Welfare of the Dairy Calf

Dairy calves are susceptible to a range of serious welfare issues. These include poor health, social deprivation, abnormal behaviour and stressful practices; which arise from the environments and procedures they experience. This information sheet outlines the main issues involved, and offers practical solutions.

Health Issues

The most common health disorders in calves are enteric and respiratory disease (Marce *et al.* 2010). National monitoring of calf disease is rare, but mortality rates appear to be lower in Europe (<5%) than the USA (~8%) (Vasseur *et al.* 2012). In a comparative survey between North America (115 farms in Quebec, mean weaning age 7.2 weeks) and Central Europe (60 farms in Austria and Germany, mean weaning age 10.8 weeks), mortality appeared to be lower in central Europe, though mortality records varied widely between farms in Central Europe and were rare in Quebec (Vasseur *et al.* 2012). In a USA survey (106 farms, median weaning age 7 weeks), median mortality was 3.6% at farm level and 5.4% at calf level (Walker *et al.* 2012). More than 50% of deaths were attributed to diarrhoea and larger farms appeared to have a greater disease burden.

The risk of diarrhoea and respiratory disease by the four main rearing systems is highest in individual housing until weaning, followed by individual housing for four weeks, followed by individual housing for two weeks and lowest in group housing (Marce *et al.*2010). Biosecurity, the prevention of introducing disease on to the farm, can be difficult when calves are sourced from different farms, but producers can decline to take calves from farms which consistently have low levels of passive immunity (due to inadequate colostrum intake), or are obviously unwell (Walker *et al.* 2012). Biocontainment, the prevention of spreading disease on the farm, can be achieved by preventative measures, such as vaccination, and by removing an ill animal from the group.

Automatic feeding is a useful management tool which can be used to monitor health. The feeders require calves to wear a transponder which identifies them, triggers milk provision and records intake. They can also be used to record changes in temperature which indicate illness (Roth *et al.* 2009a). A reduction in intake of concentrates was related to the probability of veterinary treatment; but only severely ill calves reduce their milk intake (Roth *et al.* 2009a). Therefore automatic feeders should always be used in combination with frequent manual health checks to identify illness (Roth *et al.* 2009a).

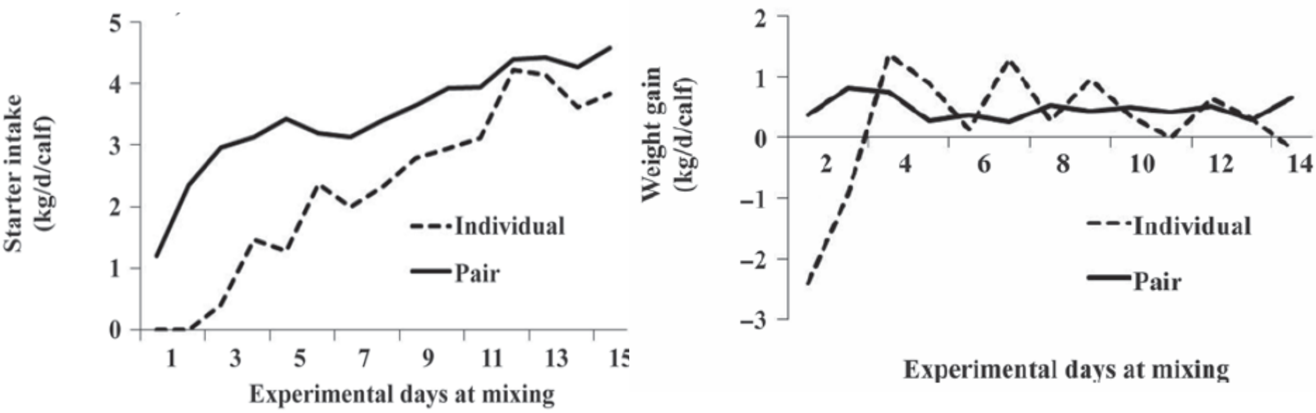
Group Housing

Veal crates have been banned in the EU since 2007 (EU Directive 91/629/EC), but calves are still permitted to be housed individually until eight weeks of age; in pens which allow visual, auditory and tactile contact with other calves. Across the EU there is a huge variation in the type of systems used. A recent survey reported that in Belgium, Germany and Sweden all calves were housed individually for eight weeks; whereas in the 11 other countries studied, calves were housed individually for up to eight weeks then moved to groups or kept in groups from birth (Marce *et al.* 2010).

