Introduction:

The contentious practice of dairy calf separation is the principal animal welfare concern confronting modern dairy production systems (Busch et al., 2017; Hötzel et al., 2017; Boaitey, 2024). In the state of nature, the bond between the dam and the calf is critical to ensure the survival and development of the calf (Vaarst et al., 2020). This bond not only provides the calf with essential nutrition in the form of its mother's milk but also plays an important role in the natural social development of the calf (Buchli et al., 2017; Vaarst et al., 2020). However, modern dairy production systems function beyond the state of nature and producers justify the practice of calf separation on economic, animal productivity, and welfare grounds (Beaver et al., 2019; Neave et al., 2022).

Current Practice:

Dairy calf separation is a conventionally accepted practice in modern dairy production systems (Johnsen et al., 2016; Pempek et al., 2017; Mason et al.,2022). Broadly speaking, there are three variations of conventional cow-calf separation: immediate separation into individual housing and bottle feeding - immediate separation into group housing and bottle feeding - immediate separation into group housing and nursing from a ‘foster’ cow (Sirovica et al, 2021). However, some producers practice delayed separation until after the first colostrum feeding and employ various hybrid systems of cow-calf contact after separation and group housing (Johnsen et al., 2016; Neave et al., 2022).

Welfare Considerations:

Cattle, a herd species, are especially susceptible to stress induced by social isolation or mixing with strangers (Newberry and Swanson, 2008). Calf separation is a highly stressful experience for both the calf and the dam (Newberry and Swanson, 2008). The stress response is often characterised by bellowing, increased heart rate, and injury during escape attempts (Newberry and Swanson, 2008). Johnsen et al. found that rearing a calf with their dam has clear developmental and welfare benefits, both nutritionally and behaviourally (2018). Contact with the dam has been shown to reduce cardiac stress in

developing calves and improve social and behavioural parameters (Buchli et al., 2017). Favourable behavioural and developmental outcomes have also been observed in separated calves that were group-housed (Valníčková et al., 2015; Johnsen et al., 2016). Calves separated from their dam and housed alone consistently fail on productivity and welfare measures with lower weight gains due to social deprivation (Valníčková et al., 2015).

For many outside observers, the vision of a baying calf being separated from its mother into group housing with other calves is a confronting prospect (Ventura et al., 2016; Busch et al., 2017; Hötzel et al., 2017). Calf separation runs against natural maternal instincts and is readily viewed as unnatural by outside observers (Ventura et al., 2016; Busch et al., 2017; Hötzel et al., 2017). A limited study of 9 dam-calf pairs by Weary and Chua found little outcome difference between separation intervals of 6 hours, one day, and four days - besides a reduced incidence of scouring in delayed separation calves (2000). However, the study was limited in its design and operated using a small sample. Anecdotal data from numerous New Zealand dairy farmers – who operate using a hybrid system of cow-calf contact and separation – proposes immunological and development benefits to allowing calves their first feed of colostrum from their mothers (Neave et al., 2022). Mason et al. support this and have demonstrated the importance of natural colostrum consumption for the immunological development and future productivity of young calves (2022).

Taurine/Indicine Divergence:

When considering the production benefits of a suckling cow-calf pair compared to a separated pair it is essential to consider the diverging results observed in Taurine and Indicine varieties (Johnsen et al., 2016). Little et al. investigated the milk off-take efficiency of restricted suckling on crossbreed (Taurine/Indicine) dairy cattle in the Ethiopian Highlands, finding a stable yield of saleable milk - in line with separated cow-calf pairs - and an improved calf growth rate (1991). Similar studies by Negrão and Marnet and Junqueira et al. on the milk yield and production efficiency of partially suckled Holstein/Gir

crossbreeds (Taurine/Indicine) in Brazil showed similar improvements in production efficiency (2002, 2005).

