RSPCA APPROVED FARMING SCHEME
INFORMATION NOTES

DAIRY CALVES

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INFORMATION NOTES
DAIRY CALVES

The RSPCA Approved Farming Scheme is part of the RSPCA's efforts to improve the lives of Australia's farm animals. The Standard for dairy calves provides the requirements for housing, handling, transport and slaughter that must be met under the Scheme. The Standard applies to dairy and dairy crossbred calves raised for meat production in Australia. The RSPCA encourages producers to exceed the requirements of the Standard as the opportunity arises and commit to a pathway of continuous improvement in the welfare of their calves. These notes provide information about a range of aspects relating to the Standards, to dairy calf welfare and to the rearing of dairy calves generally.

Dairy calves — production cycle

Dairy calves who are selected and raised for meat (veal or beef) production are usually male dairy crossbred calves or, sometimes, pure dairy breed calves. The birth of a male calf at a dairy farm signals the beginning of the calf's lifecycle. On the vast majority of dairy farms in Australia, the calf is separated from the mother (or 'dam') within 24 hours of birth. The main reasons for this separation are to reduce the risk of transmitting Bovine Johne's Disease (a fatal wasting disease) to the calf, to ensure the calf receives sufficient colostrum, and for ease of management of cows and calves. Whereas the common fate of male pure breed dairy calves is to be sent to slaughter from 5 days of age because they are a by-product of dairy farming, male calves selected for rearing are destined for the high-value veal and beef markets.

Dairy calves in Australia may be reared under different housing systems, including pasture-based systems, systems where calves have access to an outdoor area, and indoor systems (although these are not common in Australia). In their first days or weeks of life, some farms house calves individually in pens (to ensure adequate colostrum and milk intake, and to avoid disease transfer) while others house calves in groups, or a combination of the two. Milk-feeding systems also differ from farm to farm and may include bucket feeding or teat feeding. Teat-feeding systems include automatic calf feeders which allow individual calves to feed voluntarily while their milk intake is automatically recorded.

Around 5 weeks before giving birth, the calf's mother will have started to form colostrum. This colostrum is the first milk that the calf will drink shortly after birth. Calves are born with little to no immunity and colostrum provides them with antibodies that will initially protect them from infectious diseases. Colostrum has its greatest protective capacity within the first 6 hours of calving and then starts to decline rapidly within 36 hours of birth. After this time, the calf no longer has the ability to absorb the antibodies present in the colostrum, although further colostrum feeding has been shown to have additional benefits. In Australia, it is a food safety requirement that the milk from the first 8 milkings following calving is excluded from the milk vat and does not enter the milk supply chain. This 'transition milk', which may contain traces of colostrum, is usually fed to calves.

Following initial colostrum feeding in the first 1-2 days of life, the calf in the rearing stage receives transition milk, whole milk, and/or milk replacer (made up from powdered milk) until weaning at 6-8 weeks of age when milk is slowly removed from the diet. Roughage and a grain-based ration or concentrate may be introduced slowly from around 4 days of age. In most calf-rearing systems, a calf would be eating at least 1kg of concentrate per day before being gradually weaned off milk. Some calf-rearing systems provide milk as the main component of the calf's diet throughout its life, with some access to roughage and/or pasture.

The finishing stage commences after weaning when the calf is at least 6 weeks of age. The calf usually receives a gradually increasing grain-based ration until they reach slaughter weight. For dairy veal, this is at around 6 to 8 months of age. For dairy beef, calves are raised beyond 12 months of age. Calves may be slaughtered at a younger or older age depending on the rearing/finishing system and the market for which the veal or beef product is destined.

Animal welfare

The welfare of an animal includes both its physical and mental state. Ensuring good animal welfare goes beyond preventing pain, suffering or distress and minimising negative experiences, to ensuring animals can express their natural behaviour in an enriching environment, feel safe, have healthy positive experiences and a good quality of life. Thus, good animal welfare means providing animals with all the necessary elements to ensure their physical and mental health and a sense of positive individual wellbeing.

RSPCA Australia encourages participation in independent certification schemes that improve animal welfare along the supply chain, such as on farm, during transport, and at slaughter, and allow participants to demonstrate compliance with relevant codes, standards and legal requirements. Regular as well as unscheduled on-site assessments (including resource- and animal-based measurements) are important in ensuring farm animal welfare along with improving animal welfare along the supply chain, identifying and resolving animal welfare issues, and improving animal welfare standards. On-site assessments must include inspections by the relevant government authority as well as third-party audits.

See also 'Five Freedoms / Five Domains'.

Animal-based welfare assessment

Resource-based indicators of animal welfare (e.g. access to food and water, bedding condition, shed design) are commonly used to assess animal welfare in various accreditation schemes. Although these indicators are an important part of animal welfare assessment, it is also crucial to assess welfare based on animal characteristics such as the calf's physical health, appearance and behaviour. Animal-based welfare assessment provides direct information about the response of and effects on the animal, rather than just an assessment of the environment or management system.

Using a combination of select animal-based measures can be a valid and robust way of assessing welfare on-farm, at the abattoir or any other part of the production process. The RSPCA Approved Farming Scheme Standard for dairy calves require on-farm assessment of animal-based welfare measures such as the calf's general behaviour (e.g. active, responsive, sociable, calm, playing or quiet) and specific abnormal oral behaviours such as soil eating, navel or ear sucking, or urine drinking.

Routine on-farm animal-based welfare assessments should be used to complement and build on daily inspection procedures to better support management decisions, strengthen self-responsibility of the farm manager, improve transparency, and for benchmarking at the individual farm and producer levels. Routine assessment of animal-based measures promotes early intervention, meaning adjustments can be made in a timely manner and adverse impact on the calves can be minimised.

See also 'Stockpersonship'.

Animal-based welfare assessment at the abattoir

The principle of continuous improvement in animal welfare also extends to the welfare of animals at abattoirs where, through regular self-assessments using measurable and objective criteria, benchmarks can be established. The Approved Farming Scheme Standard for dairy calves requires animal-based welfare observations to be recorded at the abattoir, and trigger levels to be set for the criteria to be assessed. A trigger level is a predetermined threshold which sets in motion a course of action to investigate and address the cause of a breach of that threshold. The self-assessments should quickly and accurately allow trends to be identified and thus any deviations from that trend to be recognised and

acted upon. Animal-based welfare observations should at least cover animals slipping or falling, animals vocalising during handling or stunning, animals effectively stunned on first attempt, and animals regaining consciousness following sticking. The respective trigger levels should at least reflect those established by Temple Grandin, i.e. <1% of animals falling, ≤3% of animals vocalising, ≥96% effectively stunned at first attempt, <100% unconscious following sticking.

Antimicrobials

An antimicrobial is an agent that kills or stops the growth of microorganisms such as bacteria, viruses, fungi, and parasites. The World Organisation for Animal Health does not include anthelmintics, disinfectants or antiseptics in their definition of antimicrobial agents. Ionophores (antimicrobials not used in humans) and non-ionophores are classed as antibacterial agents. In other words, they are a category of antimicrobial. Antimicrobial resistance occurs where microorganisms continue to grow in the presence of levels of antimicrobial agents that would normally stop their growth or kill them. Calves may develop diseases that can be treated with specific antimicrobial medication. For example, several species of the *Eimeria* protozoa may cause coccidiosis in growing calves, affecting the mucosal lining of the intestines. Calves may become unthrifty and have watery feces and reduced feed efficiency for several days but the infection is not usually severe. Once diagnosed, spread of coccidiosis may be treated or prevented with a coccidiostat – an antimicrobial that kills the *Eimeria* parasite – but prevention is better than cure. The key risk factor for coccidiosis (and most other diseases) is stress, with other factors including overcrowding, wet bedding, dirty feeders and drinkers, poor hygiene, insufficient or inadequate feed (including colostrum), changes in diet, mixing of unfamiliar calves, and transport. Optimising the calf's environment and ensuring appropriate handling and management practices will go a long way towards preventing disease and reducing the need to use antimicrobials. Prophylactic (or preventive) use of antimicrobials (including coccidiostats) is strongly discouraged under the RSPCA Approved Farming Scheme Standard for dairy calves with calf rearers required to have an Antimicrobial Stewardship Plan in place that requires yearly review of antimicrobial usage with the aim of reducing/eliminating usage over time.

Bedding

Adding bedding such as straw, wood shavings or rice hulls to calf pens and shelters is a means of providing a soft floor surface. Calves may lie down for up to 18 hours a day and appear to prefer dry sawdust as a lying surface. Deep bedding has the benefit of allowing calves to nest and better regulate body temperature, unlike soft floor surfaces such as sand and rubber. Young calves are not able to thermoregulate as efficiently as older cattle and thick, dry bedding provides them with an insulating barrier. Bedding should be removed and/or topped up as necessary to ensure it remains clean and dry in order to avoid the build-up of ammonia and pathogens and to make sure that calves can always lie down on dry bedding. Wet and/or soiled bedding can increase the risk of diarrhoea and other infections.