Group housing from birth can provide welfare, health and performance benefits. Calves require a hygienic housing environment which provides sufficient space, deep bedding, natural light, good ventilation and drainage, shelter and a separate feeding area. Calves require bedding for its' thermal properties and to prevent discomfort while they are lying down (EFSA 2012). Housing calves in groups allows them to perform their natural social behaviour, provides more space for play and general activity (Charlton 2009) and allows them to acquire social skills (Jensen 2012); which improves their welfare. Research has suggested that calves desire full, rather than partial, contact with each other. Individually-housed calves were found to position their head outside the pen more often than group-housed calves, indicating they desired contact with the nearby calves (Chua *et al.* 2002). The motivation for social contact can be tested by measuring how willing calves are to work to gain access to another calf. By teaching calves to press a panel with their head, calves were found to work harder (press the panel more times) to gain full-body contact than head-only contact through a fence (Holm *et al.* 2002). Group-housed calves show a preference for a familiar calf compared to an unfamiliar calf. Grouped calves are also more confident and appeasing when they meet a new calf, compared to individually-housed calves, who can be initially fearful and then show disruptive and contact-seeking behaviour (Keyserlingk and Weary 2012). Individually-housed calves have also been found to be more fearful than group-housed calves. When they were placed in a novel arena the individual calves had a higher heart rate and were more reluctant to enter and to approach a new calf (Jensen *et al.* 1997). Their response was not affected by the space allowance in their housing (Jensen *et al.* 1997), which suggests social contact is more important than space for calf behaviour. Although a higher space allowance can encourage more play (Jensen *et al*. 1998, Jensen and Kyhn 2000). Previous experience of social contact has been shown to affect calves' social responses. In a study of pair-housed calves and calves housed individually with visual and tactile contact of others, the pair housed calves approached a new calf more quickly (Jensen 2012). This provides further support that calves need full-bodied social contact. Group-housed calves also experience social support, which improves their ability to cope with challenges. They react less to stressful procedures, including restraint and blood sampling, and vocalise less after being separated from their dam (Jensen 2012).

Housing calves in groups can also improve performance. Social facilitation, when calves imitate each other's behaviour, can result in a higher feed intake (Jensen 2012). Pair-housed calves show a higher daily weight gain (Jensen 2012) and begin eating solid feed nearly two days earlier than individually-housed calves and gained weight at a more stable rate (Figure 1, De Paula Vieira *et al.* 2010, Jensen 2012). By 14 days of age individually-housed calves were found to have still not reached the weight of pair-housed calves (Keyserlingk and Weary 2012). Group-housed calves also avoid the fluctuations in weight gain commonly experienced by individually-housed calves, who may over-consume feed, causing discomfort and consequently a reduction in intake (Keyserlingk and Weary 2012).

Figure 1. The effect of pair or individual housing on calf feed intake (a) and weight gain (b) over time (De Paula Vieira *et al.* 2010)



The choice between individual and group housing is often described as a trade-off between health and behavioural freedom. However when environmental conditions such as feed, ventilation and hygiene are optimized, the concern should be the group size and structure. The disease risk in group housing increases when the size of the group and variation in ages increases (Marce *et al.* 2010). The ideal group size is 3-8, not exceeding 10 calves (Jensen 2012), and different age groups should not be mixed (Charlton 2009). Early introduction to a large group was found to cause restlessness and difficulties in finding the feeder. In contrast, groups of 3-8 calves had a reduced incidence of respiratory disease and higher daily growth gains than groups of 6-30 calves (Svensson *et al.* 2003). Stable groups are more beneficial than dynamic groups, as they allow social bonds and result in improved respiratory health, improved daily growth and a reduction in diarrhoea (Jensen 2012). Group housing can also reduce the risk of disease. Group-housed calves were found to be less susceptible to neonatal diarrhoea and respiratory disease, compared to individually-housed calves (Marce *et al.* 2010). Automatic feeders can be used to feed group-housed calves individually and improve feed consistency, as well as reducing labour (Charlton 2009). Finally, housing calves in pairs can provide a more practical solution for producers moving from individual to group housing, while providing the same benefits of social contact (Keyserlingk and Weary 2012).

