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Dairy calf health and hygiene management in Ireland

Tejhasznú borjak egészségügyi és higiéniai menedzsmentje Írországban

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Abstract

The aim of this study was to investigate and analyse the management of dairy calf health and hygiene on several dairy farms in Ireland. This research was carried out because statistics from the Irish Cattle Breeding Federation (ICBF) demonstrate that dairy calf registrations are increasing steadily each year, indicating that correct management and good hygiene of calves is becoming increasingly vital in ensuring optimal herd health.

In September and October 2023, I distributed an online survey to dairy farmers in Ireland, it received twenty responses. The survey offered an insight on the differences in dairy herd size and calf health between 2014 (the year prior to abolition of the milk quota) and 2022. 95% of surveyed farms reported an increase in herd size. This study focused on hygiene protocols relating to calf grouping, housing, nutrition, and health management, alongside the potential health implications associated with inadequate management of these factors. Collective survey results conclude that hygiene control methods on Irish dairy farms vary greatly. Throughout this thesis, the knowledge gained from this survey will be shared and compared alongside published literature.

Absztrakt

A tanulmány célja az volt, hogy megvizsgálja és elemezze a tejelő borjúk egészségének és higiéniájának kezelését több írországi tejgazdaságban. Ezt a kutatást azért végezték, mert az Ír Szarvasmarha-tenyésztési Szövetség (ICBF) statisztikái azt mutatják, hogy a tejelő borjúk regisztrációja évről évre folyamatosan növekszik, jelezve, hogy a borjak helyes kezelése és jó higiéniája egyre fontosabbá válik az állomány optimális egészségének biztosításában.

2023 szeptemberében és októberében online felmérést osztottam ki az írországi tejtermelőknek, amelyre húsz válasz érkezett. A felmérés betekintést nyújtott a tejelő állomány méretének és a borjak egészségének különbségeibe 2014 (a tejkvóta eltörlését megelőző év) és 2022 között. A vizsgált gazdaságok 95% -a számolt be az állomány méretének növekedéséről. Ez a tanulmány a borjúcsoportosítással, az elhelyezéssel, a táplálkozással és az egészségügyi menedzsmenttel kapcsolatos higiéniai protokollokra összpontosított, valamint az e tényezők nem megfelelő kezelésével kapcsolatos lehetséges egészségügyi következményekre. A kollektív felmérések eredményei arra a következtetésre jutottak, hogy az ír tejgazdaságokban a higiéniai ellenőrzési módszerek nagymértékben eltérnek. A dolgozat során a felmérésből nyert ismereteket megosztják és összehasonlítják a publikált szakirodalommal.

Contents

Abbreviations

ICBF: Irish Cattle Breeding Federation

EU: European Union

IgG: immunoglobulin G

IgA: immunoglobulin A

IgM: immunoglobulin M

cfu/ml: colony-forming units per millilitre

IGF: insulin-like growth factor

mg/ml: milligrams per millilitre

spp: species

subsp: subspecies

RSV: respiratory syncytial virus

PI3: parainfluenza type 3 virus

IBR: infectious bovine rhinotracheitis virus

BRD: bovine respiratory disease

BHV-1: bovine herpesvirus 1 virus

BVD: bovine viral diarrhoea

CAP: Common Agriculture Policy

EC: European Commission

E. coli F5: *Escherichia coli* fimbrial adhesion

E. coli F41: *Escherichia coli* fimbrial adhesion

Introduction

Dairy farming has been, and continues to be, a large and important part of agriculture and the national economy in Ireland. With Irish Cattle Breeding Federation (ICBF) statistics revealing an average of 106.8 dairy calving's per farm in2022, a considerable jump from an average calving number of 77.1 per farm in 2014, farm management practices fall under observation. This increase can be attributed to the removal of the milk quota, which came into effect on 1st April 2015 [1, 2].

Milk quotas were implemented in 1984 to alleviate excessive milk production in the EU market. The decision to eliminate quotas was made to allow dairy farmers to respond to the significant increase in dairy product consumption worldwide at that time [3]. After abolition of the milk quota, Ireland was among the EU nations with the highest growth rates in dairy output [2]. The continuously rising numbers of dairy calves in Irish herds indicate that correct management and good hygiene of calves is becoming increasingly vital in ensuring optimal herd health.

Irish dairy herds commonly have a compact calving pattern, in which all cows are managed to calve within a 12-week timeframe during the spring months (February, March and April). This intense calving season may present calf management, health, and welfare challenges on many farms [4]. Dairy calf health can be improved by implementing management techniques that increase resistance to stress and disease [5]. Such management techniques in the early stages of life, include effective colostrum management, targeted antisepsis of navels, prompt relocation of the newborn calf to adequate and hygienic calf housing, and correct calving management [6].

Hygiene control is an essential component of any effective calf management programme as respiratory and enteric diseases can occur due to high levels of micro-organisms in bedding, feeding apparatus and in the circulating air [7]. The burden of infectious disease on the farm will be reduced by a thorough cleaning and disinfection schedule for all the calf-feeding tools, pens, and bedding.

In dairy herds, calf morbidity and mortality rates are frequently high, resulting in a severe impact on the economic viability and future performance of the farm [8]. Increased mortality in the early stages of a calf's life can either cause a direct loss of value or indirectly impact the calf's future growth and breeding potential. Illness in calves may cause lower growth rate which can have a knock-on effect causing delayed breeding maturity resulting in fewer calving's during a cow's lifetime [9]. Furthermore, an immunocompromised calf may be more susceptible to other diseases, leading to additional costs for medication and labour. For

example, in 2021, Merck Sharpe and Dohme Animal Health reported that a calf with enteritis is 18 times more likely to develop pneumonia [9].

To ensure dairy cows are highly productive throughout their lives, calf health during the first few months of life is crucial [7]. Taking the above-mentioned factors into consideration, it is essential to ensure effective health and hygiene management on dairy farms. The importance of these will be discussed throughout this thesis.

Chapter 1: Literature review

Chapter 1.1: Background information

Section 1.1.1: A brief history on dairy farming in Ireland

Dairy products have been produced and consumed in Ireland since the arrival of the Vikings towards the end of the 8th century AD. The Vikings brought innovative farming techniques and expertise in dairy husbandry, including the production of butter and cheese. It is apparent from the earliest literature that milk, buttermilk, butter, cheese, curd, and whey made up a significant portion of the Irish people's diets in that bygone era [10]. Research led by Dr Jessica Smyth of the School of Chemistry, University of Bristol [11] discovered that 90% of residue in Irish pots compromised of milk fats, with 10% compromising of a combination of milk fats and meat. This is an interesting and remarkable finding, given that dairy cows had to be physically transported into Ireland. This validates the findings from the forementioned literature, concluding that dairy farming played an essential role in ancient farming economies and dates as far back as 6,000 years [11].

Ireland is an island, located in the west of Europe. In 2022, 64% of the land was used for agriculture with 81% utilised for pasture, hay, or silage. There were approximately 17,000 multigenerational dairy farms with an average farm size of 32.4 hectares (0.32 square kilometres) and an average herd size of 83 cows [12].

Section 1.1.2 The Introduction and Abolition of the Milk Quota

In the latter years of the 1970s and early years of the 1980s, the European market experienced a milk oversupply which resulted in the notorious "butter mountains" and "milk lakes". During this time, regardless of market demand, EU dairy producers were guaranteed a price for their milk that was significantly higher than that of global markets, leading to several failed attempts to decrease EU surplus milk output. The European Commission (EC) proposed milk quota implementation in July 1983, which came into effect on 31st March 1984. A quota was set for each country and implemented for individual producers or buyers. Producers who exceeded their quota had to pay a levy and fear of the levy resulted in a steep decline in excess milk production [3].

Although milk quotas were initially set to expire after five years, the date was extended multiple times. The final expiry date was established during the Common Agriculture Policy (CAP) reform in 2003, and was reaffirmed in 2008, with actions that would guarantee a "soft landing"

by 31st March 2015. The decision to eliminate milk quotas was made to allow dairy farmers respond to the growing market demand as a result of a significant increase in dairy product consumption worldwide [3].

After abolition of the milk quota, Ireland was among the EU nations with the highest growth rates in dairy output, alongside the Netherlands [2]. The number of dairy cows on Irish farms had steadily increased in the years leading up to and following the milk quota elimination in 2015. The Irish Central Statistics Office reported that domestic milk consumption surged by just over 47% from 2013 to 2019 [13]. In one year alone (2015 to 2016), milk production in Ireland was boosted by 18.5%, in contrast to other nations, such as Italy, in which milk production declined [14]. Within the two years that followed the abolition of the milk quota (2015–2017), milk production was hiked by 29% on Irish dairy farms. This figure may be attributed to an increase in dairy herd size of 27%, an increase in milk yield per cow of 10% and increase in farm stocking rate of 2% [7].

It is evident that the EU dairy industry experienced a dramatic transformation because of the removal of milk quotas in 2015. Some of the highest increases were observed in regions with the capacity to produce milk at a low cost, including Ireland, due to the pasture-based spring calving system [15]. However, despite the advantage of a low-input, pasture-based system, the average cost of producing milk has increased in Ireland. From 2015 to 2017, costs increased at a 1.9% yearly rate [16]. This rise has placed financial pressures on dairy farmers and has had a knock-on effect on the standard of management of calf hygiene and health protocols.

Chapter 1.2: Calf grouping

Section 1.2.1: Separation from dam

"Immediately after birth, the cow is the calf's first social partner" [17]. Rearing calves with their dams facilitates the expression of natural behaviour, therefore improving animal welfare. However, a major difficulty in raising calves alongside the dam is that full-day contact results in less milk in the bulk tank; the calves would consume a large volume of milk that could otherwise be sold, causing an economic loss [18, 19]. In comparison, calves that are hand-fed away from the dam, can consume discarded milk or milk replacer that is cheaper than liquid milk destined for the creamery [19].

In contrast to full-day contact, another possibility is the restricted or half-day contact method. This method is beneficial as the calf will become accustomed to being separated from its dam,

learn how to suckle from a milk feeder and encounter positive human interaction. This method is also beneficial to the dam's udder health and there are data suggesting that suckling can positively impact the dam's total milk yield (both collected and suckled) [20, 21].

Another possible method is the foster cow system, where a group of 2–4 calves nurse from one cow. This is good for animal welfare as the calves interact with each other and an adult cow and engage in natural suckling. However, problems may arise if the foster cow refuses to accept a calf, in which case this method may be labour intensive [20].

However, it is the most common practice, that within 24 hours of birth, the calf is separated from the dam and artificially reared on either whole milk or milk replacer [18]. Early separation limits the cow-calf relationship, thereby avoiding a higher level of separation stress which would develop if the relationship had developed over a longer period [22]. Adverse reaction to weaning can present as pacing and vocalisation, which would be heightened if separation occurred later in the calf's life [18].

Section 1.2.2: Individual keeping

European legislation (Council Directive 2008/119/EC) states that for the first 8 weeks of life, calves may be housed individually. However, it prohibits individual calf pens with solid walls, thereby ensuring physical contact with other calves, stating that "no calf shall be confined in an individual pen after the age of eight weeks" [19, 23].

Individual housing of calves is a commonly used method on dairy farms. According to farmer perceptions, the calves' bedding is less likely to become infected by other calves' excretions, which could compromise the naive calf. H however scientific evidence is controversial for this perception [19]. Individual keeping permits accurate feed monitoring, and in turn, group weaning may be conducted by grouping calves of the same feed intake, weight, age etc. [24]. A disadvantage of individually housing calves is that they have limited possibilities for social interaction. Social interaction may be defined as nose-to-nose physical contact or visual contact [25]. When calves are raised individually in pens, the pens are removed at weaning and the calves are left to continue growing together. This is a stressful period for the calf, which is heightened by its inexperience in social interactions [26].

Section 1.2.3: Group keeping

The term "grouping" refers to the development of a group of animals naturally (such as herd formation due to social attraction) or by human activity (such as allocating a certain number of animals to a specific pen or grouping dairy cows based on milking performance) [27].

A 2021 survey carried out on dairy farms in Northern Ireland concluded that calves are grouped at an average age of 14 days (frequently between 1 and 4 weeks of age). The most common reason for timing of grouping, was management simplicity, age, and space availability [7].

Calves are very sociable and, under natural conditions, they engage in a variety of social interactions and form calf groups from an early age [25]. An increasing percentage of dairy calves are raised in loose (group) housing systems, because of new animal welfare regulations and larger herd size. In comparison to traditional housing systems where calves were raised in single confinement, this group housing system allows the calf greater possibilities to exercise and engage in social activities [27].

Early interaction of dairy calves with their dam or other newborn calves has been shown to improve responses, which helps prepare them for regrouping, an important stressor for calves [28, 27]. New dominance relationships are created after introduction of an unfamiliar animal into an established group, which can cause conflict, anxiety, and circadian rhythm disruption, especially for calves of a lower social standing [27]. Calves in these circumstances may have a difficult time gaining access to feed, resulting in decreased food consumption [29]. The group size and previous social reactions are significant variables that can influence how they integrate. Compared to calves raised in solitary boxes, those raised in groups are more socially secure and exhibit a lower level of fear [30]. In addition, compared to calves housed singly, calves paired together have been seen to begin eating solid food earlier and in larger quantities [24].

Similarly, other research indicated group housing is more beneficial for calves, than individual housing. The results demonstrated that from the calves' perspective, complete social contact was valued more highly than head contact. It was concluded that if calves are prevented from engaging with other calves, their welfare may be jeopardised [25]. However, a disadvantage that has been identified is that group keeping demands a greater level of stockmanship and allows for uncertainty while calculating accurate feed intake of each calf [24].

Chapter 1.3: Calf housing

Section 1.3.1: Bedding

A 2021 survey carried out on dairy farms in Northern Ireland, found that 57.6% of the analysed farms had concrete flooring, 9.1% slats, 22.7% concrete and slats, 7.6% stones and 1.5% concrete and stones. The ability of concrete floors to adequately drain urine, spilled milk and water is influenced by the slope which may vary greatly. It was found that 92.4% farms used straw as bedding, 4.5% used straw and sawdust, 1.5% used baled rushes and 1.5% used no bedding [7]. Similarly, straw was the most popular bedding in a 2022 survey focusing on calf management and housing in UK dairy herds, which concluded that 85.2% of farmers used unchopped straw as calf bedding, 9.3% used chopped straw, 2.3% used sawdust or shavings and 1.9% used another form of bedding [24].

An article which focused on the "effects of bedding quality on the lying behaviour of dairy calves" suggested that dairy calves usually lie down for approximately 18 hours per day and some research indicates that insufficient lying times may have a negative impact on growth [31]. Calves bedded with deep straw for up to 8 weeks had higher average daily weight gain than calves bedded with hardwood shavings [32]. Interestingly, research based on the incidence of injuries in dairy cows, concluded that bedding at least 10 cm thick decreased the risk of hock injuries in cows [33]. Calves spend less time lying and standing on wet bedding, concluding that dairy calves prefer dry bedding and avoid laying on bare, concrete surfaces. This proves the importance of availability of comfortable, dry bedding for growing calves [31].

Deep straw bedding allows for nesting with the creation of a layer of warm air around the calf, which reduces animal heat loss through conduction and decreases the calf's low critical temperature. Higher concentrations of bacteria were detected in straw, in comparison to other materials used. However, the study concluded that the advantages of straw bedding outweigh the disadvantages [34].