Behaviour — abnormal

An understanding of animal behaviour (both normal and abnormal) is an important skill for all people working with animals. Abnormal behaviour in calves includes repeated rubbing, tongue rolling, bar biting or chewing, licking or chewing solid objects, eating soil, navel or ear sucking, sham chewing (i.e. chewing without food in the mouth) and urine drinking. Tongue rolling and tongue playing are most apparent around feeding time as well as at times when calves would normally ruminate. It is therefore thought to be associated with chewing behaviour and rumination. Manipulating pen fixtures or buckets, on the other hand, occurs before and after feeding time and is thought to be an indication of anticipatory feeding behaviour followed by dissatisfaction at the short feeding time. Where calves exhibit repeated abnormal behaviours, the cause should be investigated and resolved, for example

through modification of the environment, provision of enrichment, more space, additional bedding, and enabling appropriate sucking behaviour. Abnormal behaviours are indicative of poor animal welfare.

Behaviour — competition

Competition for feed (or other resources) is a potential concern with group-housed calves, particularly during mixing when unfamiliar calves are grouped together or join an existing group. Displacement of calves at the milk feeder increases as group size increases and teat availability decreases. With fewer teats available and increased competition for limited teats, calves tend to increase milk uptake to compensate for reduced meal frequency. Systems that provide barriers that make it more difficult for calves to displace each other at feeding will help calves increase milk uptake and feeding duration when feeding frequency is reduced. Because feeding is a social activity, providing group-housed calves with multiple feeding stations will allow for more synchronised feeding and encourage feed intake while reducing displacement at the feeder. Also, the greater the age difference among group-housed calves, the greater the risk of increased competition.

Behaviour — suckling and cross sucking

Cross sucking is an abnormal behaviour indicative of poor welfare. Cross sucking is exhibited when the calf sucks on the body of another calf or on pen fixtures, including empty teats. Calves are strongly motivated to suckle. Suckling stimulates the closure of the oesophageal groove allowing milk to flow directly into the abomasum thereby avoiding the as yet underdeveloped rumen. Milk that ends up in the rumen can cause a number of health issues, including acidosis, bloat and abnormal feces. Suckling motivation can be satisfied by using teat feeders and by providing calves with a larger ration of milk. Natural suckling bouts would last about 10 minutes and calves in their first week of life will suckle about 10 times a day - with suckling bouts gradually decreasing before weaning. Milk feeding systems that don't allow suckling behaviour and where the milk ration is consumed quickly – such as bucket feeding - result in an inability to express normal suckling behaviour. Calves fed by bucket rather than by teat may display more bar suckling behaviour. Suckling from a teat reduces the speed at which milk is ingested and virtually eliminates any flow of milk into the rumen. Teat-fed calves tend to rest and show signs of satiety sooner after a meal than bucket fed calves. Teat feeding also reduces cross sucking. Cross sucking can be reduced by feeding calves *ad libitum* from an artificial teat, reducing the diameter of the teat in order to increase the feed duration, using automatic feeders which allow for several smaller feeds (or, preferably, *ad libitum* feeding), introducing individual feeding barriers, providing enrichment (for example dry artificial teats (although calves prefer nutritive sucking to dry sucking), netted hay, additional space for exercise), and generally by increasing feed allowance and reducing milk flow allowing for longer suckling bouts.

Biosecurity

Biosecurity is the prevention of disease incurrence and transmission as well as the management of endemic diseases. The key objective of biosecurity and quarantine measures is to prevent or control the introduction and spread of disease regardless of whether calves are housed indoors or have access to an outdoor area or pasture. Appropriate and effective biosecurity measures include hygiene and sanitation/disinfection procedures relating to the movement of staff, visitors, equipment, supplies, and vehicles onto and between different sites and work areas. Further information on biosecurity practices in the dairy industry can be found at www.farmbiosecurity.com.au.

See also 'Health and disease'.

Bobby calf

A bobby calf is a male or female dairy or dairy crossbred calf, who is less than 30 days old and is not accompanied by their dam (mother). Male bobby calves are unwanted by the dairy industry as they are not able to join the milking herd. Some bobby calves may be raised to an older age for veal while the majority are transported to the abattoir for slaughter from 5 days old. Raising excess dairy calves for veal or beef is one way in which the value of these animals can be increased. By increasing their value, enhancing their environment, and providing an alternative market, there is real potential to improve the welfare of bobby calves and provide them with a life worth living.

Castration

Males of most farm animal species are routinely castrated to prevent unwanted breeding, reduce aggression and sexual behaviour, as well as minimise the risk of injury to the animal, other animals and animal handlers. Castrated males may also produce preferred meat and carcass quality traits compared to non-castrated males. The main method of castration of male dairy calves is physical removal or irreversible damage of the blood supply to the testes either by surgical or non-surgical means. Physical methods of castration cause pain, stress and inflammation, and risk infection, bleeding and/or flystrike at the wound site. Selection of appropriate pain relief product(s) and the method of delivery should reflect the castration method used. Surgical methods of castration using a knife or blade are the most painful during and immediately following the procedure while the pain from rubber ring castration is more prolonged and wound healing less rapid. Castration of calves using rubber ring or blade results must be accompanied by local anaesthetic, where available, prior administration of analgesics and on-going administration of analgesics for the period where post-operative pain is expected and where signs of pain and discomfort are evident. Signs of pain in calves include vocalisation, abnormal postures (head down, tail tuck or twitch, arched back, foot stamping, kicking at the underbelly) and reluctance to move or walk. Signs of pain in lambs/kids include abnormal postures (arched back, 'statue standing', splayed legs, kicking or bucking) and increased lying behaviour (including lying on the sternum or side with limbs extended or rolling). Dairy calves must be closely supervised following the procedure.

Closed Circuit Television (CCTV)

The RSPCA Approved Farming Scheme Standard for dairy calves require that CCTV be used to monitor those areas of the slaughtering facility where the risk to animal welfare is greatest. CCTV should not replace the need to employ people with the right attitude towards animals, comprehensive staff training and good stockpersonship. CCTV, however, is an excellent means by which facility management and auditors can monitor compliance with standards and regulations relating to animal welfare. CCTV allows problem areas to be identified and promptly addressed. It is important that a protocol is in place to determine the use of CCTV. Such protocols should include information about the positioning of the camera to allow a clear view of calf handling, stunning and slaughtering processes; about the period for which the footage should be retained (three months is considered good practice); about the review of the footage and who should be responsible; and how the footage should be kept safe and secure. These protocols are well described in the UK Farm Animal Welfare Council's *Opinion on CCTV in slaughterhouses*.

Colostrum

Colostrum is a fluid produced by the pregnant cow in readiness for the calf at first suckling. Calves are born with little to no immunity and colostrum provides the calf with antibodies that protect it from infectious diseases. In addition to antibodies, colostrum also contains white blood cells, anti-microbial factors, growth factors and nutrients. The strongest concentration of these constituents is present at

birth. A refractometer can be used to measure the level of antibodies in colostrum indirectly. Readings of 22% or greater on the refractometer's Brix scale indicate good quality colostrum. The more antibodies (mainly immunoglobulin IgG) in the colostrum, the higher the quality (good quality colostrum contains >50mg IgG per ml). The calf's intestine is best able to absorb these large antibody molecules immediately after birth. From then on, absorption ability decreases rapidly within 6 hours and stops completely within 36 hours of birth. To achieve successful transfer of immunity, calves should receive high quality colostrum within 6 hours of birth. Calves should be provided with a sufficient quantity of colostrum over the first 24 hours to ensure IgG concentration in calf serum is at least 55mg/ml when sampled between 24 hours and 7 days of age. Testing of IgG levels in blood serum can be done on farm using a refractometer or alternatively at commercial laboratories.

See also 'Feeding — method'.

Cow-calf separation

For cows to produce milk, they must give birth to a calf. In the dairy industry, most calves are separated from their mother within 24 hours of birth to reduce the risk of transmitting Bovine Johne's Disease (a fatal wasting disease) to the calf, to ensure adequate colostrum intake in order to achieve successful transfer of passive immunity, and for ease of management of cows and calves. Separation within 24 hours of birth interferes with the development of the cow-calf bond and reduces separation distress. Cows will show a strong response (calling) if their calf is separated at an older age, for example 4 days after birth, compared to separation at 1 day or 6 hours after birth. The longer calves are allowed to stay with their dam, the stronger the cow-calf bond and the greater the response (including a negative affective state) at separation. On the other hand, calves reared by their mothers may display less abnormal oral behaviours and improved social behaviour, they may also gain more weight and have better health. Health benefits for the dam resulting from suckling may include a reduction in the incidence of mastitis and in the incidence of fetal membrane retention. Housing calves in groups appears to alleviate the stress of separation from the dam. Further research is required to determine optimal management strategies for the welfare of both cows and calves in dairy production systems.

See also 'Stress'.