Cross sucking

Cross sucking (including navel and non-nutritive sucking) is the abnormal behaviour when a calf sucks on the body of another calf, an empty teat, or a pen fixture. It can lead to injury, spread disease and indicate poor welfare. Cross sucking occurs predominantly in group housing, where it is directed at other calves' navels where the udder would normally be, but can also occur in individual housing, where it is directed towards other calves' reachable mouths and ears (Scheurmann 1974, quoted in Weber and Wechsler 2001). It may also be related to 'Intersucking' in later life, when an adult cow suckles milk from another cow (Lidfors and Isberg 2003). Cross sucking is caused by calves' strong motivation to suckle, which is not fulfilled by bucket feeding. Naturally they would suckle 3-8 times a day, totalling up to one hour (Friend and Dellmeier 1988). Calves are capable of finishing a 2.5L feed from a bucket in one minute, in contrast to natural suckling which would last 8-12 minutes (reported in Lodberg and Lidfors 2001). Suckling the dam may also be followed by sucking on a dry teat, to stimulate continued lactation, or butting, to encourage milk let-down, and is seen in bucket-fed calves on an artificial teat (de Pasillé 2001).

Several management practices can reduce cross sucking, though dam suckling is currently the only method which prevents it entirely (Froberg and Lidfors 2009, Roth *et al.* 2009b). **1) Artificial teats**. Calves fed *ad libitum* from an artificial teat drank more, for a longer duration and suckled an additional dry teat less often than calves fed *ad libitum* from a bucket, who also disrupted feeding to suckle the dry teat (Hammell *et al.* 1988). Dipping an artificial teat in milk stimulates longer sucking than a dry teat, which suggests the presence of lactose (milk sugar) triggers sucking when calves begin feeding (de Pasillé and Rushen 1997, Jung and Lidfors 2001). Alternatively, a bucket with a floating teat can reduce cross sucking compared to normal bucket feeding (Lodberg and Lidfors 2001). **2) Reduced teats**. Reducing the teat diameter from 3 or 6mm to 1.5mm increases the duration of feeding, sucking of milk and can reduce cross sucking (Herskin *et al.* 2010). The reduced teat diameter increases the vacuum in the oral cavity, which allows effective milk sucking. **3) Automatic feeders.** These provide a more natural feeding method of several smaller meals during the day or *ad libitum* feeding and can reduce cross sucking as calves make "unrewarded visits" (suckling without receiving milk). **4) Feeding area design.** Self-locking feed stalls, compared to open feed stalls, increased the duration of feeding and sucking bouts and reduced cross sucking following drinking (Weber and Wechsler 2001). **5) Environmental enrichment.** Calves with access to a separate enrichment area after feeding, consisting of dry artificial teats, a netted hay bale and an additional exercise yard, had a lower level of cross sucking for 60 days during weaning than calves without access (Ude *et al*. 2011). **6) Feed intake. *i) Feed Allowance.*** Calves fed a high milk allowance had less unrewarded visits and over time reduced their visits to a few, large meals a day. In comparison calves fed a low allowance had more unrewarded visits over time, ate as soon as feed was available and at the same rate over time, suggesting they were hungry (Jensen 2012). Hungry calves also performed more cross sucking and butting (Herskin *et al.* 2010). Increasing feed from 2.5L to 5L milk/meal significantly reduced cross sucking (Jung and Lidfors 2001) and cross sucking decreases with increasing energy balance, which suggests it is elicited partly by drinking milk and partly by hunger (Roth *et al.* 2009c). ***ii) Speed***

***of milk flow*.** Slowing the milk flow from a bucket or teat reduced cross sucking (Haley *et al.* 1998, Jung and Lidfors 2001, Lodberg and Lidfors 2001. Increasing satiety (feeling full) through a higher feeding allowance is, however, more effective in reducing cross sucking than slowing milk flow (Jung and Lidfors 2001).

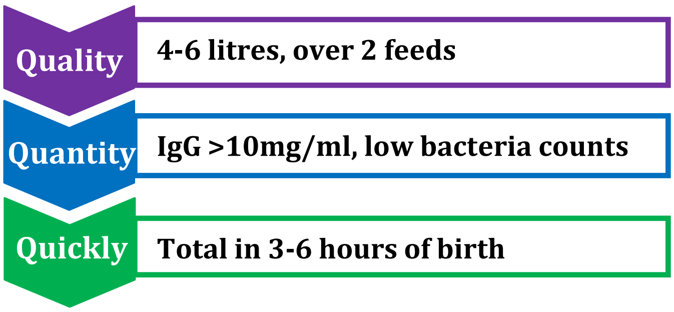
Finally, while these management factors reduce cross sucking, the behaviour is heavily influenced by personality, as there are large incidence differences between individuals. This is even stronger than the effect of milk allowance (de Pasillé *et al.* 2011) and affects the recipient, as heavier calves (who spend more time at the feeder) were identified as the most likely recipients of cross sucking (Laukkanen *et al.* 2010).