Taking this evidence into consideration, the importance of hygiene via regular changing of dirty bedding and disinfection of pens is evident.

Section 1.3.2: Hygiene

Prior to birth, the calf environment within the uterus is clean and hygienic [35]. In contrast, after birth, the calf is vulnerable and impacted by many stressors. Therefore, in effort to optimise calf health, it is crucial to ensure a clean environment.

The previously mentioned 2021 survey, carried out on dairy farms in Northern Ireland, described ‘good hygiene’ as a well-strawed pen with no damp areas and ‘poor hygiene’ as a noticeable accumulation of dirt or use of the same area for housing sick animals [7].

If bedding is dirty, excessively damp or in even worse condition (eg, if the calf environment smells of ammonia), the current bedding needs to be replaced with fresh bedding as soon as possible. Such poor bedding can threaten calf health and atmospheric ammonia may trigger respiratory problems in calves [36].

Sick calves should be housed in a separate building, but if this is not feasible, they should be placed as far away from healthy calves as possible. The contaminated bedding should not meet healthy calf pens [37].

An ideal environment for effective cleaning should have non-porous, smooth surfaces which are easy to disinfect. Cracked concrete floors and porous, unplastered stone walls are not easy to clean [7]. Ideally the height of the calf housing should allow for machinery access (for ease of completely removing bedding) and both the entrance and exit should have disinfection sites [37].

After weaning a batch of calves, buildings and pens should be power-washed, or steam-cleaned, disinfected, and kept vacant for at least two weeks before being restocked if they are used continuously for calf rearing [26]. Remarkably, literature published by Animal Health Ireland did not specify a timeframe during which pens should be left vacant, but merely advised that pens no longer in use should be able to be cleaned without affecting other pens, which may still be housing calves in the same building [37].

Adequate cleaning and disinfection methods involve removal of visible contamination, cleansing with detergent, rinsing, and then applying a suitable disinfectant agent. This is essential because most disinfectant chemicals are inactivated by organic matter. It is important that the disinfectant is applied at the recommended dilution for the specified contact time. Thorough cleaning can decrease the bacterial load by up to 90% and disinfection has the ability further decrease this load by as much as 96% [38]. As ultraviolet light is a powerful disinfectant agent, openjng the doors and windows of calf accommodation is likely to be beneficial during the summer months.

All the measures discussed in this section help restrict transmission of infectious diseases and are collectively known as farm biosecurity measures. Implementation of these is highly

dependent on the knowledge, ability and attitude of individual farmers. Therefore, it is extremely important that veterinarians advise and educate farmers on how to effectively and efficiently implement biosecurity measures to ensure optimal hygiene on their farms [38]. Because of the different circumstances on individual farms, veterinarians should have a leading role in designing farm biosecurity protocols and herd health programmes.

Chapter 1.4: Calf nutrition

Colostrum management is the most significant factor affecting health and survival of newborn calves [39]. The immunological lactoglobulin in colostrum provides passive immunity to the calves, which is essential for disease resistance [26]. Colostrum also contains a wide variety of other nutrients.

Section 1.4.1: Passive transfer status

Bovine animals have a syndesmochorial placenta, which separates the blood supply of the dam and foetus, inhibiting the transmission of defence-enhancing immunoglobulins during pregnancy. Therefore, calves are born agammaglobulinemic and must rely on colostrum to absorb maternal immunoglobulins [39].

Maternal immunoglobulins are absorbed through the calf's small intestine, only within the first 24 hours after birth; this is also termed 'passive transfer' [40]. Passive transfer helps the calf defend against common pathogens while its own immune system is developing [39]. Many factors have been found to influence the optimal absorption of immunoglobulins, such as the timing, quality and quantity of colostrum intake, method of colostrum feeding, age of the dam, colostrum pooling and whether the calf has developed any metabolic disturbances, for example, respiratory acidosis [41].

Colostrum contains a variety of immunoglobulins including. IgG, IgA and IgM. However, IgG makes up approximately 80–90% of the overall volume [42]. Colostrum also contains a high amount of growth factors, namely insulin-like growth factors (IGF) and insulin, which encourage anabolic processes [19]. Colostrum is high in oligosaccharides, which have been demonstrated to improve IgG absorption, inhibit the adhesion of pathogens to the intestinal mucosa and encourage the establishment and proliferation of beneficial bacterial in the intestinal epithelium [19].

The term ‘quality’ is taken generally to refer to the immunoglobulin concentration of colostrum. High quality colostrum is defined as having an IgG concentration of higher than 50 mg/mL (with <100,000 cfu/ml bacterial count and <10,000 cfu/ml coliforms present) [42]. A colostrometer is a useful on-farm tool that can be used to assess the IgG concentration of colostrum by measuring specific gravity. A specific gravity > 1.050 is approximately equivalent to an IgG concentration > 50 mg/ml. However, a limitation of this method is that the results can be affected by temperature and milk fat content [40].

Serum IgG concentration is used to measure the extent of passive immunity transfer received by the neonatal calf. If there has been a failure of passive transfer, the serum IgG concentration may measure less than 10 mg/ml at 24 hours of age [39]. The passive immune status of a calf can be measured in a veterinary diagnostic laboratory, in veterinary practice oron farm. However, tests such as enzyme-linked immunodiffusion assay or radical immunodiffusion can directly determine the serum concentration of IgG. The concentration of total globulins or other proteins that correlate with IgG is measured in all other tests to determine serum IgG concentration [41]. These tests can be challenging due to the costs of testing and the inconvenience of submitting a sample, which is an opportunity cost to the farmer. In comparison, hand-held refractometers are on-farm tool that offer easy, quick, and affordable estimation of blood serum total protein concentration [40]. This parameter is regarded an indicator of IgG concentration, offering the ability to estimate morbidity; however, it gives a better estimation of herd level parameters, rather than individual animal health status [42].

Section 1.4.2: Timing and quantity of colostrum

It is widely known that delaying the feeding of colostrum reduces its efficiency in terms of boosting calves' immunity, thus feeding colostrum to calves promptly is crucial [43]. In the first 4 hours of life, IgG absorption is maximal, with a rapid decrease in absorption over the first 12 hours. After 24 hours, no more immunoglobulins can be absorbed into the bloodstream as the intestine develops impermeability to large protein molecules [40].

Calf age has the biggest impact on absorption effectiveness, and the practical gold standard is to feed colostrum within the first two to six hours of birth [40]. Irish advisory services in the agriculture food sector, advise that the “three, two, one rule” has stood the test of time; this is defined as giving 3 litres of colostrum (based on a 35kg calf receiving 8.5% of its bodyweight) within 2 hours of birth using milk from the dam’s first milking [36]. Advice varies slightly

among each of the publications I have reviewed. Bovine Medicine Diseases and Husbandry of Cattle (second edition, 2004) advises that the foundation of optimal calf rearing is the consumption of at least 2 litres of colostrum via suckling or bucket feeding within the first 6 hours of life, and an additional 2 litres within the following 12 hours [26]. More recent literature advises consumption within 2 hours of birth of high-quality colostrum that has an IgG concentration of more than or equal to 50 mg/ml [42].

The majority of recommendations conclude that calves should consume 10–12% of their body weight at the first feeding of colostrum, for example 3–4 litres for a Holstein calf [39]. A study which compared serum IgG levels of calves found that calves fed 2 litres at birth and 2 extra litres at 12 hours had an average serum IgG level of 23.5 mg/ml, whereas calves fed 4 litres at birth and 2 additional litres at 12 hours had a mean serum IgG level of 31.1 mg/ml, which is 24% higher [40]. With this fast feeding, the small intestine can optimally absorb the required proteins before progressively decreasing its permeability [42]. Other studies have shown the long-term benefits of a highly adequate amount of colostrum ingested in first feeding [39]; namely greater average daily weight gain, lower morbidity and higher milk production in first few lactations [44].

The colostrum immunoglobulin concentration is highest immediately after calving but steadily decreases over time if collection is postponed. For example, research published in 2010 in the Journal of the American Veterinary Medical Association documented a 3.7% decrease in colostrum IgG content for each hour that milking was postponed [45].

Section 1.4.3: Methods of feeding colostrum

Due to a high rate of failure of passive transfer, calves should not remain on the cow to nurse, primarily because of the delay in suckling [40]. Research conducted in the United States documented that in the initial 6 hours after birth, 46–61% of calves fail to suckle, while an Asian study found that 25-–0% of calves fail to suckle in the initial 6 hours after birth [40, 46]. The conclusion is that a high percentage of newborn calves fail to suck. To alleviate this risk, calves should be removed from their dam within 1–2 hours after birth and fed a known amount of colostrum [40]. However, for practical reasons, it is difficult to evaluate the time after birth and volume of colostrum received [42].

Oesophageal tube feeding is ideal due to the high quantity of colostrum required in one feed. Although it minimises the amount of time spent administrating colostrum, it was found to be

the least common method used. This could be due to the significant risk of aspiration pneumonia and death if the tube is inadvertently inserted into the trachea, or oesophageal damage, meaning personnel experience and competence is of utmost importance. The most common methods of consuming colostrum are via a bucket or nipple bottle [42].

The main disadvantage of using buckets or nipple bottles is that this method is time consuming, and a smaller volume is usually consumed. Calves that do not willingly consume an adequate volume of colostrum, should be offered another bottle within 6 hours or tube fed. An advantage of these methods is the initiation of the oesophageal groove reflex, in comparison to oesophageal tube feeding method where this reflex is not stimulated and fluid is deposited in forestomaches as a result. (However, this fluid flows to abomasum and small intestines quickly meaning this is not a severe disadvantage of tube feeding) [39].

Section 1.4.4: Hygiene of colostrum

Colostrum containing high concentrations of bacteria, especially coliform bacteria, can attach to available immunoglobulins in the intestine, directly preventing immunoglobulin absorption through intestinal epithelial cells, impeding passive transfer. In addition, contaminated colostrum can expose naive calves to pathogens such as *Salmonella* spp., *Mycoplasma* spp., and *Mycobacterium avium* subsp. *paratuberculosis*. For these reasons, it is vital to minimize bacterial contamination of colostrum. The decreased bacterial interference has been seen to improve IgG absorption [39].

American research published in 2019 examined protein residues in feeding equipment and discovered that from the first to the last 6 weeks of the calving season, hygiene levels deteriorated [4]. Beneficial steps in maintaining optimal colostrum hygiene levels include thoroughly washing and sanitising udders before collecting colostrum, using a clean bucket to collect colostrum, and transferring this colostrum into sanitised feeding equipment or sanitised, airtight storage equipment. Despite pasteurisation damaging immunoglobulins, colostrum can be safely heat treated at low temperatures for long periods to eradicate significant pathogens [39]. Heating at 60°C for 60 minutes will not reduce IgG levels or change viscosity; but may affect other molecules (IGF, IgA) and somatic cells, resulting in implications for development of the calf's immune system [19].

Section 1.4.5: Storage of colostrum

If colostrum is not going to be consumed within 2 hours of collection, it should be chilled or frozen as bacteria can quickly multiply in warm temperatures. For a short period of time, it can be chilled at 4°C in small containers, while maintaining its composition [42]. Colostrum can be refrigerated raw or with the addition of a preservative such as potassium sorbate. A study has shown that average bacterial counts were less than 100,000 cfu/ml in colostrum preserved with potassium sorbate and refrigerated for 6 days in contrast with raw colostrum refrigerated for 2 days which had a bacterial count of over 100,000 cfu/ml [39].

Calves that do not receive colostrum often die. As a result, to prevent situations where lack of natural colostrum is available, it is wise to have some colostrum stored in a freezer for unexpected situations [26]. Colostrum can be kept frozen for up to one year if there are no repeated freeze-thaw cycles. When thawing, temperatures of >60% should be avoided as high temperatures may denature immunoglobulins and reduce the quality of the colostrum [39].

Section 1.4.6: Weaning

Prior to weaning, the term "restricted feeding" was traditionally recommended and involves feeding calves an amount of milk or milk replacer corresponding to 10% of their body weight. Restricted feeding has been noted to result in minimal weight gain, in comparison to *ad libitum* feeding where calves consumed almost 20% of their bodyweight and had the ability to gain more weight daily. Restricted fed calves also portrayed more signs of hunger. Research that I have reviewed found that prior to weaning, the feed intake of *ad libitum* fed calves was decreased to 10% of body weight for 4 days. At 50 days of age, both groups were weaned. The *ad libitum* fed calves had an increased consumption and a thicker rumen wall and stronger papillae development. Accelerated/intensified feeding is another method which involves feeding high amounts of biologically normal milk. It has proven to benefit calves by enhancing gastrointestinal and systemic organ development [19].

Weaning is an important period of transition for ruminants as they are highly dependent on rumen function. Despite efforts with pre-weaning feeding methods, a decline in average daily weight gain is frequently associated with weaning. This decline may be due to several factors such as reduced rumen function or development and reduced intake or digestion of the starter diet. Weaning is a stressful period in the calf's life. Calves are born aglobulinemic and need time to develop their immunity. Therefore, an older, more immunocompetent animal is better

equipped to deal with weaning stress. All these factors are suggestive of weaning age being an important consideration for farmers [47].

Research published in 2015 concluded that a decline in average daily weight gain was more apparent in calves weaned at 6 weeks of age in comparison to calves weaned at 8 weeks of age [48] indicating that later weaning benefits calf performance. However, earlier weaning lowers labour costs and milk replacer expenditures [47].

Chapter 1.5: Calf health management

Section 1.5.1: Frequent diseases

According to the scientific literature, calf welfare and health could be increased on dairy farms all over the world. It has been demonstrated that preventing sickness in calves or treating it promptly and effectively, when necessary, can improve lifelong health, welfare, and production metrics. Disease prevention is essential to decrease the need for interventions and their related expenses [8].

The ”epidemiological triad” refers to how the host, agent and environment interact and define the outcome of a disease. It is for this reason that control measures are very broad. Such measures affecting the host’s status include promoting the calf’s immune system by effective colostrum management, nutrition, and vaccination programmes. The agent (pathogen) challenge can be diminished, and the environmental aspect may be elevated by ensuring good hygiene and biosecurity measures, calf housing has adequate ventilation, drainage and is not overstocked [8].

Umbilical care is one of the first vital steps following the birth of a calf. The umbilicus may act as an entry point for bacteria into the blood or underlying tissues, which can cause fatal infections in newborn calves [43]. Under 15% of newborn calves may contract omphalitis, which if not treated, can result in negative effects such as stunted growth and joint ill [49]. Joint ill is a result of the navel infection travelling via the bloodstream and establishing in the joints, which are the most common site of establishment. Its clinical signs include, swollen, heated, painful, and stiff joints [50]. Navel ill can be avoided by soaking the umbilical cord in antiseptic solution as soon as possible after birth [43] and ensuring the calf is placed in a hygienic environment. A hygienic environment is achieved by maintaining optimal hygiene in the maternity pen, alongside shortening the calves’ time in an unclean maternity pen [49].

The most common causes of death for calves under 6 months of age are infectious diseases, particularly neonatal diarrhoea (scour) and bovine respiratory disease (pneumonia) [8].