Disbudding

Disbudding of horned dairy cattle is routinely performed in many parts of Australia to reduce the incidence of bruising and potential injury to other animals and animal handlers, e.g. during handling, yarding and transport. Disbudding is the removal of the horn bud before it attaches to the animal's skull. The age at which the horn attaches to the skull can vary but it is usually within 2 months for calves. Disbudding methods used include thermal cautery or hot iron disbudding (use of heat to destroy the horn bud), chemical disbudding (use of caustic chemicals) and surgical removal (using a scoop dehorner or sharp knife). Dehorning and disbudding, regardless of the method used, are known to result in pain and stress to the animal, and can additionally impact welfare through risk of bleeding, infection and flystrike. RSPCA Australia strongly supports the breeding of polled (hornless) animals to preclude the need for disbudding. The polled gene is a dominant trait and progeny who inherit the polled gene will be hornless and not require disbudding. Where disbudding of calves is considered necessary, thermal cautery (hot iron) is the preferred method as it reduces the risk of bleeding and may also limit infection, flystrike and mortality. Care is needed to minimise risk of thermal injury to the underlying bone and tissue surrounding the horn buds. Disbudding of calves results in both acute and longer-lasting (inflammatory) pain and must be accompanied by sedation, pre-operative local anaesthetic at the base of each horn bud, pre-operative administration of analgesics and on-going administration of analgesics for the period where post-operative pain is expected and where signs of pain and discomfort are

evident. Signs of pain following disbudding in calves include vocalisation, ear flicking and head shaking and rubbing. Dairy calves must be closely supervised following the procedure.

Environmental enrichment

Providing animals with environmental enrichment can be an effective strategy to improve animal welfare by enabling positive affective states and improving biological functioning, particularly where animals are confined indoors. Environmental enrichment may improve the environment by increasing the complexity of the animal's surroundings, and by increasing opportunities to engage in natural and rewarding behaviours. Poor animal welfare occurs where there is a mismatch between the animal's needs and aspects of animal management and/or the animal's environment. However, environmental enrichment alone will not address this mismatch. Good animal welfare relies on meeting an animal's physiological needs (example.g. good health, good nutrition, comfortable housing), good stockpersonship (example.g. low-stress animal handling, positive interactions), providing for innate behavioural needs (e.g. in calves, the ability to suckle, chew, ruminate, the company of other calves), and providing the opportunity to have positive experiences (e.g. through play and locomotor behaviours, through active engagement with their surroundings). Good welfare can be achieved where calves are provided with sufficient space to play in the company of other calves, sufficient quantity of milk to prevent hunger and competition at the feeder, teat feeders to satisfy the need to suckle, and roughage to promote chewing and rumination and express foraging behaviour, and bedding to allow for thermal comfort as well as nesting. An outdoor area and access to pasture will provide additional stimulation and the opportunity to further improve animal welfare. Environmental enrichment objects, such as balls, cow brushes, or dry teats are only effective if they are used by the animals. Such objects should be replaced, rotated and reviewed if calves lose interest.

Euthanasia

Euthanasia is defined as humanely ending the life of an animal when it is in the interest of the animal's welfare and using a technique that avoids further pain, suffering and/or distress. All methods of humane killing, including slaughter and on-farm euthanasia, must meet the same criteria: death of an animal without pain, suffering or distress, that ensures rapid unconsciousness followed by death without regaining consciousness; and with equipment that is easy to maintain. In calves, rapid brain death is achieved by destroying the brain stem, which is located midway between the two ear canals at the base of the ears. Blunt force trauma is not acceptable for euthanasing calves due to the calf's skull being too hard to reliably and consistently achieve immediate unconsciousness through destruction of brain tissue. Blunt force trauma relies on correct and effective application each and every time for it to be humane. Persons carrying out blunt force trauma can find it unpleasant, and operator fatigue and unreliability are potentially serious welfare risks for the animal concerned. Use of a firearm or penetrative captive bolt in the frontal position is the recommended method for on-farm euthanasia of calves. Use of the penetrative captive bolt in the poll position is more prone to operator error and can result in misdirection of the bolt into the spinal cord instead of the brain. Following firearm or captive bolt use, the calf must always be checked immediately to ensure it is dead. Persons carrying out euthanasia should be aware of the dairy industry's fact sheet on *Humane killing and disposal of sick or injured cattle* and attend accredited training to ensure competency.

Feeding — frequency

Feeding calves more frequently than once or twice a day has a behavioural benefit to the calf - it more closely reflects natural suckling frequency and reduces abnormal oral behaviours. Feeding more frequently also reduces the risk of overfilling the abomasum and/or milk spilling into the rumen as compared to larger quantities of milk fed once or twice a day. Utilisation of glucose and nutrients is

improved when meal frequency is increased. Automatic calf feeders allow group-housed calves to feed more frequently during the day. They also permit the calf to consume larger volumes of milk at each drinking bout and across multiple drinking bouts throughout the day. Automatic feeders have the ability to more closely mimic the natural nursing behaviour of the calf. Manual feeding typically involves more labour.

Feeding — method

Sufficient feeding stations should be available so that all calves are able to feed at the same time. Feeding systems incorporating teat feeders are the preferred method for milk feeding as they satisfy the calf's behavioural need to suckle and reduce the risk that calves will 'cross suck' (suckle one another or pen fixtures, including empty teats). Buckets and open troughs are often used for milk feeding because they are easier to pour milk into and also easier to clean. However, from a behavioural needs perspective, they do not address the calf's motivation to suckle despite the calf feeling full relatively quickly. Sucking milk from a teat or even sucking on a dry teat will increase the level of digestive hormones (insulin and cholecystokinin) in the calf's blood, showing that suckling may be important from a metabolic as well as a behavioural perspective. Increasing the time that the calf is able to suckle by using teat feeders and by slowing the flow of milk through the teat, better satisfies innate suckling behaviour and significantly reduces the amount of time that the calf may spend cross sucking. Suckling also increases satiety and the length of time that calves will sleep. Milk temperature is also an important factor. When feeding calves, milk temperature should be consistent at every feeding until weaning. The temperature of the mother's milk for naturally suckling calves is 38ºC. Calf body temperature is around 38.6 ºC. Milk is best fed at a temperature that will maintain, rather than decrease calf body temperature.

Feeding — milk volume

Common dairy industry practice is to feed unweaned calves around 10% of calf body weight in milk daily. This amount of milk is about half of what calves would typically drink (around 10 litres of milk over 8-12 feeds per day) in the first weeks of life if they were able to suckle from their dam. Reducing milk intake is intended to encourage the calf to consume solid feed (which is usually cheaper than milk replacer) which leads to more rapid rumen development and allows the calf to be weaned off milk more quickly. However, it appears that calves are not able to compensate low milk intake with a higher solid feed intake in their first few weeks of life. Feeding calves more than the traditional quantity – for example feeding up to 20% of calf body weight – has been shown to result in greater feed consumption, body weight gain and hip growth. Higher milk allowances may also result in less unrewarded visits to the milk feeder. A high number of such unrewarded visits is indicative of hunger. Calves that are hungry will vocalise more and play less than well-fed calves. Frequent visits to feeders will cause frustration if the calf is often not allocated sufficient milk. Increased mortalities may result if calves are fed a limited ration in winter and therefore have limited energy reserves to keep warm. There is no strong evidence that feeding calves large amounts of milk will increase the incidence of clinical diarrhoea, although their feces may be more liquid. Offering calves an amount of milk that they would choose to consume *ad libitum* will ensure calves are satiated. Potential for poor welfare exists where calves are fed limited milk rations, particularly if the diet is not supplemented with concentrate and/or roughage.

Feeding — roughage

Calves have an inherent need to chew and to ruminate and will begin to chew on solid food at around 2 weeks of age, although they prefer to consume a largely milk-based diet up to 1 month of age. Providing calves with roughage allows them to carry out normal chewing behaviour and decreases any abnormal oral behaviours such as manipulating pen fixtures and pen mates or tongue playing that may occur

around feeding time. Short chewing bouts will not satisfy this behavioural need; nor will feeding only liquid diets. By providing hay in racks *ad libitum* the calf's natural foraging behaviour is continuously stimulated as they pull the hay out of the rack similar to the way they would pull grass from the ground. Calves prefer to chew on long hay rather than chopped hay, possibly because it stimulates chewing more. Where long hay is provided in addition to their ration, overall roughage intake, rumen development and rumination are promoted. Long stalk straw, on the other hand, is generally of poor nutrient value and may limit growth and rumen development due to reduced feed intake. To reduce abnormal oral behaviours, calves should be provided with at least 50g, 500g and ≥1kg of dry matter/calf/day of long hay at 1, 3 and 6 months of age respectively. Providing course fibrous feed to calves that consume large amounts of milk replacer can increase the risk of damage to the abomasum because of the potential abrasive effect and should be managed carefully for example through the provision of long hay rather than other coarser forms of roughage. The cause of abomasal damage is multi-factorial. Consumption of large volumes of milk replacer can cause damage and ulceration of the abomasum, which is painful to the calf. Trough and bucket milk-feeding systems increase the risk compared to automatic calf feeders from which calves can drink more frequent smaller meals. It is as yet unclear whether the risk of abomasal damage is related to an underdeveloped rumen in milk-fed calves. However, the provision of concentrate to calves from a young age will stimulate early rumen development, which may help alleviate and heal abomasal damage. Textured feed (concentrate) is preferred by calves over ground meals or pellets that crumble into a fine dust.