Feeding Competition

Competition is another key concern associated with group housing, that some calves may receive a higher feed intake than others. Competition and the speed of milk ingestion was found to increase with group size, and was higher in a group of six than pairs (Jensen 2012). When fed communally from teats, full-length barriers can be used to reduce competition and stop calves switching to another teat (Jensen 2012). Automatic feeders are the most effective method for preventing competition, provided all calves can gain access, as each calf receives an individual ration. The key to preventing competition is to allow calves control over their portion size and a high milk allowance, which can be met through *ad libitum* feeding (Jensen 2012).

Colostrum

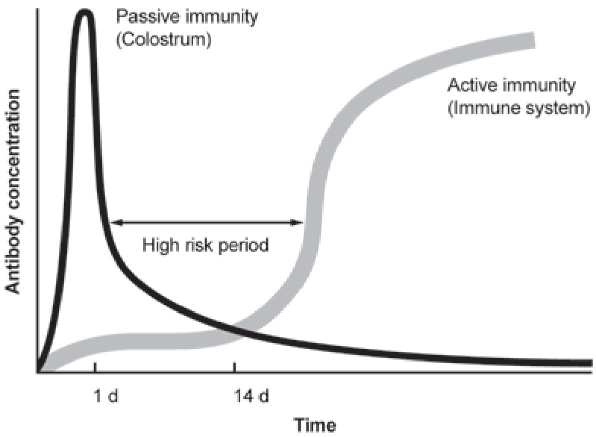
The "3 Q" Rule of Colostrum



(Adapted from Charlton 2009)

A new born calf has a poorly developed immune system, since antibodies (Immunoglobulins - Ig's) do not cross the placenta in pregnancy (unlike in humans). Good quality colostrum rich in antibodies (particularly IgG) protect the calf from diseases early in life, before its own immune system starts working (Figure 2); it is also an important first source of nutrients.

Figure 2. Calf immunity over time (Penn state 2013)



Gut absorption of Ig's drops off rapidly after birth and is virtually non-existent after 24 hours (Figure 3). The timing of colostrum provision is therefore very important. Calves should drink colostrum within the first hour, preferably within 15 minutes of birth, and finish the total quantity required by 6-8 hours after birth. The ability to absorb Ig's ends 24 hours after birth (Charlton 2009). Ideally colostrum should be provided from the dam (Charlton 2009). When provided artificially, good quality colostrum should contain: 5.1% fat (which is a laxative and energy source), 16.4% protein (which contains essential Ig's), and be high in vitamins A, D, and E (which provides resistance to infection) (Ngahawi farms 2013). Ideally colostrum feeding should provide a calf with a minimum blood serum IgG level >10 mg/ml (or a ZST level >20 g/l). Typically calves require colostrum in a volume of 10% of their birthweight, which is about 4L for small breeds and 6L for large breeds (Charlton 2009). A stomach tube should only be used for administration if necessary and with care to avoid the windpipe (Charlton 2009). The zinc sulphate turbidity test (ZST) is a semi-quantitative test for serum globulins. Studies show that calves with low immunoglobulin levels in their blood 48 hours after birth had more than double the mortality over the following 8 weeks than calves with acceptable levels of serum immunoglobulins (Figure 4).

Figure 3. The ability of a calf to absorb Immunoglobulins declines rapidly after birth (Ngahawi farms 2013)