Kaskous et al. demonstrated an improvement in Syrian Shami cattle milk yields when partially suckled and machine milked in the presence of their calves (2006). These production efficiencies aren't replicable in Taurine breeds, in which partial or restricted suckling significantly reduces the amount of saleable milk (Johnsen et al.,2016). This indicates that while Indicine and Indicine crossbreeds can maintain or improve milk production in a restricted suckling dam-calf pair, Taurine calves should be separated to maximise milk production (Johnsen et al., 2016).

Production Considerations:

Many dairy producers see dam-calf separation as a simple method to improve production efficiency and increase milk yields (Beaver et al., 2019; Mason et al., 2022). Calf separation also assists in preventing the spread of Zoonoses from the milking herd to young calves (Beaver et al., 2019; Mason et al., 2022). A significant Dutch study on the impact of prolonged contact, and partial contact, supports this idea (Wenker et al., 2022). The study detected unfavourable haematological and biological signals along with higher antibiotic use in calves reared in full contact with dams, as well as a distinct faecal microbiota composition (Wenker et al. 2022). It is worth noting that the study – while sophisticated and credible – received funding from DairyNL an organisation representing the Dutch dairy supply chain and as such could come under question for conflicting interests. While Wenker et al., observed an improved growth rate in dam-reared calve – accompanied by reduced milk yield – Valníčková et al. limited dam-derived calf weight gain to calves in the first fortnight with significant gains only observed in the first four days (2022; 2015).

While the practice of dairy calf separation is seen as an animal welfare concern by outsiders, some producers justify the practice on animal welfare grounds (Johnsen et al., 2016; Neave et al., 2022). The incorporation of separation in modern dairy production

systems by producers is often with the best intentions for cow and calf health (Johnsen et al., 2016; Neave et al., 2022). Bertelsen and Jensen show that dam-reared calves have a greater stress responses to eventual separation at weaning compared to calves separated postpartum (2023; Wenker et al., 2022; Neave et al., 2024). Given that the stress of separation is likely to be felt either at weaning or postpartum, an argument exists that supports postpartum separation on animal welfare grounds (Wenker et al., 2022; Neave et al., 2024).). Vaarst et al. found that many farmers view the prospect of housing cow-calf pairs as high cost and risky due to the need for slated floors appropriate for calf hooves, and a housing design that protects small calves from being crushed by cows in heat. Valníčková et al. showed that group housing combinations of four calves performed as well as dam reared calves in weight gain comparisons (2015). The ability to carefully manage calf development is another reason why many farmers opt to separate dam-calf pairs, as calves can be easily protected, fed, and monitored when separated from the dam and milking herd (Vaarst et al., 2020; Neave et al., 2022).

Public Sentiment:

Traditionally dairy farming has been viewed positively by Europeans and Westerners (Boogaard et al., 2011). However, social perceptions are changing with greater scrutiny placed on conventional practices like dairy calf separation (Boogaard et al., 2011). Opposition to calf separation is widespread amongst the general public throughout the Western world, though the strength of opposition varies (Neave et al., 2022).

A recent survey of German (n=491) and U.S. (n=476) public opinion regarding early calf separation demonstrates a growing aversion to the practice among Westerners (Busch et al., 2017). Furthermore, Busch et al. revealed the relative ignorance of Western urbanites to conventional farming practices and their widespread reflexive opposition to dairy calf separation upon exposure to the practice (2017). These findings are supported by Ventura et al. - who surveyed 50 ‘interested’ members of the public before and after a tour of a 500-head dairy farming operation in British Columbia, Canada (2016). While a fifth of the respondents responded positively to the experience, a third of respondents indicated a

strong disproval of conventional dairy farming practices, especially calf separation, after the experience (Ventura et al., 2016).

Despite Ventura et al. and Busch et al. presenting interesting findings well worth consideration, both failed to adequately control for sample bias with both studies surveying a skewed demographic (2016; 2017). However, a similar pattern emerged in a survey of Brazilian urbanites conducted by Hötzel et al. in Brazil (2017). Many of the urban respondents were unaware of conventional dairy farming practices like cow-calf separation and reflexively opposed the practice despite its centrality to conventional production systems (Hötzel et al., 2017).