Five Freedoms / Five Domains

The Five Freedoms were first mentioned in 1965 in a UK report on the Welfare of Animals kept under Intensive Livestock Husbandry Systems which stated that "farm animals should have freedom to stand up, lie down, turn around, groom themselves and stretch their limbs". Following the establishment of the UK Farm Animal Welfare Council shortly after, the concept was further refined into the Five Freedoms we know today:

- Freedom from hunger and thirst — by ready access to fresh water and a diet to maintain full health and vigour
- Freedom from discomfort — by providing an appropriate environment including shelter and a comfortable resting area
- Freedom from pain, injury or disease — by prevention or rapid diagnosis and treatment
- Freedom to express normal behaviour — by providing sufficient space, proper facilities and company of the animal's own kind
- Freedom from fear and distress — by ensuring conditions and care which avoid mental suffering.

The RSPCA considers that the welfare of an animal includes its physical and mental state. Good animal welfare implies both fitness and a sense of wellbeing. An overall welfare assessment can be made by looking at the calf's physical environment, its biological functioning and by observing calf behaviour in response to challenges in their environment. The latter, in particular, requires an understanding of normal behaviour, behavioural needs and wants, and being able to identify behaviour indicative of poor welfare.

More recently, a new framework for assessing animal welfare has been developed called the Five Domains which emphasises the need to consider the mental as well as physical wellbeing of animals. Thus, animals are able to be assessed on the basis of whether aspects of their nutrition, health, housing and/or behaviour affects their mental state either positively or negatively. For example, an animal housed in a barren pen may exhibit signs of frustration.

See also 'Animal welfare', 'Animal-based welfare assessment'.

Flight zone

The flight zone is effectively the animal's 'personal space' and is indicated by the distance an animal will allow a human to approach before moving away. An awareness of the flight zone allows a handler to move animals in a manner that minimises stress, particularly when combined with other low stress handling methods including slow, deliberate movements and low noise. An animal will move forward if the person stands on the edge of the flight zone at a point behind the animal, and backwards if a person stands on the edge of the flight zone in front of the animal. This point is known as the 'point of balance'. Animals quickly learn that, if they move in the desired direction, a handler will move out of their flight zone. The size of an animal's flight zone will vary depending on the individual animal, previous handling and human interactions and present level of stress or excitement.

See also 'Handling', 'Stockpersonship'.

Flooring

For a floor surface to be comfortable for calves it must be soft underfoot, prevent slipping and falling, and avoid foot or leg issues. Hard floors include concrete floors (solid or slatted) and hardwood slats whereas softer floors include concrete covered with rubber, rubber matting, sand, and floors bedded with straw or wood shavings. Calves prefer softer floors over hard floors. Sawdust is preferred over rubber floors which, in turn, are preferred over sand. Heavier animals may experience discomfort when getting up and down on hard floors. Calves on hard floors generally experience more joint injury and swelling.

Group housing

Calves born in a natural environment will begin interacting with each other at around 1 week of age. Before then, the calf is either alone or with its dam. It is common in the dairy industry to house new-born calves individually in their first days or weeks of life. This reduces the risk of disease transmission because there is generally no nose-to-nose contact between calves, it enables close management of colostrum feeding and facilitates the initial care of the calf. However, calves are gregarious animals, which means they are highly social and motivated to interact with each other and mimic each other's behaviours. From an animal welfare perspective, group housing is desirable because it improves cognitive performance (allowing calves to better respond to changes in their environment), it provides animals with more space to move around, and gives calves the opportunity to express social behaviours, including play behaviours (running, jumping, and bucking). Individual housing requires more space and more infrastructure than group housing and it allows customised feeding and care of the calf. However, stronger bonds are formed between calves paired at birth rather than later in life and these social bonds influence calf fearfulness. Tactile contact is important for calf welfare in that it enables the expression of sniffing and licking behaviours and is further improved in pair or group housing where calves can have full body contact with each other. In individually housed calves, the level of licking fixtures and their own bodies is higher than in pair-housed calves. This suggests that this licking may be redirected social grooming or redirected exploratory behaviour. The greater space allowance in group housing allows calves to lie with their legs outstretched and their head on the ground, postures which are important for ensuring proper rest and sleep. In colder climates, group housing or pair housing of calves helps calves to keep warm as they can lie next to each other. Calves housed in pairs are less reactive to novel situations (environmental or social). Although group housing may increase competition for feed and other resources, it is thought that competition and socially transmitted behaviours (for example feeding and degree of competition at feeding) improve rumen development and increase starter feed intake. Calves housed in pairs prior to weaning consume more starter feed, gain more weight and vocalise less than individually housed calves.

Group housing — health

Group housing should not be seen as a trade-off between health and behavioural freedom. The incidence of mortality, respiratory disease and diarrhoea in group-housed calves depends on a range of factors including management, environment and feeding routine. Disease transmission may occur through contact with infected calves, for example through feces or nose-to-nose contact. The common pathogens causing respiratory disease are transmitted by air. Calves housed in small groups (less than 10 calves) prior to weaning may have fewer incidences of respiratory diseases than those housed in large groups (up to 30 calves) or individually, suggesting that group size rather than grouping itself may be associated with disease risk. Keeping calves in small groups can make it easier to identify a calf that may be sick. Overall, the animal welfare benefits of housing calves in pairs and in groups outweigh the risk of transmission of disease.

Group housing — mixing

Weaning, mixing with other calves and a change in housing and diet are all acute stressors. When new calves are introduced into a group, competitive interactions usually go up, resulting in increased social stress as well as reduced feed intake. Where calves prior to weaning are kept in dynamic groups, there may be considerable age variation within the group as new calves are introduced soon after birth and older calves are removed at weaning. Post weaning, it may also be difficult to maintain stable groups as calves may need to be regrouped according to age or size. However, fewer aggressive encounters and more positive social interactions result if regrouping is limited to mixing two previously stable groups of calves. Aggression is rare in homogenous age groups, with calves displaying mainly non-agonistic social behaviours. The greater the age difference among group-housed calves, the greater the risk of increased competition for feed and other resources, presenting a welfare issue for low-ranking/younger/smaller calves. Individually housed calves tend to display a high level of activity and aggressive behaviours at grouping. Previously group-housed calves transition more smoothly when mixed with a novel group of calves. It is recommended that calves are transitioned into small groups (less than 10 calves) before being moved to larger groups (up to 30 calves). Age and weight composition must also be considered.

Handling

Calves must always be handled humanely — whether on farm, during transport or at the abattoir. Calves must not be subjected to rough handling, prodding, and use of dogs or electric goads. Very young calves have underdeveloped 'following' behaviour, which means that they do not stay together as a group. This may make moving and loading/unloading for transport difficult. When moving calves, the principles of low-stress animal handling should be applied. An understanding of animal behaviour and the animal's flight zone should be used to encourage rather than force an animal in the required direction. Cattle (including calves) are gregarious animals, so they are highly motivated to remain with their herd and do not like being isolated. Cattle also have poor perception of distance, depth and detail which means they are unlikely to want to walk into shadows or on irregular floors, move between contrasting light and dark areas, or respond well to sudden movement. Calves also do not respond well to sudden loud noise.

See also 'Flight zone', 'Stockpersonship'.

Health and disease

Calves must be protected from pain, injury and disease through good management and husbandry practice, and through rapid detection and treatment of disease. Disease can be a major cause of poor welfare and mortality in calves. Therefore, it is essential to take all reasonable steps to minimise the likelihood of disease outbreaks.

Enteric and respiratory diseases are the most common health disorders in calves. In early calf rearing, calf scours (diarrhoea) is the main priority in terms of prevention, diagnosis and treatment of disease. In young calves, respiratory disease can be a significant cause of morbidity and mortality, with the risk steadily increasing and then plateauing after 4 weeks of age. Calf scours is common in young calves and not necessarily related to housing system, with the same pathogens detectable in individual versus group-housing systems. Cleaning of the calving area after each calving so as to avoid a build-up of mud, manure and other potential disease-causing agents reduces the risk of calf scours in the rearing facility. Incidence of respiratory disease may be higher in calves prior to weaning housed in larger groups compared to those housed individually or in smaller groups. Calves that are well fed and managed, and not stressed are likely to have a stronger immune system and thus are more resistant to disease than unthrifty animals. Preventative treatment such as vaccination should be implemented where available in addition to ongoing monitoring by farm workers who should be able to recognise early signs of disease.