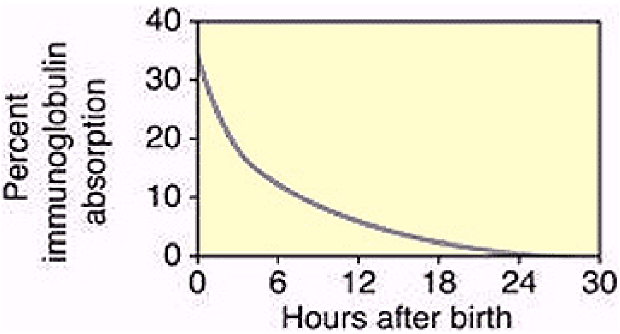
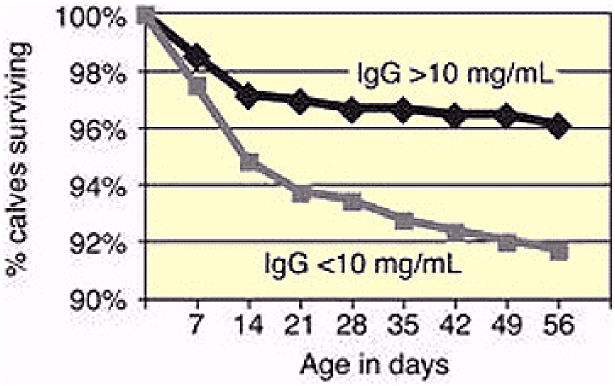


Figure 4. Survival rates of calves with adequate (>10mg/ml) and inadequate (<10 mg/ml) levels of IgG (Ngahawi farms 2013)



For best results if sourcing calves from other farms, calves should be >35kg (birthweight), delivered on farm at 10-21 days (at 50-65kg); and kept in groups according to age, breed, and gender (DairyCo 2013). The immune status of 150 bull calves from 12 dairy farms in N. Ireland showed that 19% had inadequate colostrum intake, as indicated by ZST levels <20g/l (Figure 5, Dawson and Morrison 2008). These calves had 7% slower growth rates from birth to 9 months of age, so were on average 23kg lighter and were worth €31 less (€1.34/kg) than the calves with acceptable levels of colostrum intake. Testing of calves should be routinely carried out to ensure the supplier meets their animal husbandry obligations and supplies calves which do not suffer from failure of passive transfer of Ig's. For further details on IgG testing see http://www.calfforum.org.uk.

Figure 5. The relationship between calf immune status and performance up to 9 months of age (Dawson and Morrison 2008)

Testing should become a quality benchmark for a responsible dairy farmer.

Preventing Hunger and Providing Fibre

Artificially-reared dairy calves are typically fed 4-6L of milk replacer per day (Jung and Lidfors 2001), however this ration is unlikely to be sufficient to prevent hunger. Calves fed *ad libitum* can drink 8.5L per day from 8-14 days (Vieira *et al*. 2008) or 11.9kg of milk replacer per day from 14-35 days (Hammell *et al.* 1988). EU legislation (EU Directive 97/2/EC) requires a minimum daily fibrous feed allowance of 50-250g/day from 8-20 weeks, but this is also insufficient to meet a calf's need for rumination (Webb *et al*. 2012). Assessing hunger is complex, and studies that have assessed the effect of milk allowance on cross sucking have yielded mixed results (Jung and Lidfors 2001, Vieira *et al.* 2008, Roth *et al.* 2009c, Herskin *et al.* 2010, de Pasillé *et al.* 2011). This may be because cross sucking was used to indicate hunger, but it varies hugely between individuals (de Pasillé *et al.* 2011) and may not accurately reflect hunger. Calves that were fed *ad libitum* and given a choice in their diet of milk replacer and concentrate, hay, straw and maize silage, had improved welfare compared to restricted-fed calves, as they ruminated more and showed less abnormal behaviour (Webb *et al.* 2012).

Ideally calves should have access to milk (or milk replacer) *ad libitum*, or at least sufficient feeds throughout the day to achieve satiation; as well as constant access to clean, fresh water and fibre *ad libitum* from 2 weeks. Milk replacer should have a high nutritional balance and be given from a hygienic dispenser which lets calves extend their neck upwards to allow oesophageal groove closure (Charlton 2009). Calves should also not be fed milk which has antibiotic residues, high bacteria counts, that is unpasteurized waste or from cows with transmittable pathogens (Charlton 2009).

Finally, calves reared for white veal experience serious welfare issues through iron deficiency, associated anaemia and enteric disease due to their high intake of liquid feed and inadequate fibre intake (EFSA 2012). EU legislation recommends a minimum blood IgG level of 4.5 mmol/L, but as this is the threshold level for anaemia, achieving a higher level of 7.5 mmol/L will improve calf health.