Diarrhoea is the most common disease affecting young calves and frequently occurs in the first 2 weeks of life. Diarrhoea is caused by altered gastrointestinal function which results in an increase in the volume of manure and fluids excreted. Calf scour can be described as either nutritional or infectious [51]. Nutritional scour may be caused by stress due to management issues such as the calf being overfed or the milk replacer being at the incorrect temperature [26].

Nutritional scour may lead to infectious scour, which is caused by multiple agents; parasites, viruses, cryptosporidia and/or bacteria. The most frequent pathogens causing intestinal diseases in calves *Cryptosporidium parvum*, coronavirus and rotavirus [8]. In the first week of life, cryptosporidia is a common parasitic cause of diarrhoea. Another parasite with similar clinical signs is coccidia, which commonly affects calves at 3–6 weeks of age. Rotavirus and coronavirus may be the reason for clinical signs at 1–3 weeks of age. Bacterial causes include *Eschericia coli* which frequently affects calves under 5 days old and *Salmonella* spp., which mostly affect 2–6-week-old calves [51]. In slight contrast, Bovine Medicine Diseases and Husbandry of Cattle (second edition, 2004) advises that salmonellosis can develop later, even after the milk feeding period, but it typically begins in the first 2 to 3 weeks of life. Since many *Salmonella* species can spread to people, maintaining personal cleanliness is especially important when there is an outbreak [26].

Symptoms of diarrhoea include an increased volume of faeces, which may be white or bright yellow in appearance, inappetence, depression, fever, dehydration (sunken eyes) and weight loss [51].

Isolation, rehydration therapy and continued milk feeding are considered standard treatments. Antimicrobials should only be used when indicated [8]. Parasites and viruses are the most frequent causes, which cannot be targeted using antibiotics [51]. If bacterial infection is suspected, best practice is collection of rectal swabs for laboratory investigation and sensitivity testing to allow provision of the proper antibiotic by a veterinarian [26].

Pneumonia is the second most frequent disease of young calves; commonly, viral infection begins and bacterial invasion follows. Respiratory syncytial virus (RSV) and parainfluenza type 3 (PI3) are viruses that are present in most herds in Ireland. Bovine rhinotracheitis (IBR, caused by bovine herpes virus 1) is most typically seen in older calves. Bacterial causes of pneumonia

include, *Mannheimia haemolytica*, *Pasturella multocida*, *Trueperella pyogenes*, *Histophilus somni* and *Mycoplasma bovis*. These bacteria establish in the upper respiratory tract, then travel toward the lungs where they can produce toxins which damage tissue. A parasite that can cause respiratory distress is lungworm, usually affecting calves on pasture [52]. Bovine respiratory disease (BRD) can happen at any time, but it is more common during the still, damp winter months and is worsened if calves are transported during this time. Regrouping and weaning are stressors that may also lead to a weakened immune system and pathogen burden [53].

To recognise the early signs of pneumonia, such as reduced feed consumption, fever, listlessness, or coughing, frequent observation is required. Increased respiratory rate and nasal discharge follows. Advice from a veterinarian should be sought immediately as the disease is normally well established by the time signs are observed [52]. Not only is pneumonia a significant factor in calf mortality, but sick calves that survive the infection frequently do not thrive because of lung damage [26]. Heifers treated for pneumonia as calves have a shorter lifespan than non-affected group members in their herd [8].

Castration and dehorning are traumatic procedures that should not be performed simultaneously or close to weaning, which is also unpleasant. Healthy calves can be dehorned before 3 weeks of age, using a hot iron disbudder, followed by castration at four weeks [26]. Irish legislation [S.I. No. 127/2014 - Animal Health and Welfare (Operations and Procedures) (No. 2) Regulations 2014] states that disbudding should only be performed by thermal cauterisation [54]. This legislation allows disbudding of calves up to 28 days old, with the additional requirement of administration of a local anaesthetic for calves over 2 weeks of age [55].

Section 1.5.2: Mortality rate

Decreased activity and longer laying times can indicate sick calves and, in addition, sick calves visit the feeders less frequently and feed for shorter periods of time. This requires close attention from farm personnel to identify a sick calf in a timely manner [56].

A 2009 article documented 6.8% mortality before 6 months of age and research published in 2020 reported 6% mortality in UK dairy calves before 3 months of age [57, 58]. Other literature summed these statistics up by documenting only minimal changes in mortality rates compared to the 1990s [59]. In Ireland, the goal of a well-managed calf rearing unit should be to keep the mortality rate below 3% [26].

Calves that experienced dystocia have been seen to have a 2–15 times higher risk of perinatal death. Dam parity is another risk factor, with calves from primiparous cows experiencing higher perinatal mortality than multiparous calves [60]. Other literature I have reviewed focused on the following risk factors: twin calves had a higher mortality rate than single calves and a high percentage of calf deaths occur before 8 weeks of age, with most calf deaths happening within the first week of life [61]. Temperature variations impact the prevalence of health conditions and, as a result, death rate was higher during colder months than warmer months [62, 61]. Failure in the transfer of passive immunity has a major impact on calf health and may lead to mortality, as discussed in section 1.4.1.1 [63].

In the United States, neonatal calf diarrhoea is the most common cause of calf mortality, accounting for 56.5% of preweaning heifer deaths [63]. Likewise, Irish literature outlines that diarrhoea is the most common health issue of young calves, accounting for up to 40% of calf mortality in the first 6 weeks of life [51]. Around the weaning period, calves are very susceptible to enteritis and this age group typically has the highest rates of mortality [4]. Bovine respiratory disease is the second most common cause of mortality in dairy calves [63]. Similarly, Irish literature outlines that following diarrhoea, pneumonia is the next most common health issue of dairy calves [52].

Section 1.5.3: Anthelmintic treatments

The Animal Health Ireland fact sheet published in 2023 provided a list of antiparasitics currently available in Ireland to prevent parasitic diseases in bovine animals. Three classes of anthelmintics are licensed for parasitic gastroenteritis control programmes in cattle within northern Europe: benzimidazoles, levamisole and macrocyclic lactones [64]. Taking this into consideration, the same three antiparasitic groups are recommended by Animal Health Ireland to be used as broad-spectrum wormers. If liver fluke is a concern in the herd, flukicides are recommended while coccidiostats are effective against coccidia. In addition, combination products are available, containing active ingredients from multiple groups (typically flukicide and a wormer). Ectoparasite products are available to prevent external parasites, for example lice infestation [65]. Anthelmintic resistance is a growing concern, described as a decrease in the ability of anthelmintic drugs to eradicate parasites that were previously susceptible to the recommended dose [66]. Anthelmintic misuse contributes to anthelmintic resistance, and includes continued use of the same anthelmintic, underdosing, using a suboptimal anthelmintic,

and using anthelmintics too often. It is important to use anthelmintics according to the manufacturer's instructions and in combination, to lessen reliance on them and in turn, reduce anthelmintic resistance [67]. Throughout Ireland, anthelmintic resistance is rising for the three most popularly used anthelmintics; benzimidazole (white suspension), levamisole (yellow suspension) and macrocyclic lactones (clear suspension) [68].

Section 1.5.4: Vaccination protocols

Preventing new or recurrent illnesses in calves requires effective vaccination protection. A successful vaccination protocol enhances herd health and productivity [69]. There are many vaccines available in Ireland to help prepare the calf's immune system for contact with possible antigens throughout the calf's life.

IBR vaccine is indicated to decrease the length and severity of respiratory signs caused by BHV-1 infection. Live and inactivated vaccines are available and are usually administered intramuscularly to animals 3 months of age and above [70].

Leptospira infections (commonly *Leptospira interrogans* serovar *Hardjo* and *Leptospira borgpetersenii* serovar *Hardjo*), are common while cattle are grazing on pasture. Therefore the spring/summer period is the optimal time to administer leptospira vaccines [71]. The minimum age of leptospira vaccine administration is one month [72].

Vaccines for protection against *Clostridium* species can be administered to calves from 2 weeks of age. These vaccines protect against *C. perfringens* type A (haemorrhagic diarrhoea), *C. perfringens* type B (malignant oedema/calf enterotoxaemia), *C. perfringens* type C (malignant oedema/calf enterotoxaemia), *C. perfringens* type D (pulpy kidney disease), *C. novyi* (necrotic hepatitis), *C. chauvoei* (blackleg), *C. septicum* (malignant oedema), *C. sordellii* (malignant oedema), *C. haemolyticum* (bacillary hemogloginuria) and *C. tetani* (tetanus) [73]. Interestingly, since 1930, immunisation against *C. chauvoei* has been documented as a common preventive measure, particularly in bovine animals [74].

Vaccinations for active immunisation against *Salmonella dublin* and *S. typhimurium* strains may be given to healthy calves from 3 weeks of age, including pregnant cows. A second dose should be administered 2–3 weeks later.

When exposed to the vaccine antigen *in vitro*, calves born to vaccinated dams exhibit an increased leukocyte proliferative response [69]. BVD vaccination is used to boost immunity in

cattle, thereby decreasing the number of susceptible animals in an infected herd. While it is an optional precaution, it is also essential that biosecurity measures, elimination of the virus and continuous monitoring is carried out primarily [75]. It can be administered to heifers from 8 months of age [76], at least 2–3 weeks before service, as protection begins 3 weeks after administering the vaccine [77]. The aim of this vaccine it to protect the foetus from bovine viral diarrhoea infection and prevent the risk of a persistently infected foetus [71].

There are vaccines available for active immunisation against *E. coli* adhesions F5 and F41, rotavirus and coronavirus, which cause enteric disease in calves. Usually, these vaccines should be administered during each pregnancy, 3–12 weeks before the expected calving date [78] although there are slight variations in the timing of different vaccine compositions [71].

Section 1.5.5: Personnel and practical factors relating to health management

Farm personnel play an important role in the health and welfare of the herd [8]. Farmers should be capable of handling livestock competently, in a stress-free, effective, and efficient manner. Moreover, there are many decisions that must be made during management of a herd. Decision making influenced by individual values, priorities, awareness of a problem, readiness to modify practices and capacity for development. Constraints of time, labour, and money can also be obstacles to adopting measures to safeguard the health and welfare of animals on farms. Effective decisions and actions at the farm level, such as those relating to milk feeding of calves, might also be hampered by conflicting information and guidance. Therefore, it is essential to comprehend the practical and personal elements that affect disease management and have a thorough herd health programme in place [8].

It had been previously concluded that many farmers felt they understood what was involved in correct calf rearing techniques, but when it came to applying this knowledge on their own farm, they experienced difficulties [79]. Similar literature indicated that although farmers appeared to have adequate understanding of control programmes, they still failed to implement the necessary changes [80]. This signifies the importance of guiding farmers to help them achieve the implementation of the necessary changes to improve calf health and hygiene in their herds.

Chapter 2: Objectives

The protocols and practices that are determined to be most conducive to optimal calf health vary greatly. Many previous studies have been executed with various conclusions being reached regarding many aspects of dairy calf management. The overall objective of this thesis was to identify the most important factors influencing calf health on dairy farms in Ireland by conducting and analysing the results of a survey of dairy farmers. The detailed objectives of this study were to compare the information gained from the survey results (Chapter 3) with previously published studies and scientific assumptions discussed within the literature review, (Chapter 1) to assess, firstly, whether dairy herds have increased in size in recent years, and most importantly, whether dairy calf health and hygiene management in Ireland is favourable and sufficient, or if there are areas of management that could benefit from continued development.

Chapter 3: Method

Section 3.1: Project development

Initially, the project title was chosen as the author deemed it to be in an area of importance and relevance with statistics showing that Irish dairy herds are increasing in size yearly, since the abolition of the milk quota in 2015. After discussion with the project supervisor and other relevant persons, the project title was accepted. A plan was formulated, outlining the sequence in which tasks were to be carried out and intended timelines for completion of each task. Literature was reviewed, and a survey was designed and distributed to Irish dairy farmers. When the allotted time lapsed, the survey results were gathered and analysed.

Section 3.2: Survey design and distribution

The survey was drafted to define the main characteristics of current (2022) dairy calf health and hygiene management in Ireland and to provide an insight to differences in comparison to 2014 (prior to abolition of the milk quota). Based on the findings of the literature review, the author believed there were areas that impacted greatly on calf hygiene and health. Therefore, the survey questions were divided into sections of interest, including general questions, and questions about calf grouping, calf housing, calf feeding and calf health management. This survey used a mixed-method approach, which combines the collection of quantitative and qualitative data. The questionnaire contained several open-ended questions that allowed participants to convey their opinion freely. Altogether the survey contained 6 sections and 31 questions. The survey can be viewed in Appendix 1. The questions referred to data from 2022 unless stated otherwise. Prior to distribution of the survey, it was shared with my project supervisor for corrections and approval.

The survey was completed by 20 Irish dairy farmers throughout Ireland, with many dairy farms located in County Galway in the west of Ireland. It is important to note the survey is not representative of the whole country. The survey was published online via Google Forms and was available from 4 September to 15 October 2023. The survey included a cover note, with a brief introduction, sentences explaining the purpose of the survey and contact information. If any questions were raised by the respondents, they could ask the author via email. To access the questionnaire, the link was shared with a local agriculture college and dairy farmers. The participants took part in the survey voluntarily and remained anonymous. On average, it took 10–15 minutes for them to complete the questionnaire.

The obtained data were processed in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA). Once the responses were gathered, an analysis was carried out. The responses to each question were examined for aberrant results, such as incomplete or unsuitable answers, where the question may have been misunderstood by the participant. The results were collated and displayed using bar charts, pie charts and tables where appropriate. These graphs were generated automatically by Google Forms and in cases where the results were difficult to comprehend on charts, the author collated tables on Microsoft Word.

Chapter 3: Results and Discussion

Section 3.1 General background information

The initial set of questions on the survey pertained to the average number of cows on the farm and calves born onto Irish dairy farms in the comparator years of 2014 and 2022. Additionally, information was gathered on the calving distribution throughout the year on each farm.

Q.1. What was the average number of cows on the farm in 2014? (Prior to abolition of the milk quota in 2015)

As outlined (in **Figure 4.1.1)** below, from the 20 farms that responded to this question, the average number of cows in the herds varied from 0 to 140. Two farms had no cows in their herd in 2014, with one of these farmers explaining that the farm had transitioned from beef to dairy in 2017; prior to changing to dairy, they had 30 sucklers in 2014.

The most common average number of cows on dairy farms included in this survey for 2014 (prior to abolition of the milk quota) was 50 (recorded on three farms) and 100 cows (also recorded on three farms). Following this, the second most popular average number of cows in 2014 in the herds surveyed was 60, noted on two farms. Other respondents noted 61 cows on one farm, 70 cows on two farms, 90 cows on two farms and 140 cows on two farms. One farm had 40 cows, another farm had 80 cows and one other farm had 120 cows.