Ongoing adherence to established biosecurity protocols can help reduce the incidence of disease. Preventative treatment such as vaccinations should be implemented where available in addition to ongoing monitoring by farm workers who should be able to recognise early signs of disease. It is a requirement of the Approved Farming Scheme Standard that producers develop a veterinary health plan in consultation with a designated veterinarian.

See also ‘Antimicrobials’, ‘Biosecurity’.

Hormone growth promotants

The use of hormone growth promotants (HGPs) to increase growth rates is a widespread practice in the Australian beef cattle industry. Cattle naturally produce steroid sex hormones to regulate reproduction and growth. In cattle, natural and synthetic hormones may be implanted under the skin of the animal’s ear to improve daily weight gain, feed conversion and carcass quality. Hormones increase the rate at which muscle grows by about 10-30% thereby reducing the time to reach slaughter weight. Hormone implant sites may become infected if the implant is not injected properly or the site is not disinfected. Hormones may also cause cattle to become more sensitive to hot climatic conditions. Hormonal implants interact with the animal’s natural hormones and side effects of their use may include aggressiveness (particularly in the first few weeks after implantation), difficulty in handling, nervousness, rectal prolapse, ventral oedema (swelling) and the base of the animal’s tail being elevated. There is also some evidence of chronic stress conditions as a result of hormone implant use. Although uncommon, these side effects of hormone use are all signs of poor welfare.

Iron deficiency

The system of veal production where calves spend their entire lives in small, individual crates is not used in Australia. This system of housing calves for veal production is designed to produce the 'classic' white-coloured veal by restricting movement and denying the calf access to iron. Veal crates have been illegal in the UK and Europe since 2007 but are still used in some countries. Calves that are exclusively fed on milk or milk replacer without iron supplements are likely to be anaemic, i.e. have iron deficiency. Iron is essential in haemoglobin formation in red blood cells ensuring that oxygen is carried around the body. Iron is also important for the concentration of myoglobin in muscle. Myoglobin is responsible for the red colour of muscle, which is why iron-deficient calves produce white or pale meat. Calves fed on a grain ration and/or provided with roughage and/or access to pasture are unlikely to suffer from iron deficiency.

Pasture

Cattle spend 90-95% of the day grazing, ruminating and resting, with grazing being the most common of these behaviours. Grazing occurs mostly during the day, rumination occurs while cattle are resting, and ruminating and resting occur mostly at night. When given a choice, dairy cows prefer to be on pasture at night and in the shed during the day (particularly after milking) where they can access feed (mixed ration). The shed may also be preferred on warmer days when dairy cows seek shade, on rainy days when they seek shelter, and as the days get progressively colder in winter when they seek warmth. In experiments where animals are given a choice, beef cattle in feedlots have also shown a preference for pasture, not necessarily influenced by temperature or rainfall, with time spent in the feedlot coinciding with feeding at the feed bunk. Providing fresh cut grass to calves prior to weaning may reduce abnormal behaviours and increase positive behaviours such as tail swishing, self-grooming and rubbing. Where calves do not have access to pasture, attention needs to be given to providing appropriate and palatable forage feeds (fibrous feeds including silage, hay and straw) to allow calves to express some foraging behaviour.

Rumen development

Cattle are ruminants and have a stomach that consists of four compartments: reticulum, rumen, omasum, and abomasum. The reticulum and the rumen together are a large fermentation vat. The omasum absorbs water and minerals, and the abomasum is the 'true stomach'. In cattle, only the abomasum is fully developed at birth. Suckling stimulates the closure of the oesophageal groove by allowing milk to flow directly into the abomasum, thereby avoiding the as yet underdeveloped reticulum and rumen. Because these two compartments are bypassed, reticulum and rumen development are slow if the calf is only milk fed. In the abomasum, the milk forms a curd-like clot and is steadily released throughout the gut. Complete digestion of this milk can take 12-18 hours. Once the calf begins to consume dry feed, concentrate or forage feeds, this ends up in the rumen and starts off rumen development and digestion. Calves must always have access to plenty of clean fresh water as, without it, bacterial fermentation in the rumen is not possible. When the calf is born, the rumen capacity is approximately 1-2l, whereas when fully developed by 3 months of age it can reach 25-30l. An obvious sign that the rumen is developing is the calf beginning to chew the cud (ruminating) at about 2 weeks of age. Digestive bacteria gradually multiply in the rumen and it takes about 3 weeks from the point where calves are consuming sufficient amounts of concentrate (around 1kg per day) for the rumen to be fully developed and able to absorb nutrients to support the calf post weaning. The longer and the more frequently a calf drinks, the slower rumen development will be. On the other hand, calves fed less milk and more concentrate can have a functioning rumen by 3 weeks of age and can be weaned by 6 weeks of age.

See also 'Colostrum', 'Feeding — frequency', 'Feeding — milk volume', 'Feeding — roughage'.

Pest control

There are a wide range of pest control methods available. The methods vary greatly in their impact on animal welfare. Many pest control methods cause significant pain, suffering and distress. Humane pest control is the development and selection of feasible control programs that avoid or minimise pain, suffering and distress to target and non-target animals. A humane pest control method is one where the animal experiences no pain, suffering or distress. The pest control methods employed should be the most humane methods available. Furthermore, considerations should be made to physically exclude pest animals from the production site and minimising or eliminating environmental factors that encourage pest animal activity. RSPCA Australia encourages ongoing investment in research and development to identify more humane pest control methods.

Slaughter

For an animal to be killed humanely, they must be either killed instantly or rendered insensible until death supervenes, without pain, suffering or distress'. When killing animals for food (termed 'slaughter'), this means they must be stunned so they immediately become unconscious prior to bleeding out. All methods of humane killing, including slaughter and on-farm euthanasia, must meet the same criteria: death of an animal without panic, pain or distress; instant unconsciousness followed by rapid death without regaining consciousness; reliability; simple; and with equipment that is easy to maintain. A high level of operator skill is essential for the humane killing of animals. Operators must be trained in animal handling; selection of the best killing method; correct application of the killing method; and proper maintenance of equipment. At the very least, abattoirs should meet the Australian meat industry's *Animal Welfare Standards for Livestock Processing Establishments*.

Stocking density

Animals need enough space to ensure they remain physically healthy and can carry out natural behaviours. Space allowance should enable animals to exercise, explore and express social behaviours. When determining the appropriate stocking density for animals, consideration needs to be given to a range of factors, including: ventilation, temperature, humidity; age, size and sex of the animal; the group size and composition; weather conditions; bedding management; and quality and management of the outdoor area and/or paddock. In other words, it is not only the quantity of space provided to each animal, but also the quality of the space provided that influences animal welfare. Calves given sufficient space exhibit fewer abnormal behaviours, have room to exercise, play (run, buck and jump), can lie with their legs outstretched and head on the ground, and have full body contact with each other. Stocking density should be reviewed regularly and where animals are diseased, injured, aggressive or behaving abnormally, space allowance should be increased to ensure the welfare of the animals.

See also 'Behaviour — abnormal', 'Behaviour — competition', 'Behaviour — suckling and cross sucking'.

Stockpersonship

The interaction between stockpersons and animals (the human-animal relationship) is a large determinant of welfare outcomes. It is important to recognise that humans have the potential to both compromise and enhance animal welfare. The attitude and behaviours of a stockperson strongly affects an animal's fear of humans and subsequently their wellbeing, productivity and meat quality. The attitudes and competence of stockpersons and staff are vital in determining whether high standards of animal welfare can be achieved. It is the responsibility of management to ensure there is a culture among staff that prioritises animal welfare and recognises and rewards staff for maintaining good welfare. Financial rewards, career pathways, working conditions, organisational policy and general job satisfaction may also contribute to motivation and performance. In addition to attitude and behaviour, technical skills, and knowledge are essential. Therefore, selection of the right people and formal training of stockpeople is crucial. It is essential that stockpersons are suitably selected, trained and experienced (or directly supervised by experienced staff) and are able to recognise indicators of poor and good welfare. Stockpersons must have a good working knowledge of the husbandry system used and the animals under their care. High standards of husbandry must be maintained at all times with the welfare of animals considered a priority. The stockperson is responsible for optimising the environment that calves rely on for survival and must maintain the highest environmental quality at all times.

See also 'Handling'.

Stress

The mechanism that allows animals to cope with challenges in their environment is called a stress response and it allows the animal to overcome or avoid such challenges (referred to as 'stressors'). Some stressors cause the animal to exhibit an acute stress response, whereby behavioural and physiological responses are generally short lived and biological functioning is soon able to return to normal. However, where the animal is not able to escape the stressor or where stressors persist beyond the short term, chronic stress can result. Chronic stress compromises animal welfare and can usually be observed through physical and behavioural changes in the animal (for example loss of appetite and weight, compromised immune and reproductive system, impaired mental function and coping ability). Many stressors may elicit a fear or anxiety response, and as such fear, anxiety and stress are often considered together. In animal welfare terms, the distinction between fear (the perception of actual danger) and anxiety (the perception of potential danger) is not critically important as it is the animal's perception of the situation and potential negative experience which will have the greatest impact on the animal's welfare.