Weaning

Calves must be weaned to solid food in order for their rumen to develop. In the USA it is common for weaning to occur at six weeks of age (de Pasillé *et al.* 2010), and, while highly variable, in the EU weaning usually occurs at 8-12 weeks of age (Marce *et al.* 2010). The ability of a calf's digestive system should define their diet at that age, to ensure good health and growth (Charlton 2009). Introducing solid feed too early can result in low energy problems because the rumen is undeveloped, but introducing it too late causes nutrition and welfare problems (Webb *et al*. 2012). In early stages calves are only capable of digesting lactose, so must be fed a milk-based liquid diet. From 2 weeks of age they are capable of digesting some fibre and by 6-8 weeks of age they require largely fibrous, solid feed. Solid feed provision should increase with age to establish and maintain high levels of chewing and ruminating, and to prevent abnormal oral behaviours (such as manipulation of pen structures, tongue rolling and sham chewing) arising (Webb *et al*. 2012). Signs that indicate poor digestion include changes in faecal consistency, poor growth and increased susceptibility to disease (Charlton 2009). Ideally the weaning regime should balance a reduction in milk intake with a gradual increase in concentrate, in line with rumen development. If a high milk allowance is followed with abrupt weaning, the transition to solid feed may be slow and calves may be hungry. Additionally if the milk allowance is reduced too quickly, calves cannot utilise solid feed as their rumen is not yet developed. Gradual weaning (over 10-14 days) can increase solid feed intake and prevent the increase in cross sucking seen after abrupt weaning (Nielsen *et al.* 2008). Late weaning (12-13 weeks) is also more beneficial for growth, than abrupt weaning, as the calf is ready

(Passillé 2012). Weight gain is associated with normal development of the papillae in the rumen (Roth *et al.* 2009a). Grain (starch) intake is more important than hay or straw to ensure rapid rumen development and a smooth transition at weaning, at which point high quality forage (hay) is required for rumen development (Charlton 2009).

Management practices can assist the weaning transition. Automatic feeding allows individual weaning, rather than weaning a group by age. The age at which calves wean themselves can vary by as much as 53 days (for a concentrate-dependent diet) (Roth *et al.* 2009a). Therefore weaning individuals according to their "ability to eat" reduces the negative effects of weaning on energy intake, weight gain and hunger (de Passillé 2012) and meets the different nutritional needs and age of beginning to eat solid feed of each calf (Roth *et al.* 2009a). For further information on calf rearing systems, including natural weaning and cow-calf separation, see Information sheet 6.

Transport

Transport is particularly stressful to young calves, and can result in mortality rates of 1- 23% (Knowles 1995). As their immune and stress responses are undeveloped, calves are poorly adapted to transport. They also have little control over their body temperature (Weeks 2007); which makes them susceptible to heat and cold stress. There are high risks calves will suffer leg bruising and mortality (Hemsworth *et al.* 1995); and following transport calves often succumb to disease, usually within four weeks, due to not being able to respond appropriately (Knowles 1995). After as little as one hour of transport calves have a reduced body weight. After 19 hours of transport with a one-hour break, calves lost an average of 1.4kg in summer and 2.0kg in winter, which took up to seven days to stabilise (Knowles *et al.* 1999). Lost bodyweight occurs due to feed and water deprivation and urinary and faecal excretion during the journey, which in combination lead to acute dehydration and hypoglycaemia (low blood glucose level), both of which increase with journey time (Mormede *et al.* 1982). Providing rest stops during the journey has been shown to be ineffective in preventing this bodyweight loss. Rest stops are also likely to cause more stress than they prevent, as loading and unloading can be the most stressful part of the journey (Trunkfield and Broom 1990).

Young calves respond to transport with an increase in body temperature, heart rate and plasma cortisol concentration (Steinhardt and Thielscher 1999) and significantly increased levels of adrenaline (Thielscher and Steinhardt 2004) which indicates stress. Calves aged 7 - 15 days spent significantly more time resting and sleeping following transport than non-transported control calves and small calves were particularly adversely affected (Atkinson 1992). Calves from individual housing also showed a greater stress response to handling and loading than group-housed calves (Trunkfield *et al*., 1991). Overall, transport usually leads to poor welfare in calves, which is supported by physiological and behavioural evidence that it is stressful to them (Trunkfield and Broom 1990). Transport causes stress to calves at any age (Thielscher and Steinhardt 2004) and therefore should be avoided wherever possible or kept to a minimal duration, never exceeding 8 hours (SCAHAW 2002).

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