Producer/Stakeholder Sentiment:

Many producers view dam-calf separation as an integral component of conventional modern dairy production systems (Vaarst et al., 2020; Neave et al., 2022). While the prospect of separation is viewed as largely unpleasant it is justified because separation will be required at weaning if it isn't done postpartum (Vaarst et al., 2020; Neave et al., 2022). Given that calf separation at weaning is arguably a greater stressor, postpartum separation is often justified as the right approach by producers (Vaarst et al., 2020; Neave et al., 2022).

It is worthwhile to consider the evolving perspectives of dairy producers in emerging and developing markets. Chen and Weary's mini-ethnographic case study of emerging Chinese perspectives on animal welfare unearthed some interesting findings (2022). Amongst Chinese stakeholders and producers, the concept of animal welfare is seen as foreign with little receptivity for considerations on the impact of dam-calf separation beyond productivity (Chen and Weary, 2022). However, there appeared to be a consensus among producers surveyed about the mutual benefits of human and animal welfare and a moral instinct to preserve the well-being of cows and calves (Chen and Weary, 2022). An eye-opening finding were the comments of a contract milker who perceived the treatment and welfare status of the cows and calves to be better than his own (Chen and Weary, 2022).

While Chen and Weary's study presents a fascinating insight into Chinese dairy production and emerging perspectives on animal welfare its limited sample size means its results cannot be generalised (2022).

A common theme across several studies is the move from small and medium family dairy farming operations towards larger intensified commercially oriented production systems (Boogaard et al.,2008; Cardoso et al., 2017; Chen and Weary, 2022). Brombin et al. observed a reduction in animal welfare in association with industrialised dairy production systems (2019). More studies are needed to explore the economic, productivity, and animal welfare implications of increasingly intensified dairy production systems in comparison to traditional small and medium-scale family farming systems (Boogaard et al.,2008).

Conflicting Findings & Future Research:

The emerging pattern of reflexive opposition to dairy calf separation amongst the general public demonstrated by (Busch et al., 2017; Hötzel et al., 2017) is yet to be replicated in Australia. There is a need for further research to demonstrate the replicability of this pattern amongst the Australian public. The replication of these findings would raise serious public relations questions for the Australian dairy industry and may go some way to elucidating the logic behind loud and confronting 'animal liberation' campaigns against calf separation.

Economic considerations of calf separation and dam-rearing are another area with little investigation that requires future research. Alvåsen et al, conducted an economic analysis on cow-calf contact models using a stochastic budgeting approach and found cow-calf contact to decrease margins by up to 5.4% (2023). Another area of future study well worth consideration is the biological faecal microbiota and microbiota of calves reared using various calf contact systems. Wenker et al. found distinct calf faecal microbiota compositions in their 2022 study but were unable to conclude any biological implications

from the finding. If investigated and developed further faecal microbiota could emerge as future diagnostic measure of calf welfare.

While there is a body of research investigating the impacts of cow-calf separation upon the calf there is comparatively little research conducted on the dam (Beaver et al., 2019). The systemic review of dairy cow-calf separation undertaken by Beaver et al. reveals the relative absence of studies – besides Wenker et al., 2022 – investigating the impact of cow-calf separation on the dam's longevity, postpartum immunology, and productivity (2019). On a final note, Indicine dairy breeds - while rarely utilised for dairy production in Western nations - could serve as the foundation for new dairy production systems that eschew the practice of calf separation.

Conclusion:

Dairy calf separation is both harmful and beneficial to calves in modern dairy production systems. The stress experienced by calves separated from their dams postpartum is reflected in much of the literature, and on this basis, the case against the practice rests. The animal welfare case in favour of calf separation rests on the assertion that calves need to be separated before weaning and as such can be more efficiently managed and protected when separated and group-housed. Production outcomes in Taurine calves separated and group-housed is the most economical, efficient, and productive method for calf rearing in modern dairy production systems. Calves housed individually suffer social deprivation and perform poorly on both productivity and welfare standards. Calves maintaining contact with their dam perform better on an individual level up to weaning while reducing overall production efficiency through milk yield reductions and management inefficiencies.

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