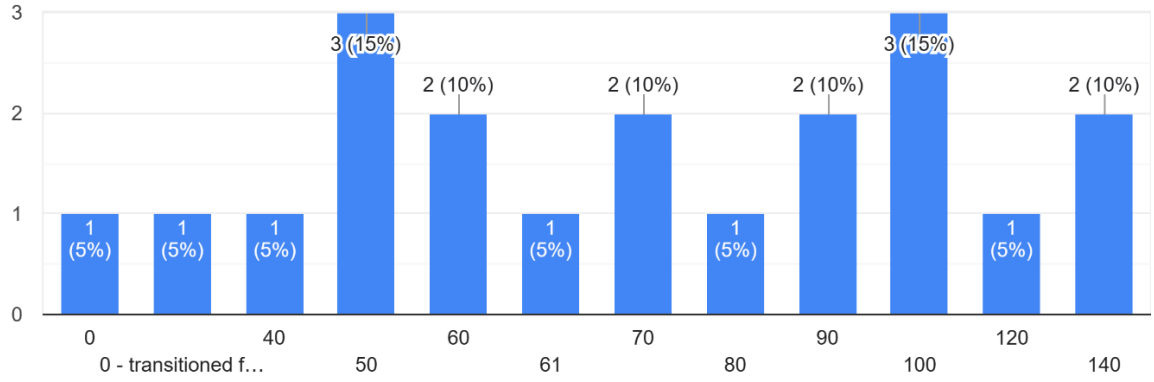

FIGURE 4.1.1. *Bar chart showing the average number of cows on Irish dairy farms in 2014 (Prior to abolition of the milk quota in 2015)*

Q.2. What was the average number of cows on the farm in 2022?

The below graph **(Figure 4.1.2)** shows the average number of cows on the dairy farms included in this survey in 2022; all 20 responses were received. The highest percentage of farms had either 90 cows (recorded on two farms), 95 cows (recorded on two farms) or 100 cows (recorded on two farms). The number of animals varied greatly among all other farms surveyed and it can be seen from the graph that the average number of cows on the farms in 2022 ranged from 23 to 320.

Although the results of the survey were anonymous, Google Forms collected the responses in a format on Microsoft Excel that allows comparison of the answers in questions 1 and 2 for each farmer. **Table 4.1.1** details the average number of cows in each farm in 2014 and 2022 and this table was used to make the comparative graph in **Figure 4.1.3**. In **Figure 4.1.3**, each farmer is represented by a number, with the blue line representing the number of cows in their herd in 2014 and the red line the number of cows in 2022, for ease of visualisation of the differences between the years.

Out of the 20 farms that participated in the survey, 19 of these farms had increased the numbers of cows in their herd between 2014 and 2022. There was only one farm where the average number of cows had not changed between 2014 and 2022. **Table 4.1.1** shows this farm had 50 cows in 2014 and 50 cows in 2022.

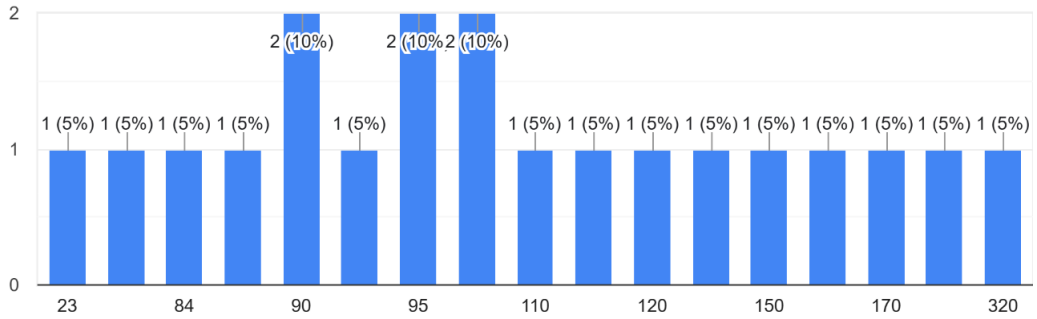

FIGURE 4.1.2. *Bar chart showing the average number of cows on Irish dairy farms in 2022 (after abolition of the milk quota in 2015)*

TABLE 4.1.1. *Table comparing the average number of cows on Irish dairy farms in 2014 and 2022*

Average number of cows on the farm	
2014	**2022**
60	90
120	150
50	84
100	116
0 (transitioned from beef to dairy in 2017)	120
100	250
100	170
50	50
80	100
61	85
140	320
40	95
70	95
0	23
90	132
60	90
50	100
70	91
90	110
140	160

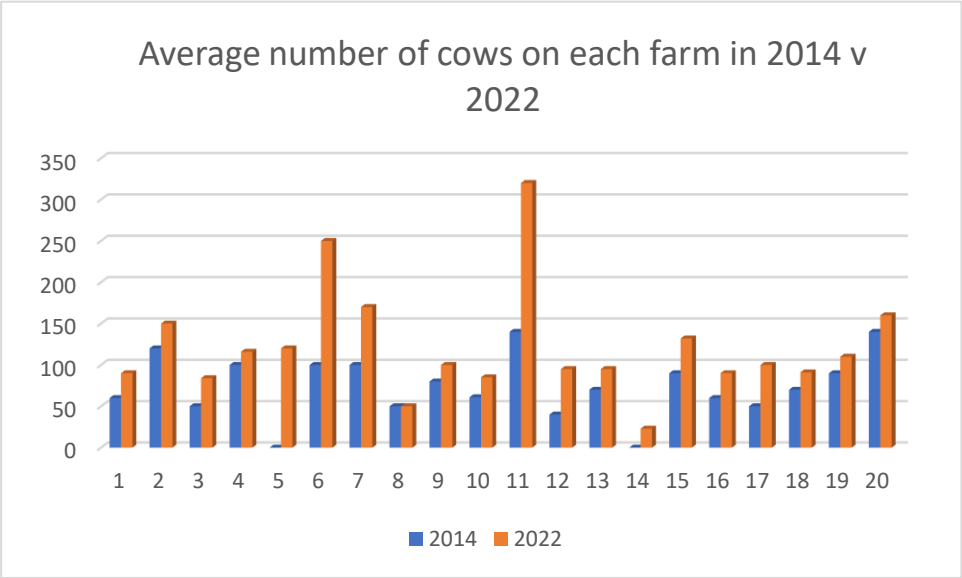

FIGURE 4.1.3. *Bar chart comparing the average number of cows on Irish dairy farms in 2014 and 2022*

Q.3. How many calves were born on the farm in 2014? (Prior to abolition of the milk quota in 2015)

The graph **(Figure 4.1.4)** illustrates that from the 20 responses received, 50% of the farms can be referred to in 5 different groupings, each referring to 2 farms (10%). The groupings represent different numbers of calves born: 40 calves, 50 calves, 80 calves, 100 calves and 120 calves. **Table 4.1.2** can also be referred to for the detailed numbers of calves born. The number of calves born varied greatly on all other farms surveyed and it can be seen from the graph that the number of calves born on each farm in 2014 ranged from 0 to 135.

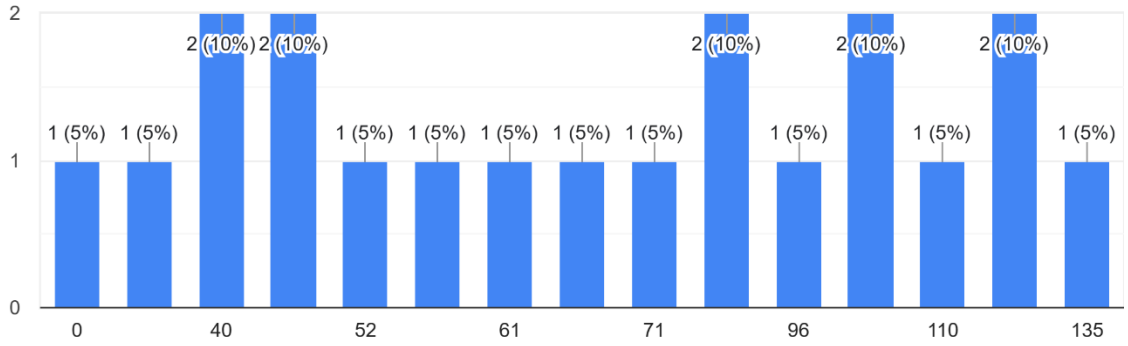

FIGURE 4.1.4. *Bar chart showing the number of calves born on Irish dairy farms in 2014 (prior to abolition of the milk quota in 2015)*

Q.4. How many calves were born on the farm in 2022?

As can be seen (in **Figure 4.1.5)** below (alongside **Table 4.1.2** for detailed numbers), out of the 20 responses received, the highest percentage of farms (20% = four farms) had 100 calves born in the 2022 calving period (last calving season). The next highest was 10%, which equates to 2 farms with 88 calves born and 10%, which also equates to 2 farms with 90 calves born. The number of calves born in 2022 varied greatly on all other farms surveyed, ranging from 23 to over 300.

Google Forms processed the data obtained in Microsoft Excel, which allowed comparison of the responses to questions 3 and 4 for each farmer. **Table 4.1.2** details the number of calves born in each farm in 2014 and 2022 and was used to make the comparative graph in **Figure 4.1.6.** In **Figure 4.1.6**, each farmer is represented by a number (the same number as they had in **Figure 4.1.3,** which compared the average number of cows in 2014 and 2022), the blue line represents the number of dairy calves born in their herd in 2014 and the red line the number of dairy calves born in 2022, allowing for easy visualisation of the differences between the years.

Out of the 20 farms that participated in the survey, 19 (95%) had an increase in the number of dairy calves born into their herd between 2014 and 2022. There was only one farm where the number of calves born had not changed between 2014 and 2022. **Table 4.1.2** shows this farm had 50 calves born in 2014 and 50 born in 2022.

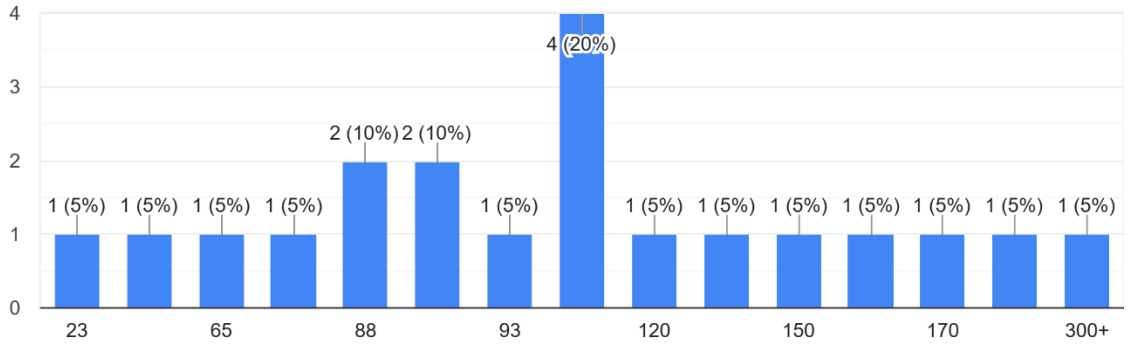

FIGURE 4.1.5. *Bar chart showing the number of calves born on Irish dairy farms in 2022 (after abolition of the milk quota in 2015)*

TABLE 4.1.2. *Table comparing the number of calves born on each Irish dairy farm in 2014 and 2022*

Number of calves born on the farm	
2014	**2022**
60	90
120	150
52	88
100	120
30 - sucklers	100
110	300+
100	170
50	50
80	100
61	82
135	290
40	100
66	93
0	23
96	140
40	65
50	100
71	88
80	90
120	160

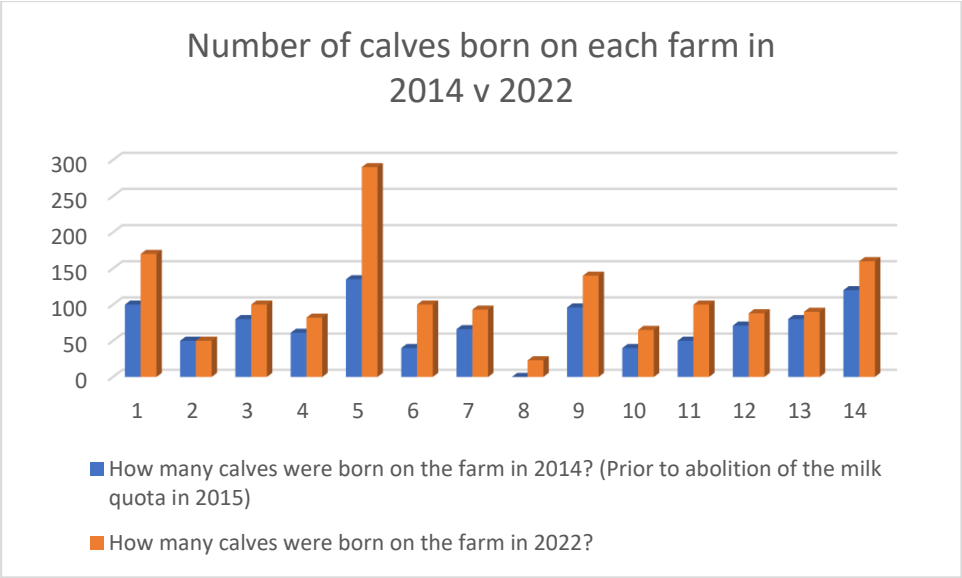

FIGURE 4.1.6. *Bar chart comparing the average number of cows on Irish dairy farms in 2014 and 2022*

Q.5. How would you describe the distribution of calving's during a year?

The responses to this question were collected by short answer text and, as a result, 20 different sentences were obtained. The author grouped many of the same responses together and made a simplified table **(Table 4.1.3)**. Most of the detailed, original responses are discussed in the following paragraphs.

As outlined in **Table 4.1.3**, the highest proportion (45%) of farmers calved their cows solely in the spring, and this equates to 9 of the 20 farms surveyed. With an additional 5%, which is one farm, describing their distribution as 80% percent of the herd calving within 8 weeks in spring (compact), 10% calving outside of this 8-week block and the other 10% calving in autumn. Another farmer's response was "concentrated in September to March", which the author understood as "autumn to spring calving", while one farm in the survey described their calving distribution as "all year around". Taking these responses into consideration, it can be concluded that over half of the farms (approximately 55% or above) in this survey are experiencing calving on their farm in spring.

Six (30%) farmers described their calving period as "compact", a term referring to all calving's happening within a short space of time. Farmers included in this 60% referred to their distribution as, "90% calved 6 weeks, 100% in 11 weeks" and "60% in first 4 weeks". An additional 10% (two farms) referred to compact calving by writing "concentrated" and "80%

calf within 8 weeks in spring, 10% outside the 8 weeks. 10% autumn". Therefore, 40% of the farms surveyed described their calving distribution as "compact".

Some responses were difficult to interpret, with 10%, which equates to two farms, describing the calving distribution as "good" and 5% (one farm) describing their distribution as "hard". One farmer responded "0", which the author interprets as no response, as each farm in the survey had calves born in their herds (**Figure 4.1.7**).

TABLE 4.1.3 *Distribution of calving's during the year on Irish dairy farms*

(Table made by author based on sentence responses collected from the survey)

Calving distribution on each farm		
Distribution	**Number of responses**	**Percentage**
Spring calving	7	35%
Compact spring calving	2	10%
Compact	4	20%
Majority compact in spring, 10% autumn	1	5%
Autumn to Spring	1	5%
All year round	1	5%
"Good"	2	10%
"Hard"	1	5%
"0"	1	5%

Discussion 4.1

To summarise the General Background Information collected in section 4.1; 95% of the Irish dairy farms surveyed had increased the number of cows kept in their herd with a consequent increase in the number of dairy calves born into their herd between 2014 and 2022. This is most likely largely due to abolition of the milk quota in 2015, which was discussed in section 1.1.2 of the literature review.