See also 'Group housing', 'Handling', 'Stockpersonship'.

Temperature, ventilation and air quality

Shed temperature should provide a comfortable environment for calves at all stages of production and at all times of the year. Temperature extremes (heat or cold) require additional monitoring of the calves (for example for signs of panting or huddling) and ventilation may need to be adjusted to minimise any impact on the animals. Adequate air exchange is essential for managing heat, moisture, dust and harmful gases, including ammonia. If ammonia can be smelled/detected by humans (10–15ppm) or dust levels are noticeably unpleasant, corrective action such as increasing ventilation must be taken.

Training and competency

Good stockpersonship includes the knowledge, skill, attitude and behaviour necessary to handle animals, and is an essential component of any farming system. Stockpersons must always interact with animals in a caring and compassionate manner that ensures good animal welfare and enhances the human-animal relationship. Stockpersons must be appropriately trained and competent in their required tasks. Stockpersons should successfully complete recognised training and accreditation programs where they exist, and on-the-job training in all aspects of husbandry and care relevant to their role, including euthanasia.

Stockpersons must have an understanding of normal and abnormal animal behaviour, as well as have a basic understanding of how to optimise the environment for animal welfare, recognise conditions where animal welfare may be compromised, and take appropriate action to rectify the situation if observed. The development of a positive culture to support the humane treatment of animals is essential to ensuring good animal welfare.

See also 'Handling', 'Stockpersonship'.

Transport

The length of transport, the motion of the truck, the weather and the time off feed and water are all factors to consider when transporting calves, particularly young calves. Climatic conditions influence calf comfort during transport. During hot weather, calves should be transported during the cooler parts of

the day for the shortest possible time, avoiding any unnecessary stops of the vehicle. Loading and unloading facilities should ideally provide a loading bay that allows calves, particularly young calves, to walk straight into or out of the vehicle without the need for a ramp. Young calves, especially smaller calves, show a preference for lying down during transport. If provided with straw bedding during transport, they will lie down for longer. Providing straw bedding also reduces fatigue in calves compared to mesh flooring, which they are reluctant to lie on. Calves should be given sufficient space on the transport vehicle to move unhindered from a lying position to a standing position and vice versa. Calves are able to be transported legally from as young as 5 days old (or younger if they are transported directly to a rearing facility). However, calves are best transported at an age where they are better able to withstand the stressors of transport, which include loading and unloading, and mixing with unfamiliar animals in unfamiliar environments. Very young calves (up to approximately 3 weeks of age) have underdeveloped 'following' behaviour, which means that they do not stay together as a group and move to where they are directed. This may make moving and loading/unloading young calves for transport difficult. Group-reared calves appear to have less difficulty walking up a loading ramp than individually-reared calves. At the very least, preparation for transport should meet the recommendations set out in *Is the animal fit to load? A national guide to the pre-transport selection and management of livestock* published by Meat & Livestock Australia.

See also 'Stress'.

Veal

Veal is the meat product from a young bovine of either a dairy or beef breed or a cross between the two. In Australia, Aus-Meat is responsible for establishing national industry-agreed standards for meat production and processing. Aus-Meat standards help ensure a consistent meat product that satisfies certain requirements and is described using a consistent language. The Aus-Meat veal category defines veal as a "female or castrate or entire male bovine that has no evidence of eruption of permanent incisor teeth; weighs no more than 150kg HSCW; shows no evidence of secondary sexual characteristics; and shows youthfulness and veal colour". HSCW, or hot standard carcase weight, is the weight once the dead animal's head, feet, hide and internal organs have been removed. HSCW is, very roughly, around half of the animal's live weight. Aus-Meat also have meat colour standards which are assessed on the rib eye muscle area of the chilled carcase. For veal, the colours range from a light pink (V1) to a light red (V5). Within the Aus-Meat veal category, there are three main veal classes: 'light veal (bobby)' which must weigh no more than 40kg (HSCW); 'light veal' which must weigh no more than 70kg (HSCW); and 'veal' which weighs between 70.1kg to 150kg (HSCW). Another Aus-Meat veal category is 'rosé veal' which must weigh between 100kg-200kg (HSCW), have a fat score between 0-2, and a meat colour between V1-V3. Rosé veal is from calves aged between 150-200 days.

Weaning

Calves would be naturally weaned by their dam at around 8 months of age, with the amount of milk produced by the dam gradually reducing as the calf eats more solid feed. In most calf-rearing systems, calves are weaned from 6-10 weeks of age and introduced to solid feed (grain ration or concentrate) within their first week of life. At weaning, calves can show signs of stress including increased vocalisations, cross sucking and signs of hunger, increased locomotion and less play. Reduced growth, weight loss and immunosuppression may also result. Weaning stress is usually a result of the change in the calf's diet and the mixing with unfamiliar calves. These behavioural and physiological signs of stress can be reduced by weaning calves off milk gradually rather than abruptly and by weaning calves at an older age. For example, weaning 8-week old calves over a 7-day period results in fewer behavioural signs of stress and increased weight gain compared to weaning at 6 weeks old over the same period. Weaning stress can also be reduced by gradually reducing the milk allowance as the calf eats more solid feed.

Ensuring group composition is based on age and size (i.e. grouping of calves of similar age and size) will reduce displacement of lower ranking calves at the feeder.

See also 'Group housing — mixing', 'Stress'.

BIBLIOGRAPHY

Adams-Progar A, Pereira R, Moore D (2015) Group housing preweaned dairy calves: Socialization versus disease transmission. Veterinary Medicine Extension, ag animal health *spotlight*, October 2015. Washington State University.

Adcock SJJ, Cruz DM, Tucker CB (2020) Behavioral changes in calves 11 days after cautery disbudding: Effect of local anesthesia. Journal of Dairy Science 103:8518–8525.

Animal Health Australia (2014) Australian Animal Welfare Standards and Guidelines for Cattle. Edition 1. Animal Health Australia, Canberra, ACT

Animal Health Australia (2016) Johne's Disease spread and prevalence. Animal Health Australia, Canberra, ACT.

Arnott E, Early J, Wade C et al (2014) Estimating the economic value of Australian stock herding dogs. Animal Welfare 23:189–197.

Arnott G, Ferris CP, O'Connell NE (2017) Review: Welfare of dairy cows in continuously housed and pasture-based production systems. Animal 11(2):261-273.

Averós X, Aparicio MA, Ferrari P et al (2013) The effect of steps to promote higher levels of farm animal welfare across the EU. societal versus animal scientists' perceptions of animal welfare. Animals 3(3):786–807.

Baszczak JA, Grandin T, Gruber SL et al (2006) Effects of ractopamine supplementation on the behavior of British, Continental, and Brahman crossbred steers during handling. Journal of Animal Science 84(12):3410-3414.

Bretschneider G (2005) Effects of age and method of castration on performance and stress response of beef male cattle: A review. Livestock Production Science 97:89–100.

Buchli C, Raselli A, Bruckmaier R, Hillmann E (2017) Contact with cows during the young age increases social competence and lowers the cardiac stress reaction in dairy calves. Applied Animal Behaviour Science 187:1–7.

Burgstaller J, Wittek T, Smith GW (2017) Invited review: Abomasal emptying in calves and its potential influence on gastrointestinal disease. Journal of Dairy Science 100:17–35.

Camiloti TV, Fregonesi JA, von Keyserlingk MAG et al (2012) Short communication: Effects of bedding quality on the lying behavior of dairy calves. Journal of Dairy Science 95:3380–3383.

Centner TJ, Alvey JC, Stelzleni AM (2014) Beta agonists in livestock feed: Status, health concerns, and international trade. Journal of Animal Science 92:4234–4240.

Charlton GL, Rutter SM, East M et al (2011a) Preference of dairy cows: Indoor cubicle housing with access to a total mixed ration vs. access to pasture. Applied Animal Behaviour Science 130:1–9.

Charlton GL, Rutter SM, East M et al (2011b) Effects of providing total mixed rations indoors and on pasture on the behavior of lactating dairy cattle and their preference to be indoors or on pasture. Journal of Dairy Science 94:3875–3884.

Chua B, Coenen E, van Delen J et al (2002) Effects of pair versus individual housing on the behavior and performance of dairy calves. Journal of Dairy Science 85:360–364.

Cobb CJ, Obeidat BS, Sellers MD et al (2014) Improved performance and heightened neutrophil responses during the neonatal and weaning periods among outdoor group-housed Holstein calves. Journal of Dairy Scinece 97:930–9.

Coetzee JF (2011) A review of pain assessment techniques and pharmacological approaches to pain relief after bovine castration: Practical implications for cattle production within the United States. Applied Animal Behaviour Science 135:192– 213.

