their mothers for less than 24 hours, with some even being snatch-calved and never permitted to suck.

Concern has been expressed that the removal at such a young age is not in the welfare interest of cow or calf, but data now suggests that the 'stress' response after weaning calves from their mothers is greater in calves left with their mothers for longer than in those removed within 24 hours of birth (Lawrence et al. 2005).

Once a calf has received adequate colostrum, it then needs to be fed on a liquid diet with some solid feed for the first 6-8 weeks of life until weaning. This pre-weaning diet must achieve target growth rates while also encouraging the development of the rumen, which will allow the transition from liquid to solid feed at weaning with minimal loss in growth rate.

While whole milk may be the ideal feed for calves, it is not economical to feed whole milk unless it is 'dump' milk unfit for sale, as the cost of milk replacer on a dry matter basis is 60-80% of the sale value of liquid milk (Garnsworthy 2005).

There are concerns over feeding dump milk, due to the risk of disease transmission and development of antibiotic resistance. In addition, some dump milk may be of lower nutritional value and there is unlikely to be sufficient available to rear calves exclusively on it, so feeding milk replacer is common on modern dairy farms.

Milk replacers

Various forms of milk replacer are available, but the main two types are skim-milk powder replacer and whey powder replacer. Skim-milk powder replacer clots in the abomasum in the same way as whole raw milk.

The degree of clot formation depends on the level of heat treatment used in the manufacturing process with severely heat treated skim-milk powder replacers having poor clot formation and high passage of undigested protein into the small intestine.

Younger calves (less than one month old) have limited intestinal digestive capacity which may be overwhelmed by this undigested protein, so careful consideration must be given to the type of skim-milk replacer being used in animals of this age.

Whey powder replacers do not form a clot in the abomasum so there is high passage of undigested whey protein into the small intestine. In calves less than one month old whey powder has a faecal digestibility of 0.92 of that of skim-milk powder, but in calves over one month old this increases to 0.95 and various studies have shown that there is no significant difference in growth rates of calves fed whey powder replacer compared to those fed skim-milk powder replacer (Tanan 2005).

However, again careful consideration should be given when feeding it to younger calves.

Milk replacers based on vegetable protein, for example soya and wheat gluten, are another alternative, although they are better suited to animals over one month old.

Whatever milk replacer is used, it is important that it is made up as recommended by the manufacturer as failure to do this can result in nutritional scour.

As a general rule calves should be fed 10-12% of their body weight in litres of liquid feed per day, although manufacturers' recommendations should be consulted for milk replacers, and feeding times should be consistent.

Various liquid feeding systems are used on modern dairy farms, the advantages and disadvantages of which can be seen in Table 2.

Twice daily restricted feeding	
Advantages:	Calves fed according to their individual needs. Reduced feed costs (less milk consumed). Higher solid feed intakes – promotes rumen development.
Disadvantages:	High labour requirements. Lower growth rates. Feeding times must be strictly adhered to
Once daily restricted feeding	
Advantages:	Calves fed according to their individual needs. Lower labour requirements. Reduced feed costs (less milk consumed). Higher solid feed intakes – promotes rumen development.
Disadvantages:	Welfare of Farmed Animals (England) Regulations 2000 state that 'all calves shall be fed at least twice daily'. Lower growth rates. Feeding times must be strictly adhered to. Lower level of supervision by stockman.
Computer controlled restricted feeding	
Advantages:	Low labour requirements. Calves fed according to their individual needs. Records each calf's actual daily milk intake.
Disadvantages:	High set-up costs. Lower level of supervision by stockman.
Ad-lib feeding of acidified cold milk	
Advantages:	Low set-up costs. Higher growth rates. Lower labour requirements. Flexible feeding times.
Disadvantages:	Increased feed costs (more milk consumed). Lower solid feed intakes – could result in slower rumen development. Lower level of supervision by stockman. Potential for bacterial growth in milk if hygiene is not excellent. Increased urine production – more bedding required and calves must be cleaned out more regularly.
Automated ad-lib feeding	
Advantages:	Higher growth rates. Low labour requirements.
Disadvantages:	High set-up costs. Increased feed costs (more milk consumed). Lower solid feed intakes – could result in slower rumen development. Lower level of supervision by stockman. Increased urine production – more bedding required and calves must be cleaned out more regularly.

Table 2. Advantages and disadvantages of different liquid feeding systems used on modern dairy farms.

Solid feed

Solid feed is known to be the stimulus for rumen development as development is inhibited in calves fed only milk or milk replacer (Blum 2005).

Development of the rumen epithelium, rumen muscularisation and expansion of rumen volume are known to occur independently and dietary factors which influence one may not influence the others (Heinrichs and Lesmeister 2005).

Development of the rumen epithelium involves increases in papillary length and width providing a greater surface area for efficient absorption of digestion products.

Ingestion of solid feeds stimulates rumen microbial proliferation and production of volatile fatty acids, which are the stimulus for development of the rumen epithelium, especially butyrate and propionate (Brownlee 1956 and Harrison et al. 1960).