The results of this survey are presumptive that the average of the 20 Irish dairy farms surveyed was 122 (exactly 121.5) cows in the herd in 2022, with an average of 111 (exactly 110.47) calves born on the surveyed farms in 2022. The results of this survey are slightly higher than

the national average herd size of 83 cows, which was reported in section 1.1.1 of the literature review [12].

In Ireland, the most common time for dairy cows to give birth is in the spring, which is defined in Ireland as February, March and April. Spring calving is portrayed as having easier management than autumnal calving, possibly due to environmental temperatures and seasonal weather, offering better conditions for a healthy calf. The results of this survey validate this assumption, with the data displayed in **Table 4.1.3** dictating that over half of the farms in this survey are experiencing calving on their farm in spring.

Most responses in the survey described the calving distribution as compact. This busy period for the farm makes it vital that effective and efficient management protocols are adhered to, in order to ensure optimal hygiene and health of dairy calves. Section 1.3 of this thesis, focusing on calf housing, and section 1.4 focusing on calf nutrition, allude to the important management techniques in a dairy farm.

A limitation was noticed on the above analysed section of the survey, which was based on general background information of the participant farmers. The calving distribution question required a short answer text as the response, as opposed to multiple choice answers, check box or drop-down options. As a result, 20 different sentences were obtained. Upon reflection, the author should have listed the most common and expected options, also including an option named “other” at the end of the answer list, which the farmer could use if necessary. In that way, the responses would have been more concise and easier to evaluate.

Section 4.2 Calf grouping

This part of the survey focused on many aspects of grouping, such as: calf age at separation from dam, how calves are kept once they have been taken from their dam, age they are when groups are formed, group sizes, factors considered when groups are formed, and whether the groups change or not. Responses refer to data in 2022.

Q.6 At what age are calves typically separated from their dam on the farm?

It is evident from **Table 4.2.1** that from the 20 responses received, the majority (80%) of calves were separated from their dams (mothers) within the initial 24-hour period after the cow had

given birth, and this equates to 16 of the 20 Irish dairy farms surveyed. The highest percentage (30% or six farms) separated the calves from their dams immediately after birth, with the second highest percentage (20% or 4 farms) allowed the calves and their dams remain together for 24 hours (one day old). Another 15% of the farms surveyed separated calves from their dams at 12 hours of age and a further 15% separated them at 48 hours of age (two days old). Finally, each of the four remaining farms allowed the calf to stay with their dam for the following timeframes, respectively: 1 hour, 3 hours, 6 hours and 36 hours.

TABLE 4.2.1. *The age at which calves are separated from their dams after birth on Irish dairy farms*

Age	Number of responses	Percentage
At Birth	6	30%
1 hour	1	5%
3 hours	1	5%
6 hours	1	5%
12 hours	3	15%
24 hours (1 day old)	4	20%
36 hours	1	5%
48 hours (2 days of age)	3	15%

Q.7. How are calves housed after separation from their dam (multiple choice question)?

This was a multiple-choice question, allowing each of the 20 respondents participating in this survey to choose whether the calves were housed individually or in groups and indoors or outdoors. Based on the number of responses seen **(Figure 4.2.1)**, alongside corresponding data in **Table 4.2.2,** it is evident that not all farms had documented both aspects. Google Forms recorded every chosen answer for each respondent, with only 9 respondents documenting both individual/group housing and whether the calves were housed indoors or outdoors.

It is evident from **Figure 4.2.1** that most calves (80%) were housed individually after separation from their dam, which equates to 16 farms. In contrast, 35% were housed in groups. These data suggests some farms utilise both individual and group housing after separation from the dam. **Table 4.2.2** shows that 5 farms were included under this bracket.

It is evident from **Table 4.2.2** that 80% (16 farms) house their calves individually after separation from the dam, while 10% (2 farms) house their calves in groups. Another 10%, which equates to 2 of the farms surveyed, did not specify whether calves were housed individually or in groups, only sharing information that they were housed indoors.

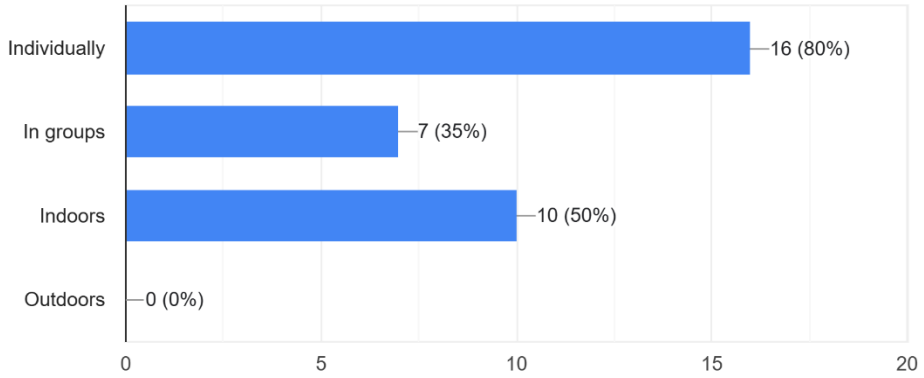

FIGURE 4.2.1. *Bar chart showing how many calves are housed after they have been separated from their dams on Irish dairy farms*

TABLE 4.2.2. *Number of calves housed after they have been separated from their dams on Irish dairy farms*

How calves are housed after separation from their dam	Number of responses	Percentage
Individually	8	40%
Individually, Indoors	3	15%
Individually, In groups, Indoors	4	20%
Individually, In groups	1	5%
In groups	1	5%
In groups, indoors	1	5%
Indoors	2	10%

Q.8. If calves are housed individually first, at what age are they typically brought together in groups?

This question received 17 responses, with 15% (3 farms) submitting no response, as detailed in **Table 4.2.3**. Although the survey was anonymous, with the respondent's name not asked for or recorded, it is possible to view a summary of responses from each person who completed the survey. Using this visibility, the author can see that two of these farms grouped the calves immediately after separation from the dam, with the other farm reporting the calves being kept both individually and in groups after separation from the dam without documenting an age at which these individually kept calves were brought together in groups.

The highest percentage of farms (35% or 7 farms) brought calves into groups (that were initially housed individually after separation from their dam) when the calves were 7 days of age (1 week old), with the second highest percentage (20% or 4 farms) grouping calves after they were first housed individually at 4 days old. Calves that were kept individually at first, were merged into groups at 2 weeks of age on 10% (two farms). 3 days old, 5 days old and 4 weeks old were the responses for 3 other farms, with another respondent documenting "6–12", without specifying a timeframe (e.g., days or weeks). This lack of clarity is clearly a disadvantage of short sentence answers.

TABLE 4.2.3. *Ages at which calves are typically brought together into groups, if they were housed individually at first on Irish dairy farms*

Age	Number of respondents	Percentage
3 days old	1	5%
4 days old	4	20%
5 days old	1	5%
7 days old (1 week)	7	35%
2 weeks	2	10%
4 weeks	1	5%
6 to 12	1	5%
No response	3	15%

Q.9. What is the typical size of calf groups on the farm?

It is evident from **Table 4.2.4** that the most common calf group size on the 20 farms that responded to this question, was a group of 10 calves, with 5 farms using this group size which equates to 25%. Four farms (20%) put 6 calves in one group, 3 farms (15%) had 8 calves per group, while two farms (10%) recorded grouping their calves in numbers of 30. Groups of 3, 4, 5, 12 and 15 calves were recorded on one farm each.

One response was "5 days" and it could be assumed that the respondent intended to write 'calves' and due to human error wrote the wrong word. However, this assumption is not definite, so unfortunately this response cannot be used in the analysis of answers.

TABLE 4.2.4. *Typical size of calf groups on Irish dairy farms*

Group size	Number of responses	Percentage
3 calves	1	5%
4 calves	1	5%
5 calves	1	5%
6 calves	4	20%
8 calves	3	15%
10 calves	5	25%
12 calves	1	5%
15 calves	1	5%
30 calves	2	10%
5 days	1	5%

Q.10. Which factors are considered when calf groups are formed (multiple choice questions)?

Figure 4.2.2 shows that all the farms (100%) included in this survey grouped calves according to their age; all 20 responses were received. Of the 20 farms, 40%, which equates to 8 farms, considered the weight of each calf when forming groups, with 50% (10 farms) considering the health status of each calf when placing the calves into groups. It is evident from the responses collected on Google Form, that the 6 farms took all the above mentioned (age, weight, and health status) into consideration when placing calves into groups. One farm (5%) considered the breed and sex of each calf when forming calf groups.

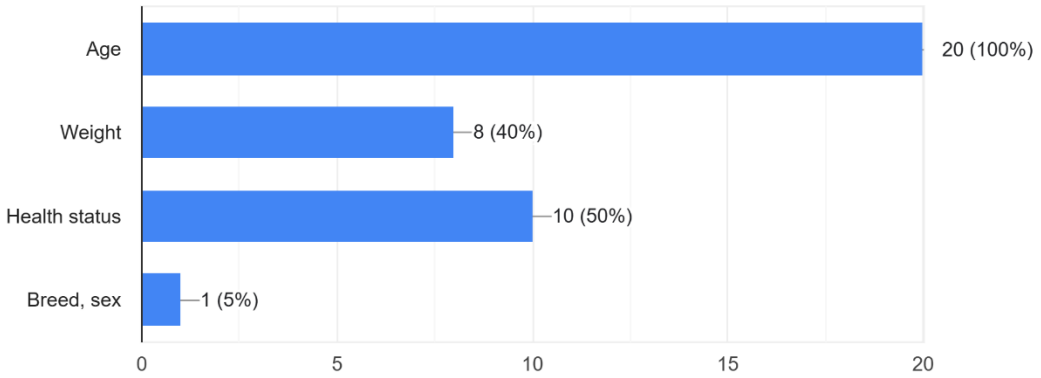

FIGURE 4.2.2. *Bar chart showing the criteria on which individually housed calves are placed in groups on Irish dairy farms*

Q.11. Are calf groupings permanent or changing?

All 20 responses were received to this question. **Figure 4.2.3** clearly visualises that over half of the farms (55% which equates to 11 farms) change their calf groupings from the original groups they are placed in. Nine farms (45%) do not change the group after they are originally formed.

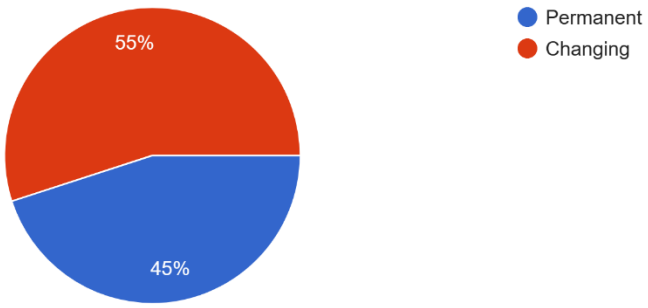

FIGURE 4.2.3. *Pie chart showing the percentage of calf groupings which are either changed or remain the same on Irish dairy farms*

Discussion 4.2

The following paragraphs summarise and discuss the responses collected in section 4.2, based on the grouping of calves.

The most common practice in Irish dairy farms is to separate the calf and dam within 24 hours after birth; 80% of farms surveyed reported this while 30% of farms separated calves from their

dams at birth. This corresponds with the literature reviewed in section 1.2.1, from which it is concluded that it is common practice to separate calf from the dam within 24 hours of birth [18].

The results of the survey indicate that 80% of dams were housed individually after separation from their dam and, if housed individually at first, 65% of farms surveyed brought the calves together into groups on or before 7 days of age, with 80% grouping their calves on or before 4 weeks of age. These findings suggest that most Irish dairy farmers abide by European legislation which was discussed in section 1.2.4 of the literature review. This Council Directive 2008/119/EC states that "no calf shall be confined in an individual pen after the age of eight weeks" [23].

Question 7 (**Figure 4.2.1**) was a multiple-choice question, allowing each survey participant to choose whether the calf was housed individually or in groups and indoors or outdoors. Based on the number of responses (**Figure 4.2.1**), it is evident that not all farms documented both details. Google Forms recorded every chosen answer for each respondent, with only 9 respondents documenting both individual/group housing and whether the calves were housed indoors/outdoors. On reflection, to ensure that each element of the question received a response from all participants, the question could have been divided into two individual questions.

Table 4.2.3 details the ages at which calves are typically brought together into groups, if they were housed individually at first on Irish dairy farms. One respondent documented "6-12", without specifying a timeframe (e.g., days or weeks) and this lack of clarity is a disadvantage of short sentence answers and posed a limitation when collectively analysing these results.

Six to 10 calves per group was the most common size (60%) with all farms taking age into consideration when forming groups. This correlates with Northern Irish literature (discussed in literature review, section 1.2.2), which found the most common reason for timing of grouping, was management simplicity, age, and space availability [7]. One response on calf group sizes, (**Figure 4.2.5**) was "5 days". It could be assumed that the respondent intended to write 'calves' and due to human error wrote the wrong word. However, as this assumption is not definite, unfortunately this response cannot be used in the analysis of the answers. This is another limitation found regarding short answer text responses.

Just over half (55%) of groups were changing, with 45% remaining permanent. As discussed in section 1.2.2, regrouping can cause conflict, anxiety, and a circadian rhythm disruption,

especially for calves of a lower social standing, which can be perceived as an advantage of groups remaining permanent [27].

Section 4.3 Calf housing

This section of the survey comprised of questions focusing on the bedding type used for calf housing, the frequency of completely changing bedding, disinfection frequency and type used. The responses refer to data for 2022.

Q.12. What type of bedding is used in the calf pens on the farm?

There was a total of 20 responses to this question. As shown below **(Figure 4.3.1)**, all Irish dairy farms included in this survey used straw as primary bedding for their calf pens. Most (95%), which equates to 19 out of the 20 farms surveyed, use only straw as bedding, with one farm (5%) reporting that straw was used as a bedding on top of wooden slats.

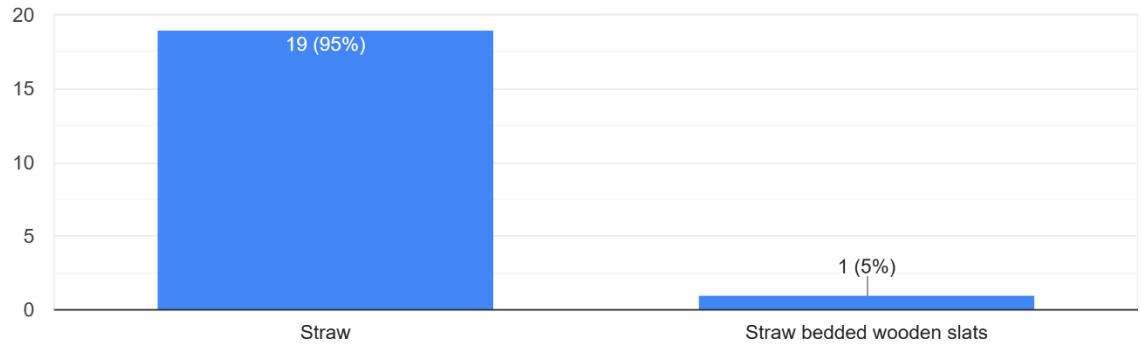

FIGURE 4.3.1. *Bar chart showing the types and percentage of bedding used in calf housing on Irish dairy farms*

Q.13. How often is bedding changed in the calf pens completely?