Commonwealth of Australia (1999) The use of antibiotics in food-producing animals: Antibiotic-resistant bacteria in animals and humans. Report of the Joint Expert Advisory Committee on Antibiotic Resistance (JETACAR).

Conneely M, Berry DP, Murphy JP et al (2014) Effect of feeding colostrum at different volumes and subsequent number of transition milk feeds on the serum immunoglobulin G concentration and health status of dairy calves. Journal of Dairy Science 97:6991–7000.

Costa J, Daros R, von Keyserlingk M et al (2014) Complex social housing reduces food neophobia in dairy calves. Journal of Dairy Science 97:7804–7810.

Costa JHC, von Keyserlingk MAG, Weary DM (2016) Invited review: Effects of group housing of dairy calves on behavior, cognition, performance, and health. Journal of Dairy Science 99:2453–2467.

Dairy Australia (n.d) Bovine Johnes Disease (BJD): Dairy farm guidelines for BJD control: Best practice recommendations for managing the risk of BJD in Australia dairy herds. Dairy

Australia, Melbourne, VIC.
Dairy Australia (n.d) Rearing Healthy Calves: Colostrum management. Dairy Australia, Melbourne, VIC.
Dairy Australia (n.d) Rearing Healthy Calves: Weaning management. Dairy Australia, Melbourne, VIC.
de Passillé AM (2001) Sucking motivation and related problems in calves. Applied Animal Behaviour Science 72:175-187.
de Passillé AM, Cockram M, Haley D et al (2016) Code of practice for the care and handling of veal cattle: Review of scientific research on priority issues. Veal cattle code of practice scientific committee.
De Paula Vieira A, de Passillé AM, Weary DM (2012) Effects of the early social environment on behavioral responses of dairy calves to novel events. Journal of Dairy Science 95:5149–5155.
Dockweiler JC, Coetzee JF, Edwards-Callaway LN et al (2013) Effect of castration method on neurohormonal and electroencephalographic stress indicators in Holstein calves of different ages. Journal of Dairy Science 96:4340–4354.
European Food Safety Authority (2006) Scientific Opinion on the risks of poor welfare in intensive calf farming systems. The EFSA Journal 366:1-36.
European Food Safety Authority (2012) Scientific Opinion on the welfare of cattle kept for beef production and the welfare in intensive calf farming systems. The EFSA Journal 10(5):2669.
European Food Safety Authority (2016) Review of proposed MRLs, safety evaluation of products obtained from animals treated with zilpaterol and evaluation of the effects of zilpaterol on animal health and welfare. EFSA Journal 14(9):4579.
European Union (2015) Commission Notice: Guidelines for the prudent use of antimicrobials in veterinary medicine. 2015/C 299/04.
Faerevik G, Jensen MB, Bøe KE (2010) The effect of group composition and age on social behavior and competition in groups of weaned dairy calves. Journal of Dairy Science 93:4274–4279.
Fisher AD, Stevens BH, Conley MJ et al (2014) The effects of direct and indirect road transport consignment in combination with feed withdrawal in young dairy calves. Journal of Dairy Research 81:297–303.
Flower FC, Weary DM (2001) Effects of early separation on the dairy cow and calf: 2. Separation at 1 day and 2 weeks after birth. Applied Animal Behaviour Science 70(4):275-284.
Fröberg S, Gratte E, Svennersten-Sjaunja K et al(2008) Effect of suckling (’restricted suckling’) on dairy cows’ udder health and milk let-down and their calves’ weight gain, feed intake and behaviour. Applied Animal Behaviour Science 113:1–14.
Godden SM (2008) Colostrum management for dairy calves. Veterinary Clinics of North America: Food Animal Practice 24(1):19-39.
Grandin T (2007) Livestock Handling and Transport, 3rd edition. CABI International.
Grandin T (2010) Improving Animal Welfare: A Practical Approach. Edited by T Grandin, Colorado State University.
Grandin T (2013) Making slaughterhouses more humane for cattle, pigs, and sheep. Annual Review of Animal Biosciences 1:491–512.
Grondahl-Nielsen C, Simonsen HB, Lund JD et al (1999) Behavioural, endocrine and cardiac responses in young calves undergoing dehorning without and with use of sedation and analgesia. Veterinary Journal 158:14–20.
Grøndahl AM, Skancke EM, Mejdell CM et al (2007) Growth rate, health and welfare in a dairy herd with natural suckling until 6-8 weeks of age: A case report. Acta Veterinaria Scandinavica 49:16.
Grooms DL, Kroll LAK (2015) Indoor confined feedlots. Veterinary Clinics of North America - Food Animal Practice 31:295–304.
Hammell KL, Metz JHM, Mekking P (1988) Sucking behaviour of dairy calves fed milk *ad libitum* by bucket or teat. Applied Animal Behaviour Science 20:275-285.
Hänninen L, de Passillé AM, Rushen J (2005) The effect of flooring type and social grouping on the rest and growth of dairy calves. Applied Animal Behaviour Science 91(3–4):193–204.
Hernandez D, Nydam DV, Godden SM et al (2016) Brix refractometry in serum as a measure of failure of passive transfer compared to measured immunoglobulin G and total protein by refractometry in serum from dairy calves. Veterinary Journal 211:82–87.
Hulbert LE, Moisá SJ (2016) Stress, immunity, and the management of calves. Journal of Dairy Science 1–18.
Jensen MB, Duve LR, Weary DM (2015) Pair housing and enhanced milk allowance increase play behavior and improve performance in dairy calves. Journal of Dairy Science 98(4):2568-2575.
Jensen MB, Larsen LE (2014) Effects of level of social contact on dairy calf behavior and health.

Journal of Dairy Science 97:1–10.
Jensen MB, & Weary D (2013) Group housing and milk feeding of dairy calves. WCDS Advances in Dairy Technology 25:179 -189.
Jongman EC, Butler KL (2013) Ease of moving young calves at different ages. Australian Veterinary Journal 91:94–98.
Jongman EC, Butler KL (2014) The effect of age, stocking density and flooring during transport on welfare of young dairy calves in Australia. Animals 4:184–199.
Jongman EC, Conley MJ, Borg S et al (2020) The effect of milk quantity and feeding frequency on calf growth and behaviour. Animal Production Science 60: 944–952.
Khan MA, Bach A, Weary DM et al (2015) Invited review: Transitioning from milk to solid feed in dairy heifers. Journal of Dairy Science 99:885–902.
Khan MA, Weary DM, von Keyserlingk MAG (2011) Invited review: Effects of milk ration on solid feed intake, weaning, and performance in dairy heifers. Journal of Dairy Science 94:1071–81.
Kilgour RJ (2012) In pursuit of "normal": A review of the behaviour of cattle at pasture. Applied Animal Behaviour Science 138(1-2):1-11.
Klein-Jöbstl D, Iwersen M, Drillich M (2014) Farm characteristics and calf management practices on dairy farms with and without diarrhea: A case-control study to investigate risk factors for calf diarrhea. Journal of Dairy Science 97:1–10.
Knowles TG, Warriss PD, Brown SN et al (1997) Effects on calves less than one month old of feeding or not feeding them during road transport of up to 24 hours. Veterinary Record 140:116–24.
Krachun C, Rushen J, de Passillé AM (2010) Play behaviour in dairy calves is reduced by weaning and by a low energy intake. Applied Animal Behaviour Science 122:71-76.
Le Neindre P (1993) Evaluating housing systems for veal calves. Journal of Animal Science 71:1345–1354.
Leary S, Underwood W, Lilly E et al (2013) AVMA Guidelines for the Euthanasia of Animals: 2013 Edition.
Lee C, Fisher AD, Colditz IG et al (2013) Preference of beef cattle for feedlot or pasture environments. Applied Animal Behaviour Science 145:53–59.
Leruste H (2014) Assessing welfare of veal calves on farms: Measures of behaviour and respiratory disorders and potential ways for welfare improvement. Dissertation. Wageningen University & Research.
Loberg JM, Lundmark F (2016) The effect of space on behaviour in large groups of domestic cats kept indoors. Applied Animal Behaviour Science 182:23–29.
Loneragan GH, Thomson DU, Morgan Scott H (2014) Increased mortality in groups of cattle administered the B-adrenergic agonists ractopamine hydrochloride and zilpaterol hydrochloride. PLOS ONE 9(3).
Lürzel S, Münsch C, Windschnurer I et al (2015) The influence of gentle interactions on avoidance distance towards humans, weight gain and physiological parameters in group-housed dairy calves. Applied Animal Behaviour Science 172:9-16.
Mandel R, Whay HR, Klement E et al (2016) Invited review: Environmental enrichment of dairy cows and calves in indoor housing. Journal of Dairy Science 99:1695–1715.
Marti S, Meléndez DM, Pajor EA et al (2017) Effect of band and knife castration of beef calves on welfare indicators of pain at three relevant industry ages: II. Chronic pain. Journal of Animal Science 95:4367–4380.
Maunsell F, Donovan GA (2008) Biosecurity and risk management for dairy replacements. Veterinary Clinics of North America - Food Animal Practice 24:155–190.
Meat & Livestock Australia (2012) Welfare outcomes of calves of two ages castrated by rings. MLA final report, project B.AWW.0008 prepared by J. Carol Petherick.
Mee JF, Boyle LA (2020) Assessing whether dairy cow welfare is "better" in pasture-based than in confinement-based management systems. New Zealand Veterinary Journal 68(3):168–177.
Meléndez DM, Marti S, Pajor EA et al (2018) Effect of a single dose of meloxicam prior to band or knife castration in 1-wk-old beef calves: I. Acute pain. Journal of Animal Science 96:1268–1280.
Meléndez DM, Marti S, Pajor EA et al (2018) Effect of subcutaneous meloxicam on indicators of acute pain and distress after castration and branding in 2-mo-old beef calves. Journal of Animal Science 96:3606–3621.
Miller-Cushon EK, Bergeron R, Leslie KE et al (2014) Competition during the milk-feeding stage influences the development of feeding behavior of pair-housed dairy calves. Journal of Dairy Science 97:6450–62.
Miller-Cushon EK, DeVries TJ (2015) Invited review: Development and expression of dairy calf feeding behaviour. Canadian Journal of Animal Science 95:341–350.