Solid feeds differ in their efficacy to stimulate rumen epithelium development, with concentrates having a greater efficacy than forages (Brownlee 1956 and Harrison et al. 1960). While forages are less effective at stimulating rumen epithelium development than concentrates, they are the primary stimulators for rumen muscle development and expansion of rumen volume (Hibbs et al. 1956), which are also essential for future rumen function.

Therefore it is advisable to feed calves a combination of concentrates and forages in the pre-weaning period to optimise rumen development.

There has been much debate on the ideal time for weaning. Garnsworthy (2005) states that solid feed is <10% of the sale value of liquid milk on a DM basis, which provides a strong economic case for early weaning, but weaning should not be carried out so early that it has a negative effect on growth rate or calf

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Table 3. Sward and animal factors which influence growth rates.

Animal factors
Growth potential
Stage of development – calves do not perform as well as yearlings at pasture
Stocking rate
Sward factors
Digestibility
Sward height – intake increases up to a 'critical' sward height and then decreases thereafter. Sward height can be measured using a plate meter
Sward density
Sward management – this has a huge effect on grass quality. Tight grazing of spring grass is important to prevent build-up of stemmy low digestibility grass

Continuous grazing	
Advantages:	Lower set-up costs (for example fencing and water supply). Lower labour requirements.
Disadvantages:	Skill is required for monitoring/managing the sward to prevent under grazing early on in the season and over grazing later on. Risk of parasite build-up without proper control.
Rotational grazing – calves and yearlings grazed separately	
Advantages:	Grass supply can be adjusted according to demand. No risk of infection of younger animals with parasites from older animals.
Disadvantages:	Higher set-up costs (for example fencing and water supply). Higher labour requirements. Calves are very selective so only harvest a small proportion of the herbage available resulting in overgrowth and build-up of stemmy low digestibility grass.
Rotational grazing – calves and yearlings grazed together	
Advantages:	Grass supply can be adjusted according to demand. Yearlings are less selective than calves so harvest a larger proportion of the herbage available preventing overgrowth and build-up of stemmy low digestibility grass.
Disadvantages:	Higher set-up costs (for example fencing and water supply). Higher labour requirements. Risk of infection of younger animals with parasites from older animals.
Rotational grazing – leader/follower system where yearlings follow calves	
Advantages:	Grass supply can be adjusted according to demand. Calves are able to select the best quality herbage. Yearlings are less selective than calves so harvest a larger proportion of the herbage available preventing overgrowth and build-up of stemmy low digestibility grass. No risk of infection of younger animals with parasites from older animals.
Disadvantages:	Higher set-up costs (for example fencing and water supply). Higher labour requirements.

Table 4. Advantages and disadvantages of different grazing systems.

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health. As a general guideline, calves should be weaned when they are consuming 1.0-1.5kg of solid feed for two consecutive days.

After weaning, a calf needs to be fed on a post-weaning diet of concentrates and forages which is designed to continue to achieve target growth rates. Replacement heifers can be reared without grazing, but this is costly so in the majority of cases they are grazed. Growth rates while grazing depend on both sward and animal factors, which are summarised in Table 3.

Supplementation, either with concentrates or conserved forages, may be required while at pasture to improve or maintain growth rates if grass supply is inadequate.

Response to supplementation is variable and depends on many factors, including: animal's growth potential, sward height and supplement type, composition and substitution rate.

Steen (1994) found that concentrate supplementation had no effect on growth rate of bull calves grazing swards ≥7.9cm but increased live weight gain of those grazing 6.7cm swards.

Steen (1994) also found that good quality pasture has the potential to sustain near maximum performance, even in calves with a high growth potential.

It is important to maximise the use of grazed grass to reduce costs associated with feeding concentrates or conserved forages. Various grazing systems are used on modern dairy farms, the advantages and disadvantages of which are summarised in Table 4. The main aims of all of the systems are to achieve desired growth rates, while efficiently utilising the grass available.

Parasite control

Parasite control is important when replacement heifers are grazed. Grazing 'clean' pasture (pasture which has not been grazed the previous year) is not often possible on modern dairy farms.

In addition, animals grazing it are not exposed to parasites so fail to build up immunity to them, which can be a disadvantage.

In most cases replacement heifers will be grazed on pasture with parasite contamination so anthelmintics may need to be used until they have built up immunity to the parasites. Anthelmintics should be used in such a way to minimise development of resistance. Taylor (2010) suggests that strategies to reduce the risk of development of resistance include:

- Administering anthelmintics effectively – underdosing should be avoided by dosing for the weight of the heaviest animal.
- Only administering anthelmintics when necessary – faecal egg counts can be used to assess the level of parasite infection.
- Selecting an appropriate anthelmintic – narrow spectrum anthelmintics should be used where possible and combination or long acting products should be avoided.
- Rotating anthelmintic class used.
- Preserving susceptible worms on farm.

The faecal egg count reduction test can be used to assess effectiveness of anthelmintics and therefore monitor anthelmintic resistance.

Vaccination can be useful in the control of lungworm but care must be taken if the vaccine is being used in combination with anthelmintics, as it is a live vaccine so anthelmintics will interfere with its activity. ■

References are available from the author on request