There were 20 responses to this question. **Figure 4.3.2** shows that 25% of the farms surveyed (5 farms) completely changed bedding in calf pens twice weekly, with the next highest percentage (20%, which equates to 4 farms) completely changing bedding once weekly. Following these figures, the third most common response was change of bedding once every 2

weeks, with 15% (3 farms) reporting this frequency. Of the remaining 8 farms in the survey, 2 changed bedding daily, 2 changed bedding every second day, 2 changed bedding once a month and 2 farms only completely changed bedding at the end of the season. In this regard, a huge variation in frequency was found.

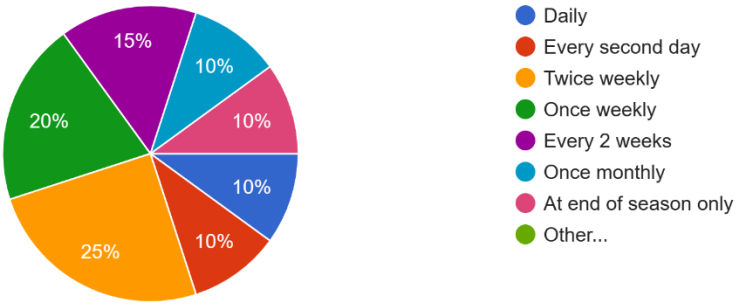

FIGURE 4.3.2. *Pie chart showing the frequency of complete bedding changes in calf housing units on Irish dairy farms*

Q.14. How often are the calf pens disinfected?

It is evident from a glance at the pie chart below (**Figure 4.3.3**) that out of 20 responses received for this question, over half relate to two disinfection frequencies. Six farms (30%) disinfected the calf pens once weekly and the second most common procedure was disinfecting the calf pens every 2 weeks (25%, equating to five farms).

Following this, 4 farms (20%) disinfected calf pens at end of the season only. Interestingly, the response sheet for each farm recorded that the farms who disinfected pens only at the end of each season, one of these changed bedding once weekly, another changed bedding every two weeks and the other two farms in this group changed bedding at the end of the season only.

Three farms (15%) disinfected the pens twice weekly and 10% (equating to two farms) were disinfected once monthly.

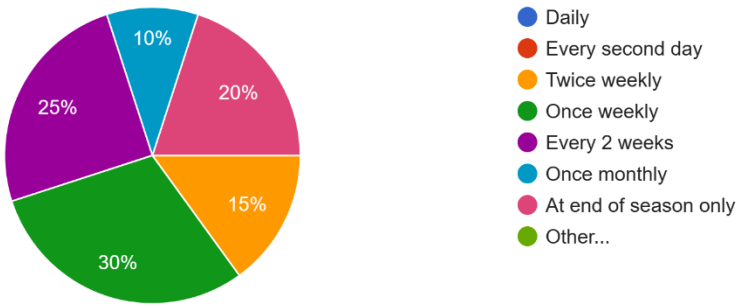

FIGURE 4.3.3. *Pie chart showing the frequency of disinfecting calf housing units/pens on Irish dairy farms*

Q.15. What type of disinfectant is used for calf pens?

20 responses were received for this question, a summary of these responses can be seen in **Table 4.3.1**. 40% (eight farms) use Lime as their disinfectant of choice to disinfect their calf housing, this is the most popular product of choice among the twenty farms that partook in this survey. An additional 5% (one farm) used a combination of lime and kilcox extra (active/primary ingredient: Glutaraldehyde). One farm (5%) used Kilcox extra independently. The second most popular disinfectant of choice is Iodine spray, with 15% (three farms) using this as disinfectant. Two farms used Jeyes fluid (active/primary ingredient: 4-chloro-m-cresol), Virophis (active/primary ingredient: iodophor) was the disinfectant of choice for one farm and Cylex (active/primary ingredient: chlorocresol) for another, with one respondent detailing the following as their response, “Bedding lime between straw changes and a disinfectant usually for coccidiosis at minimum”, it is unknown what the disinfectant was used on this farm. Additionally, two of the farms surveyed documenting using ‘Neutrogen’, this raised a limitation in the responses collected as the author could not locate information on the active ingredient.

TABLE 4.3.1. *Table showing the types of disinfectants used in calf housing units in Irish dairy farms*

Type of disinfectant	Number of responses	Percentage
Lime	8	40%
Lime and Kilcox	1	5%
Kilcox extra	1	5%
Iodine spray	3	15%
Neutrogen	2	10%
Jeyes fluid	2	10%
Virophis	1	5%
Cyclex	1	5%
Bedding lime between straw changes and a disinfectant usually for coccidiosis at minimum	1	5%

Discussion 4.3

The following paragraphs summarise and discuss the responses collected in section 4.3, based on the grouping of calves.

Straw was the one and only type of bedding used by all Irish dairy farms in the survey. This correlates with literature discussed in section 1.3.1 of the literature review, which found 92.4% dairy farms in a Northern Irish study used straw as bedding [7]. Deep, straw bedding allows for nesting, creating a layer of warm air around the calf, which reduces animal heat loss [34].

25% of farms surveyed completely changed calf bedding two times weekly, this was the highest percentage recorded within all responses. The best possible answers the respondents could have chosen in this survey was ‘daily’ and ‘every second day”, with no farms documenting these responses. Following these options, the next best option was ‘twice weekly’ followed by ‘once weekly’, these were the most common responses in the survey. This signifies Irish dairy farms could improve their hygiene regard frequency of complete bedding changes; however, their efforts cannot be classed as poor or minimal either. This question (13) asked how often bedding was completely changed in calf pens. On reflection, a follow-on question from this could have assessed how often the bedding in the calf housing units was ‘topped up’ between complete changes. This would have given an additional, beneficial insight into the hygiene standards on each farm, aside from the information obtained from the survey on complete bedding change.

The highest percentage of farms in the survey (30%) were disinfected once weekly, with 25% farms disinfected every 2 weeks. The most popular disinfectant was lime, with 40% of Irish dairy farms that partook in the survey using it to disinfect their calf housing. The chosen disinfectant should have a wide spectrum of activity against the pathogens in the calf’s environment, such as bacteria and viruses. As discussed in the literature review (section 1.3.2) it is important that disinfectant is applied at the adequate dilution for a specified amount of time [38]. The author was conscious that if the survey contained too many questions, it may deter participants from completing the full survey, therefore tried to keep questions as concise as possible. However, on reflection, additional questions asking the disinfectant dilution used and application time, would have collected valuable information on whether the farms in the survey were completing efficient hygiene management.

Section 4.4 Calf Nutrition

This section of the survey comprised of questions focusing mostly on the feeding procedures in place for calves on Irish dairy farms. Responses refer to data 2022.

Q.16. Do you control the QUALITY of colostrum offered to each calf? If yes, How?

The responses to this question were collected in short answer text, two simplified tables were made using the data collected from the responses, which can be seen in **Table 4.4.1** and **Table 4.4.2**.

It can be seen in **Table 4.4.1** that one farm did not respond to this question, therefore there was only 19 responses. Another farm response wrote" Bucket form", it is difficult to interpret how the colostrum quality is controlled on this farm. 45% (nine farms) controlled the quality of colostrum the calves received, with the same percentage of farms not controlling colostrum quality.

Table 4.4.2 details the methods used by farms to measure the quality of colostrum; the eleven farmers that didn't control colostrum quality were not required to respond to this part of the question as. From the responses received, 3 farms (equating to 15%) used a refractometer. Another 15% of farms documented that the calf's received the mother's colostrum however this does not confirm the colostrum quality was checked on these 3 farms. Similarly, another farm documented "3 litres in the first 2 hours" which also doesn't confirm the colostrum quality was measured. To summarise, it can be concluded that only four of the twenty farms included in this survey, controlled colostrum quality.

TABLE 4.4.1. *Table detailing whether the quality of colostrum offered to the calf is controlled in Irish dairy farms*

Is quality controlled?	Number of responses	Percentage
Yes	9	45%
No	9	45%
"Bucket form"	1	5%
No response	1	5%

TABLE 4.4.2. *Table detailing how the quality of colostrum offered to the calf is controlled in Irish dairy farms*

If yes, how?	Number of responses	Percentage
Refractometer	3	15%
Measured	1	5%
Receives mothers' colostrum	3	15%
3 litres in first 2 hours	1	5%
Answered yes but didn't explain how	1	5%

Q.17. Do you control the QUANTITY of colostrum intake? Please list the measures used on the farm?

There were 19 responses to this question. Each response was collected in short answer text, three simplified tables were made using the data collected from the responses, which can be seen in **Table 4.4.3**, **Table 4.4.4** and **Table 4.4.5**. Some responses had extra information than required, in these cases the author will include the respondent's extra remarks throughout the analysis below.

It is evident from **Table 4.4.3** that 95% of the Irish dairy farms surveyed (nineteen farms) controlled the quantity of colostrum each calf consumed, with the remaining farm giving the colostrum in bucket form. The author is unsure whether the exact quantity the calf consumed was controlled via the bucket feeding technique used on this farm.

Table 4.4.4 details the methods used to control the quantity of colostrum each calf received. The use of stomach tubes (used on four farms) and bottle feeding (used on four farms) was the most common technique, with 3 farms documenting that they used both techniques. One informative response was "Use a bottle with measurements on it. All calves receive 3 litres usually by bottle. If this fails will use stomach tube. Colostrum is usually taken very soon after calving". 35%, equating to 7 farms, measured the amount of colostrum calves consumed but did not explain the method of measurement. Additionally, one other farm used the "321 rule" which was referred to in section 1.4.2 of the literature review (giving 3 litres of the dam's milk within 2 hours of birth).

The respondents included a lot of detail in their responses to this question, also documenting the amount of colostrum each farm gave to the newborn calves, this information can be seen in Table 4.4.5. 50% (10 farms) gave 3 litres of colostrum to each calf. The range of results varied from 2 litres to 4 litres, with one response describing "Each calf gets minimum 2.5 litres up to 4 litres colostrum".

TABLE 4.4.3. *Table detailing whether the quantity of colostrum intake is controlled on Irish dairy farms*

Is quantity controlled?	Number of responses	Percentage
Yes	19	95%
No	0	0%
Bucket form	1	5%

TABLE 4.4.4. *Table detailing the measures used to control colostrum intake on Irish dairy farms*

Please list the measures used	Number of responses	Percentage
Stomach tube	4	20%
Bottle fed	4	20%
Stomach tube and Bottle fed	3	15%
"Bucket form"	1	5%
"321 rule"	1	5%
Specific amount given, didn't document method of measurement	7	35%

TABLE 4.4.5. *Table detailing measures used to control colostrum intake on Irish dairy farms*

Quantity given	Number of responses	Percentage
2 litres	2	10%
2.5 litres	1	5%
3 litres	10	50%
3.5 litres	1	5%
4 litres	1	5%
2.5 up to 4 litres	1	5%
Quantity measured but not documented	3	15%
Bucket form	1	5%

Q.18. Within how many hours of life do you aim for the calf to have received colostrum?

The responses to this question were collected in short answer text, a simplified table **(Table 4.4.6.)** was made using the data collected from the responses.

It can be seen in **Table 4.4.6** that there were two common responses, with eight farms (40%) aiming for each calf to receive colostrum within 1 hour and another eight farms (40%) aiming for each calf to receive colostrum within 2 hours, equating to sixteen responses of the twenty farms surveyed. One farm aimed for the calf to receive colostrum within 1 hour but not more than 2 hours, with another response writing 1-2 hours. 5% (one farm) aims to give colostrum immediately after birth, with the last respondent aiming for the calf to receive colostrum within 30 minutes of life.

TABLE 4.4.6. *Table detailing within how many hours of life the farm aims for calf to receive colostrum on Irish dairy farms*

Timeframe	Number of responses	Percentage
Immediately	1	5%
30 minutes	1	5%
1 hour	8	40%
1 hour (not more than 2 hours)	1	5%
1-2 hours	1	5%
2 hours	8	40%

Q.19. If colostrum is not used immediately, for how long is it stored before discarding it? How is it stored?

The responses to this question were collected in short answer text. For the readers ease of viewing these responses, data collected was compiled into **Table 4.4.7** and **Table 4.4.8**. This question received nineteen responses.

Table 4.4.7 shows the highest percentage (20%) of responses stored colostrum for 24 hours before discarding it, with one of these respondents detailing that it was kept in the fridge during this time. The other 20% recorded in **Table 4.4.7** referred to respondents that did not specify the length of time colostrum was kept before discarding. The next highest percentage of responses (10%) was for a storage time of 2 months before discarding. Each of the remaining farms documented a different timeframe, the range was between 4 hours and 2 days. The farm at the lowest end of this range “Stored in a bucket, dumped after 4 hours” while the farm at the higher end of this range of times, reported the colostrum was stored for “"1-2 days then surplus frozen and used within the season".

Table 4.4.8 details how colostrum is stored, it is evident that the highest percentage, 45% which equates to nine farms, store their unused colostrum in a freezer. 10% (two farms) reported that they stored some colostrum in a fridge and other colostrum in a freezer, with another 10% (two farms) keeping colostrum in a fridge. The above-mentioned respondents equate to 65% who store their unused colostrum either chilled or frozen. One farm simply discarded all unused

colostrum, with another farm either freezing or discarding it. Three farms did not specify how the unused colostrum was stored.

TABLE 4.4.7. *Table detailing how long colostrum is stored for before discarding on Irish dairy farms*

Length of time	Number of responses	Percentage
4 hours	1	5%
12 hours	1	5%
24 hours	4	20%
1 month	1	5%
2 months	2	10%
6 months	1	5%
1 year	1	5%
Discarded	1	5%
Either Frozen or Dumped	1	5%
"12 hours unless frozen"	1	5%
"1-2 days then surplus frozen and used within the season"	1	5%
Not specified	4	20%
No response	1	5%

TABLE 4.4.8. *Table detailing how colostrum is stored on Irish dairy farms*

Method of storage	Number of responses	Percentage
Refrigerated	2	10%
Frozen	9	45%
Refrigerated or frozen	2	10%
Frozen or discarded	1	5%
"Stored in a bucket, dumped after 4 hours"	1	5%
Discarded	1	5%
Not specified	3	15%
No response	1	5%

Q.20. Is passive immunity status monitored in individual calves?

This question also received 19 responses, **Figure 4.4.1** groups each of these responses into a pie chart. It is evident from this pie chart that a high percentage farms in this survey do not monitor the passive immunity status of individual calves, this can be seen by the red section of the chart, representing eleven farms. The orange section of the chart represents the farms that sometimes monitor passive immunity status. Only one farm, represented by blue section of the chart, frequently measures the calf's passive immunity status.

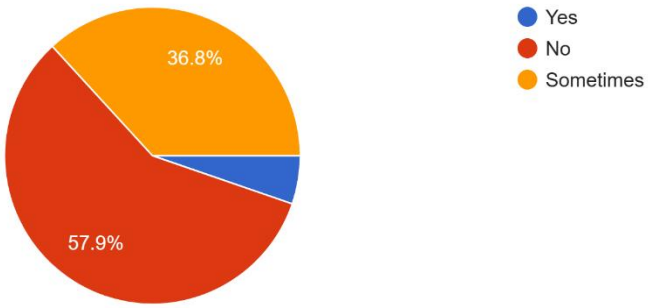

FIGURE 4.4.1. *Pie chart showing how passive immunity status is monitored in calves on Irish dairy farms*

Q.21. Is the same feeding equipment used for all calves without cleaning? (eg. stomach tube)

This question received 20 responses. It is evident from the purple section in **Figure 4.4.2**, that the most common procedure among Irish dairy farms in the survey is to clean feeding equipment between each calf, eleven farms do this. The next most common response, (indicated by the oranges section) is using the same equipment for all calves and cleaning it daily, six farms follow this procedure. One farm cleans equipment between groups and another farm clean the equipment weekly. Represented by light blue shade on the bar chart, the remaining respondent chose the 'other' option in the multiple-choice list, writing "Stomach tube cleaned after each use. Milk feeding troughs cleaned twice daily after use".