Molony V, Kent JE, Robertson IS (1995) Assessment of acute and chronic pain after different methods of castration of calves. Applied Animal Behaviour Science 46:33-48.
Montgomery JL, Krehbiel CR, Cranston JJ et al (2009) Effects of dietary zilpaterol hydrochloride on feedlot performance and carcass characteristics of beef steers fed with and without monensin and tylosin. Journal of Animal Science 87(3):1013-1023.
Moran J (2012) Rearing young stock on tropical dairy farms in Asia. CSIRO Publishing.
National Farm Animal Care Council (2016) Code of practice for the care & handling of veal cattle: review of scientific research on priority issues, December 2016.
New Zealand Government (2016) Code of Welfare: Dairy Cattle. Ministry for Primary Industries, Wellington, New Zealand.
O'Driscoll K, von Keyserlingk MAG, Weary DM (2006) Effects of mixing on drinking and competitive behavior of dairy calves. Journal of Dairy Science 89:229–233.
Palczynski LJ, Bleach ECL, Brennan ML et al (2020) Giving calves 'the best start': Perceptions of colostrum management on dairy farms in England. Animal Welfare 29(1):45-58.
Petherick JC, Phillips CJC (2009) Space allowances for confined livestock and their determination from allometric principles. Applied Animal Behaviour Science 117:1-12.
Phillips CJC (2004) The effects of forage provision and group size on the behavior of calves. Journal of Dairy Science 87:1380–8.
Renaud DL, Waalderbos KM, Beavers L et al (2020) Risk factors associated with failed transfer of passive immunity in male and female dairy calves: A 2008 retrospective cross-sectional study. Journal of Dairy Science 103(4):3521-3528.
Roland L, Drillich M, Klein-Jöbstl D et al (2016) Invited review: Influence of climatic conditions on the development, performance, and health of calves. Journal of Dairy Science 99:2438–2452.
Rosenberger K, Costa JHC, Neave HW et al (2017) The effect of milk allowance on behavior and weight gains in dairy calves. Journal of Dairy Science 100(1):504–512.
Rushen J, Wright R, Johnsen JF et al (2016) Reduced locomotor play behaviour of dairy calves following separation from the mother reflects their response to reduced energy intake. Applied Animal Behaviour Science 177:6–11.
Schnyder P, Schönecker L, Schüpbach-Regul G et al (2019) Effects of management practices, animal transport and barn climate on animal health and antimicrobial use in Swiss veal calf operations. Preventive Veterinary Medicine 167(1):146-157.
Scientific Committee on Animal Health and Animal Welfare (2002) The welfare of animals during transport (details for horses, pigs, sheep and cattle). European Commission, Health & Consumer Protection Directorate-General.
Shaban RZ, Simon GI, Trott DJ et al (2014) Surveillance and reporting of antimicrobial resistance and antibiotic usage in animals and agriculture in Australia, report to the Department of Agriculture, Griffith University and The University of Adelaide, Australia.
Silper BF, Lana AMQ, Carvalho AU et al (2014) Effects of milk replacer feeding strategies on performance, ruminal development, and metabolism of dairy calves. Journal of Dairy Science 97(2):1016–25.
Small AH, Jongman EC, Niemeyer D et al (2020) Efficacy of precisely injected single local bolus of lignocaine for alleviation of behavioural responses to pain during tail docking and castration of lambs with rubber rings. Research in Veterinary Science 133:210–218.
Stackhouse-Lawson KR, Tucker CB, Calvo-Lorenzo MS et al 92015) Effects of growth-promoting technology on feedlot cattle behavior in the 21 days before slaughter. Applied Animal Behaviour Science 162:1–8.
Stafford KJ, Mellor DJ (2005) The welfare significance of the castration of cattle: a review. New Zealand Veterinary Journal 53(5):271-278.
State of Victoria, Department of Primary Industries (2008) Nutritional scours in milk-fed calves: causes and treatment by John Moran. Agriculture Notes AG0578.
Sutherland MA, Worth GM, Stewart M (2014) The effect of rearing substrate and space allowance on the behavior and physiology of dairy calves. Journal of Dairy Science 97(7):4455-4463.
Svensson C, Linder A, Olsson S-O (2006) Mortality in Swedish dairy calves and replacement heifers. Journal of Dairy Science 89:4769–4777.
Thomas TJ, Weary DM, Appleby MC (2001) Newborn and 5-week old calves vocalise in response to milk deprivation. Applied Animal Behaviour Science 74:165-173.
Todd SE, Mellor DJ, Stafford KJ et al (2000) Effects of food withdrawal and transport on 5- to 10-day-old calves. Research in Veterinary Science 68:125–134.
Trunkfield HR, Broom DM (1990) The welfare of calves during handling and transport. Applied Animal Behaviour Science 28:135–152.
Vasseur E, Borderas F, Cue RI et al (2010) A survey of dairy calf management practices in Canada

that affect animal welfare. Journal of Dairy Science 93(3):1307-1315.
Vasseur E, Rushen J, de Passille AM et al (2010) An advisory tool to improve management practices affecting calf and heifer welfare on dairy farms. Journal of Dairy Science 93:4414–4426.
Vaughan A, de Passillé AM, Stookey J et al (2014) Urination and defecation by group-housed dairy calves. Journal of Dairy Science 97:4405–11.
von Keyserlingk MAG, Weary DM (2007) Maternal behavior in cattle. Hormones and Behavior 52:106–113.
von Keyserlingk M, Weary D (2009) Improving the welfare of dairy cattle: Implications of freestall housing on behaviour and health. In: Western Dairy Management Conference 2009.
Wagner K, Barth K, Palme R et al (2012) Integration into the dairy cow herd: Long-term effects of mother contact during the first twelve weeks of life. Applied Animal Behaviour Science 141:117–129.
Walker M, Díez-Léon M, Mason G (2014) Animal welfare science: Recent trends and future research priorities. International Journal of Comparative Psychology 27:80–100.
Weary DM, Chua B (2000) Effects of early separation on the dairy cow and calf 1. Separation at 6 h, 1 day and 4 days after birth. Applied Animal Behaviour Science 69:177–188
Walker JK, Waran NK, Phillips CJC (2014) The effect of conspecific removal on the behaviour and physiology of pair-housed shelter dogs. Applied Animal Behaviour Science 158:46–56.
Webb LE, Bokkers EAM, Engel B et al (2012) Behaviour and welfare of veal calves fed different amounts of solid feed supplemented to a milk replacer ration adjusted for similar growth. Applied Animal Behaviour Science 136:108–116.
Webb LE, Bokkers EAM, Heutinck LFM et al (2013) Effects of roughage source, amount, and particle size on behavior and gastrointestinal health of veal calves. Journal of Dairy Science 96:7765–76.
Webb LE, Jensen MB, Engel B et al (2014) Chopped or long roughage: What do calves prefer? Using cross point analysis of double demand functions. PLoS One 9:88778.
Webb LE, van Reenen CG, Berends H et al (2015) The role of solid feed amount and composition and of milk replacer supply in veal calf welfare. Journal of Dairy Science 98:5467–5481.
Weeks C (2007) UK Calf Transport and Veal Rearing. A report for Compassion in World Farming.
Wichman A, Norring M, Pastell M et al (2010) Effect of crate height during short-term confinement on the welfare and behaviour of turkeys. Applied Animal Behaviour Science 126:134–139.
Wilcox CS, Schutz MM, Rostagno MR et al (2013) Repeated mixing and isolation: Measuring chronic, intermittent stress in Holstein calves. Journal of Dairy Science 96:7223–7233.
Worth GM, Schütz KE, Stewart M et al (2015) Dairy calves' preference for rearing substrate. Applied Animal Behaviour Science 168:1–9.

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