FIGURE 4.4.2. *Pie chart showing whether same feeding equipment is used for all calves without cleaning on Irish dairy farms*

Q.22. What type of milk is used to feed the calves during the first few days after separation from the dam?

This question received 20 responses. **Figure 4.4.3** details the four possible responses that accompanied this answer, two of these responses were not chose at all by any farmer, therefore no farms in the survey used the milk of sick cows undergoing treatment or milk replacer to feed calves after separation from their dam. Seven farms (35%) used only the dam's milk in the initial stages of feeding calves while 65% of farms (equating to thirteen farms) used the milk of freshly calved cows.

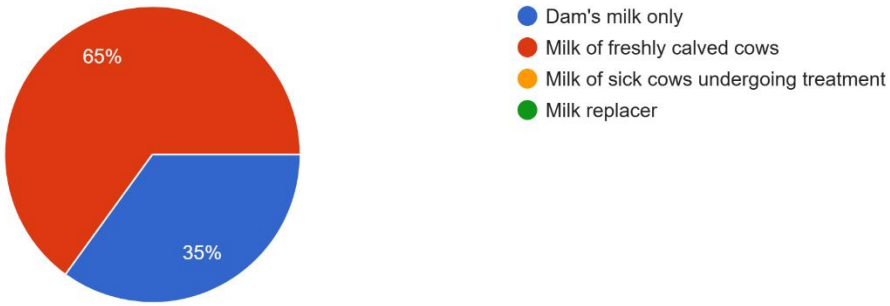

FIGURE 4.4.3. *Pie chart showing the type of milk used to feed calves in first few days after separation from their dams on Irish dairy farms*

Q.23. At what age are calves typically weaned off milk on the farm?

This question received 20 responses. It is evident from **Table 4.4.9** that the highest percentage of farms typically wean calves off milk at 10 weeks of age (35% which equates to seven farms) with the next most common age of weaning being 12 weeks (10%, equating to two farms). A further 5% (one farm) weaned the calves at 10-12 weeks of age.

The responses were obtained in short answer text, allowing responses to each document a different age, with ages widely ranging from 4 weeks of age (28 days of age) to 120 days of age. Additionally, one farm weaned their calves at 4 months old and another completely weaned their calves off milk at 8 months of age.

TABLE 4.4.9. *Table detailing the age calves are typically weaned off milk on Irish dairy farms*

Age	Number of responses	Percentage
2 weeks	1	5%
6 weeks	1	5%
8 weeks	1	5%
9 weeks	1	5%
10 weeks	7	35%
8-10 weeks	1	5%
12 weeks	2	10%
10-12 weeks	1	5%
70 days	1	5%
3 months	1	5%
100-120 days	1	5%
4 months	1	5%
8 months	1	5%

Discussion 4.4

The following paragraphs summarise and discuss the responses collected in section 4.4, based on calf nutrition.

It can be concluded that only four (20%) of the twenty farms included in this survey accurately controlled colostrum quality (three farms specified use of a refractometer) (**Table 4.4.2**), despite 9 farms (45%) answering 'yes' to question 16 which asked whether the colostrum quality was controlled (Table 4.4.2). Likewise, **Figure 4.4.9** illustrates that over half of the farms surveyed don't monitor passive immunity transfer in calves. In comparison, 95% of Irish dairy farms in the survey, controlled colostrum quantity (**Table 4.4.3**), with 50% of the farms aiming for each calf to receive 3 litres of colostrum (**Table 4.4.5**). As discussed in section 1.4.1 of the literature review, high quality colostrum is defined as having IgG of higher than 50 mg/mL [42]. A refractometer can be uses to measure this value, with a specific gravity measurement greater than 1.050, approximately equivalent to an IgG concentration > 50 mg/ml [40].

It is evident from **Table 4.4.6** that the maximum time passed between birth and a calf receiving colostrum is two hours. This is best practice, as according to section 1.4.2, IgG absorption is at

its best in the first 4 hours of life, with decreased absorption which eventually results in no immunoglobulins absorption after 24 hours of age [40].

65% of farms that partook in the survey, either refrigerate or freeze unused colostrum. With 10% discarding it and 20% not specifying how it was stored. This corresponds with literature advice, as discussed in section 1.4.5, if colostrum is not consumed within 2 hours of collection, it should be chilled or frozen, as bacteria can quickly multiply in warm temperatures [42].

Over half of the respondents (55%) cleaned feeding equipment between each calf, with an additional 30% cleaning the equipment daily (**Figure 4.4.2**). To maintain optimal hygiene methods, it is vital that feeding equipment is sanitised.

The Irish dairy farms in this survey either used milk of freshly calved cows (65%) or the dam's milk only (35%) to feed calves after separation from their dam. This is a preferred result as cows as it is of high quality and most nutritious for calves, in comparison to the milk of sick cows undergoing treatment or milk replacer, no farms in the survey used either of these (**Figure 4.4.3**).

Table 4.4.9 indicates that 50% of the farms surveyed weaned calves off milk between 10-12 weeks of age, concluding this is the most common weaning timeframe, among the twenty farms surveyed. Section 1.4.6 reviewed research which concluded that a decline in average daily weight gain was more apparent in calves weaned at 6 weeks of age in comparison to calves weaned at 8 weeks of age, this suggests the average weaning age of farms in this survey, is adequate to benefit calf performance [48].

Section 4.5 Calf health management

The questions in this section of the survey focus on the health of calves and diseases seen on Irish Dairy Farms in 2022, the last question of the survey assesses the levels of knowledge and/or education Dairy farmers and farm workers possess.

Q.24. Which diseases were most commonly seen on the farm? Choose the 3 most common.

Despite the question asking for the three most common diseases on the farm, from the 20 respondents completing the survey, not all chose three answers for this question. It is evident from Google Forms summary on Microsoft Excel that only seven respondents chose all three answers.

Out of the four farms that responded "none" (seen in **Figure 4.5.1**), two of these farms also chose another option, the accompanying choices were viral/parasitic diarrhoea and pneumonia/non specified diarrhoea. Therefore, truly only two out of the twenty farms surveyed, had no disease commonly seen on their farms.

Pneumonia was reported on 12 farms (60%), with diarrhoea (un-specified cause) being reported on eleven farms (55%). The other responses detailed the possible causes of diarrhoea if the farmer had this information. Bacterial diarrhoea was documented on 4 farms, viral diarrhoea was documented on 3 farms and parasitic diarrhoea was reported on 2 farms. Microsoft Excel (containing data from Google Forms survey) demonstrates that sixteen of the twenty farms surveyed (80%), reported at least one type of diarrhoea.

Joint problems were an issue on two farms (10%) followed by the least common disease reported in this survey, navel infections.

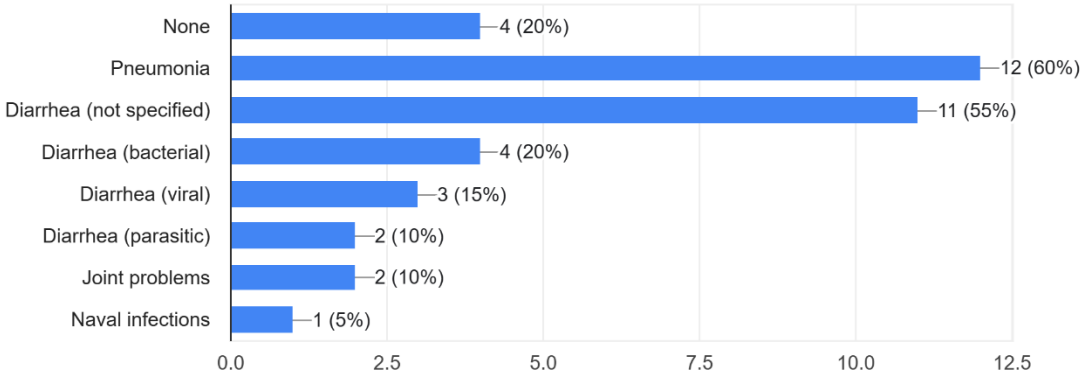

FIGURE 4.5.1. *Bar chart showing the most common diseases on Irish dairy farms*

Q.25. What was the approximate proportion of calves receiving veterinary treatment in 2014?

There were 20 responses collected for this question. From a glance, it is evident that the blue section of the pie chart **(Figure 4.5.2)** involves most farms in this survey. This section refers to 75% (15 farms) which reported less than 5% of their calves receiving veterinary treatment in 2014. The red section represents four farms that recorded 6-15% of their calves needing veterinary equipment in 2014. One farm reported 50%<", regrettably this was a typing error on the authors part, it should have read"50%>", this response is discussed further under the subheading 'Discussion 4.5'.

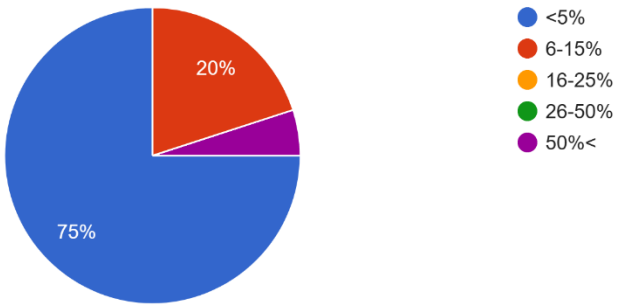

FIGURE 4.5.2. *Pie chart showing the approximate proportion of calves requiring veterinary treatment in 2014 on Irish dairy farms*

Q.26. What was the approximate proportion of calves receiving veterinary treatment in 2022?

There were 20 responses to this question. **Figure 4.5.3** clearly demonstrates that only one farm (%5) had 6-15% of their calves requiring veterinary treatment in 2022. With all other farms surveyed (19 farms) recording less than 5% of the calves in their herd requiring veterinary treatment in 2022. None of the other possible responses listed for this question (seen in Figure 4.5.3) were chosen.

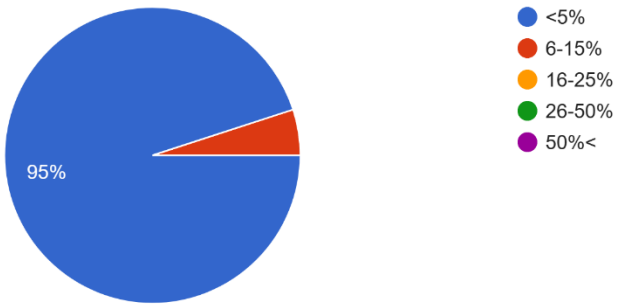

FIGURE 4.5.3. *Pie chart showing the approximate proportion of calves requiring veterinary treatment in 2022 on Irish dairy farms*

Q.27. What was the calf mortality rate in 2014?

This was a short text answer question, offering the 20 respondents' freedom to write their preferred answer, this explains the extensive variation of results seen in (**Table 4.5.1**).

One respondent wrote "4/70" referring to the death of 4 out of 70 animals, this equates to a mortality rate of 5.7% which is in keeping with the most common mortality rate of 5% (in this survey). Four farms experienced a mortality rate of 5% in 2014. Another equally common calf mortality rate was 2%, with another four farms recording this. Three farms recorded a 0% calf mortality rate in 2014, while two farms referred to the mortality rate as "low". The calf mortality rates in 2014 ranged from 0% to 10% among all farms surveyed.

TABLE 4.5.1. *Table detailing the mortality rates experienced in 2014 on Irish dairy farms*

Mortality rate	Number of responses
0%	3
1%	1
2%	4
3%	2
4%	1
5%	4
8%	1
10%	1
Low	2
4 out of 70 animals	1

Q.28. What was the calf mortality rate in 2022?

There were 20 responses to this question. It is evident from **Table 4.5.2** that the most common calf mortality rate in 2022, reported by 4 farms, was 5%. There were 3 farms each who reported the following mortality rates: 0%, 2% and 3%. The farm that reported a "high" mortality rate is discussed in 'Discussion 4.5'. One farm documented "2/95" referring to 2 calf deaths out of a total of 95 calves in the herd in 2022, which equates to a mortality rate of 2.1%.

Except for the farm that reported a "high" mortality rate, the 2022 calf mortality rate ranged from 0% to 8%, a lower range than 2014 calf mortality rate.

TABLE 4.5.2. *Table detailing the mortality rates experienced in 2022 on Irish dairy farms*

Mortality rate	Number of responses
0%	3
1%	1
2%	3
3%	3
4%	1
5%	4
7%	1
8%	1
Low	1
High due to amount sick	1
2 out of 95 animals	1

Q.29. How often are anthelmintic treatments given on the farm?

This was a short text answer question. The author combined similar results to make a more concise table of results, seen in **Table 4.5.3** and has mentioned any extra detail within the responses, throughout this analysis.

18 responses were received, with two farms not responding to this question. Additionally, one farm responded "0", which the author can only assume means this farm does not give anthelmintic treatment and another farm responded "Lungworm dosing" without advising a timeframe. The highest percentage (25% which equates to five farms) give anthelmintic treatments as necessary, with one of these farms explaining that "Faecal analysis is carried out and dosed accordingly". Following this, the next most popular frequency of administering anthelmintic treatment was every 6 weeks (two farms), with one of these farms responding, "every 6 weeks from mid-July as calves" and the other detailing that it "Varies depending on signs of problems, generally every 6 weeks when at grass during the first year of life".

Two farms give anthelmintic treatment weekly, with each remaining farm reporting many variations such as: rarely, 0-1 times yearly, twice yearly, four times yearly, every 5 weeks, every 8 weeks and "drenching as recommended".

TABLE 4.5.3. *Table detailing how often anthelmintic treatments are administered on Irish dairy farms*

How often	Number of responses	Percentage
"0"	1	5%
Rarely	1	5%
0-1 times yearly	1	5%
Twice yearly	1	5%
Four times yearly	1	5%
Weekly	2	10%
Every 5 weeks	1	5%
Every 6 weeks	2	10%
Every 8 weeks	1	5%
When necessary	5	25%
As recommended	1	5%
Lungworm dosing	1	5%
No response	2	10%

Q.30. In calves, which vaccinations are regularly used on the farm (multiple choice question)?

This question had multiple-choice answers, therefore each person completing the survey could choose as many responses as applicable (or use the 'other' option to add more if necessary). 19 respondents answered this question.

Figure 4.5.4 shows the most common vaccination used was against IBR (Infectious Bovine Rhinotracheitis), with seventeen out of twenty farms vaccinating against it. BVD (Bovine Viral Diarrhoea) was the second most common vaccine used (nine farms), followed by vaccinating the dam against rotavirus during pregnancy (seven farms) and vaccination calves against clostridial diseases (six farms). Three farms vaccinated against salmonellosis.

One farm vaccinated the dam during pregnancy against Escherichia. Coli scours. The remaining vaccinations on this bar chart were added by respondents. Vaccines against blackleg, leptospirosis and 'Bovipast' (which helps protect cattle against bovine respiratory diseases) were used on one farm each. One farm recorded using no vaccines.

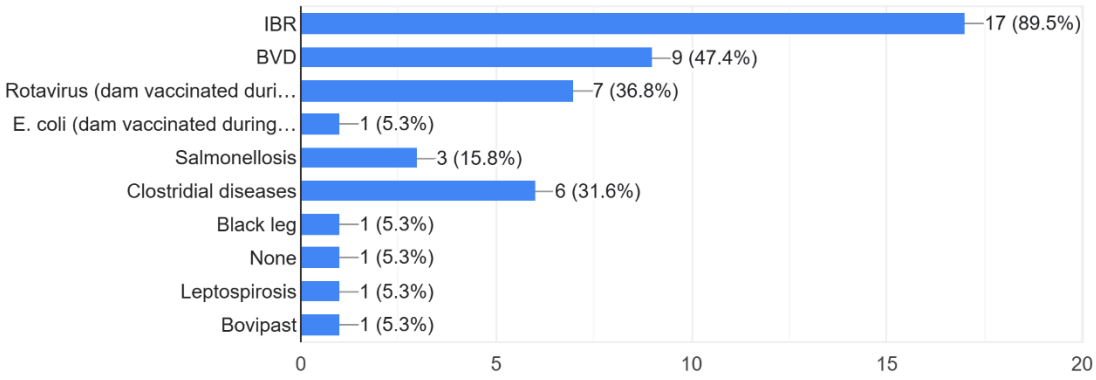

FIGURE 4.5.4. *Bar chart showing the vaccinations regularly used on Irish dairy farms*

Q.31. What type of formal training did the person responsible for the health management of calves on the farm receive?

There were 20 responses received to this question. **Table 4.5.4** concludes that 60%, or 12 participants in the survey, have received some form of training or qualification related to farming. This includes 35% (seven respondents) with a "green cert" (a primary agriculture certificate in Ireland), 10% (two participants) with an agricultural science degree, 1 participant (5%) with both a green cert and agricultural science qualification, 5% (1 person) with a veterinary nursing qualification and 5% (1 person) with veterinary qualification.

In contrast, 40%, or 8 participants, did not receive formal training. 20% (4 respondents) received no training, 1 participant (5%) trained themselves, another participant (5%) wrote that they learned from their mistakes. Two participants job shadowed (10%), with one of these participants "shadowed predecessor long term" and the other "work shadowing the farm owner".

TABLE 4.5.4. *Table detailing the type of formal training received by the person responsible for the health management of calves on Irish dairy farms*

Formal training	Number of responses	Percentage
None	4	20%
Self-training	1	5%
"Learn from your mistakes"	1	5%
Job shadowing	2	10%
Green Cert	7	35%
Green cert and Agricultural science degree (level 8)	1	5%
Agricultural science degree (level 8)	2	10%
Veterinary nursing	1	5%
Veterinary	1	5%

Discussion 4.5

The following paragraphs summarise and discuss the responses collected in section 4.4, based on calf health management.

Figure 4.5.1 specifies many of the different causes of diarrhoea. Non specified diarrhoea was reported on eleven farms (55%), additionally, four farms reported bacterial diarrhoea, three reported viral diarrhoea and four reported parasitic diarrhoea. As each respondent could choose many options, Microsoft Excel (containing data from Google Forms) was referred to for each farm's response. It demonstrates that sixteen of the twenty farms surveyed, reported at least one type of diarrhoea. Pneumonia followed very closely behind as the second most common cause, with twelve farms reporting this ailment. The results of this survey correlate with the information from literature reviewed, section 1.5.1 of the literature review advised that scour was the most common disease affecting young calves, followed by pneumonia.

It is expected that the proportion of farms effected by navel ill (5% equating to one farm) and joint problems (10% equating to two farms) would be similar, as joint problems are often a consequence of an umbilical infection. Corresponding to the literature reviewed in section

1.5.1, recording under 15% of newborn calves may contract omphalitis, which if not treated, can result in negative effects like stunted growth and joint ill [49].

Comparing **Figure 4.5.2** (2014 statistics) and **Figure 4.5.3** (2022 statistics), it can be noted that less calves required veterinary treatment in 2022 (95% recorded <5% of calves receiving veterinary treatment) than 2014 (75% recorded <5% of calves receiving veterinary treatment, with remaining farms recording a higher proportion of sick calves).

One possible answer for the responses for question 25 (asking the approximate proportion of calves receiving veterinary treatment in 2014) was "50%<", regrettably this was a typing error on the authors part, it should have read"50%>". The list of response options is listed in numerical order, as seen in the list in Figure 4.5.2, therefore it may have been suspected by the respondents that this particular response should have referred to more than 50%. One farmer chose this option. Based on the Figure 4.5.2, one would be unsure whether this farm was documenting less than or more than 50% of calves required veterinary treatment in 2022, however, using each farms answer summary on google forms, this farm responded "high because of amount" of sick animals for question 28 which asked the calf mortality rate for 2022. The author suspects the farmer misread the year in question regarding mortality and should have said the mortality rate was high due to the number of sick animals in 2014. Therefore, after a lot of analysis, it could be concluded that this farm had more than 50% of calves required veterinary treatment in 2022.

Although the responses were anonymous, as mentioned previously, it is possible to review each completed survey, allowing the comparison of responses for each farmer. When comparing the 2014 results **(Table 4.5.1)** and 2022 results **(Table 4.5.2)** for calf mortality rate, this additional visibility concluded that out of the 20 farms surveyed, four farms seen an increase, six farms seen a decrease and ten farms recorded the same percentage of calf mortality. On reflection the questions regarding calf mortality rate should have included the word 'approximate', because many farmers might not exactly record the number of calf deaths, therefore some of the responses are an estimation rather than an exact figure.

Although there was a wide variation in results regarding anthelmintic treatment frequency **(Table 4.5.3)**, the most common result was to give anthelmintic treatments as necessary, recorded by five farms (25%). One of these farms advised faecal analysis were performed and calves were dosed accordingly. This procedure is the optimal method, to help prevent anthelmintic resistance, mainly of the three most popularly used anthelmintics; benzimidazole,

levamisole and macrocyclic lactones, which was discussed in section 1.5.3 of the literature review [68]. In contrast, two farms that completed the survey recorded administration of anthelmintic treatment to calves weekly, it is not known if all calves received this treatment weekly, but this response is a cause for concern regarding anthelmintic resistance in Ireland.

Figure 4.5.4 contains results of the most popular vaccine used on Irish dairy farms which completed this survey. It is a vaccine against IBR, with seventeen of the twenty farms reporting use of this vaccine. It is administered to animals three months of age and above, to help decrease the length and severity of respiratory symptoms of infectious bovine rhinotracheitis, which is caused by a BHV-1 infection [70]. A vaccine against bovine viral diarrhoea was the following most common vaccine, with nine of the twenty farms surveyed administering it. As explained in section 1.5.4 of the literature review, it is used as an additional preventative measure, alongside biosecurity measures and elimination of the virus.

Table 4.5.4 gives an insight into the formal training (if any), the person responsible for the health management of calves on the farm received. The results show that 40% of the personnel on the farms involved in this survey, received no 'formal' training. This survey was populated with dairy farmers in the region and additionally to dairy farm students within a local agriculture college**,** this may reflect the 35% of respondents with a "green cert" (an Irish primary agriculture certificate), however it is unknown whether many of these students completed the survey or not (this is another contributing factor to the survey being non-representative). Although the average responses to each question portrayed an adequate management of heard health and hygiene within Irish dairy farms surveyed, there were some suboptimal responses recorded to questions throughout the survey. This further demonstrates the importance of guiding farmers, to help them achieve the implementation of the necessary changes to improve calf health and hygiene in their herds, which was discussed in section 1.5.5 of the literature review.

Chapter 5: Summary

The abolition of milk quotas in 2015 seen an increase in dairy herd sizes, which was mirrored in the survey results with 95% of the Irish dairy respondents, recording an increase in the number of dairy cows and calves in their herd between 2014 and 2022.

The survey concludes that 80% of the respondents group calves on or before 4 weeks of age. This trend is suggestive of optimal calf rearing on Irish dairy farms, as literature reviewed concludes that group keeping encompasses more benefits than individual keeping.

As part of regular hygiene control methods, it is essential to change bedding regularly, clean and disinfect all surfaces to prevent pathogen accumulation. Collective survey results conclude that hygiene control methods on Irish dairy farms vary greatly, with room for improvement on many Irish farms.

It can be concluded that only 20% farms included in this survey, controlled colostrum quality and over 50% don't monitor passive immunity transfer in calves. This indicates an area of improvement on Irish dairy farms as ensuring passive immunity transfer with good quality colostrum are essential for calf health. According to survey results, all calves receive colostrum within 2 hours of birth, indicating favourable management in this aspect. 50% of the farms surveyed weaned calves off milk between 10-12 weeks of age, this is adequate to benefit calf performance. The survey results signify that herds with a weak level of management are more commonly affected by disease, the most common health issues affecting Irish dairy farms was diarrhoea (16 farms) and pneumonia (12 farms).

It has been established throughout the literature review that the correct management and good hygiene of calves is vital in ensuring optimal herd health. In conclusion, the author feels that the health and hygiene management of calves on Irish Dairy Farms is not, severely compromised at present. However, based on some suboptimal responses recorded throughout the survey, the author recommends more guidance to Irish dairy farmers, to help them implement necessary changes to improve calf health and hygiene in their herd.

Limitations

As mentioned throughout the results and discussion (Chapter 4), many of the questions in the survey had short answer responses. Some of these responses were difficult to interpret, leading to an uncertainty during analysis. Participants did not respond to every question, with 19 responses or less collected for questions.

Despite the survey being populated among many Irish dairy farmers, via a link to Google Forms, the survey was completed by only 20 participants, many of which were in a localised region. Motivated farmers may have been attracted to the survey, more so than other dairy farmers in Ireland. Therefore, the survey is non-representative of dairy farms throughout Ireland.

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List of figures and tables

Appendices

Appendix 1 – Survey

General questions

In this section, questions refer to data from 2022, unless stated otherwise.

1. What was the average number of cows on the farm in 2014? (Prior to abolition of the milk quota in 2015)

2. What was the average number of cows on the farm in 2022?

3. How many calves were born on the farm in 2014? (Prior to abolition of the milk quota in 2015)

4. How many calves were born on the farm in 2022?

5. How would you describe the distribution of calving's during a year?

Questions about calf grouping

In this section, questions refer to data from 2022.

6. At what age are calves typically separated from their dam on the farm?

7. How are calves housed after separation from their dam (multiple choice question)?
   - Individually
   - In groups
   - Indoors
   - Outdoors
   - Other:

8. If calves are housed individually first, at what age are they typically brought together ingroups?

9. What is the typical size of calf groups on the farm?

10. Which factors are considered when calf groups are formed (multiple choice questions)?
    - Age
    - Weight
    - Health Status
    - Other:

11. Are calf groupings permanent or changing?

    Mark only one oval.
    - Permanent
    - Changing

Questions about calf housing

In this section, questions refer to data from 2022.

12. What type of bedding is used in the calf pens on the farm?

13. How often is bedding changed in the calf pens completely?

    Mark only one oval.
    - Daily
    - Every second day
    - Twice weekly
    - Once weekly
    - Every 2 weeks
    - Once monthly
    - At end of season only
    - Other:

14. How often are the calf pens disinfected?

Mark only one oval.

- o Daily
- o Every second day
- o Twice weekly
- o Once weekly
- o Every 2 weeks
- o Once monthly
- o At end of season only
- o Other:

15. What type of disinfectant is used for calf pens?

Questions about calf feeding

In this section, questions refer to data from 2022.

16. Do you control the QUALITY of colostrum offered to each calf? If yes, How?

17. Do you control the QUANTITY of colostrum intake? Please list the measures used on the farm

18. Within how many hours of life do you aim for the calf to have received colostrum?

19. If colostrum is not used immediately, for how long is it stored before discarding it? Howis it stored?

20. Is passive immunity status monitored in individual calves?

Mark only one oval.

- o Yes
- o No
- o Sometimes

21. Is the same feeding equipment used for all calves without cleaning? (eg. stomach tube)

Mark only one oval.

- o Yes, same equipment used for all calves and rarely cleaned
- o Yes, same equipment used for all calves and cleaned weekly
- o Yes, same equipment used for all calves and cleaned daily
- o Cleaned between groups
- o Cleaned between each calf
- o Other:

22. What type of milk is used to feed the calves during the first few days after separation from the dam?

Mark only one oval.

- o Dam's milk only
- o Milk of freshly calved cows
- o Milk of sick cows undergoing treatment
- o Milk replacer
- o Other:

23. At what age are calves typically weaned off milk on the farm?

Questions about calf health management

In this section, questions refer to data from 2022, unless stated otherwise.

24. Which diseases were most commonly seen on the farm? Choose the 3 most common.

Check all that apply.

- o None
- o Pneumonia
- o Diarrhea (not specified)
- o Diarrhea (bacterial)
- o Diarrhea (viral)
- o Diarrhea (parasitic)

- Joint problems
- Other:

25. What was the approximate proportion of calves receiving veterinary treatment in 2014?

Mark only one oval.

- <5%
- 6-15%
- 16-25%
- 26-50%
- 50%<

26. What was the approximate proportion of calves receiving veterinary treatment in 2022?

Mark only one oval.

- <5%
- 6-15%
- 16-25%
- 26-50%
- 50%<

27. What was the calf mortality rate in 2014?

28. What was the calf mortality rate in 2022?

29. How often are anthelmintic treatments given on the farm?

30. In calves, which vaccinations are regularly used on the farm (multiple choice question)?

- IBR
- BVD
- Rotavirus (dam vaccinated during pregnancy)
- E. coli (dam vaccinated during pregnancy)
- Salmonellosis
- Clostridial diseases
- Other: _____

31. What type of formal training did the person responsible for the health management ofcalves on the farm receive?

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Thesis progress report for veterinary students

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Department: Department of Animal Hygiene, Herd Health and Mobile Clinic

Thesis title: Dairy calf health and hygiene management in Ireland

Consultation – 1st semester

	Timing (year month day)	Topic / Remarks of the supervisor	Signature of the supervisor
1.	2023.02.20.	Consultation on thesis structure and work schedule	✓
2.	2023.04.12.	First draft of literature review	✓
3.	2023.04.26.	Second draft of literature review	✓
4.	2023.05.08.	Consultation on how to create a questionnaire	✓
5.	2023.05.19.	Discussing work schedule for the summer	✓

Grade achieved at the end of the first semester: 5

Consultation – 2nd semester

	Timing (year month day)	Topic / Remarks of the supervisor	Signature of the supervisor
1.	2023.09.01.	Consultation on changing the topic of the thesis	✓
2.	2023.09.06.	Drafting the survey for the thesis	✓
3.	2023.10.31.	First draft consultation	✓
4.	2023.11.05.	Final changes and suggestions on thesis before submission	✓
5.	2023.11.08.	Finalizing the thesis after plagiarism check	✓

Grade achieved at the end of the second semester: 5

The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and found suitable to defence,

.....

signature of the supervisor

Signature of the student: ..... Sarah Louise Nolan

Signature of the secretary of the department: ……..……

Date of handing the thesis in..…… ……...