

RESEARCH

Open Access



Survey of farm, parlour and milking management, parlour technologies, SCC control strategies and farmer demographics on Irish dairy farms

Alice Uí Chearbhaill^{1,2*} , Pablo Silva Boloña¹, Eoin G. Ryan², Catherine I. McAloon², Alison Burrell³, Conor G. McAloon² and John Upton¹

Abstract

Background This cross-sectional study describes a survey designed to fill knowledge gaps regarding farm management practices, parlour management practices and implemented technologies, milking management practices, somatic cell count (SCC) control strategies, farmer demographics and attitudes around SCC management on a sample of Irish dairy farms.

Results We categorized 376 complete responses by herd size quartile and calving pattern. The average respondent herd was 131 cows with most (82.2%) operating a seasonal calving system. The median monthly bulk tank somatic cell count for seasonal calving systems was 137,000 cells/ml (range 20,000 – 1,269,000 cells/ml), 170,000 cells/ml for split-calving systems (range 46,000 – 644,000 cells/ml) and 186,000 cells/ml for ‘other’ herds (range 20,000 – 664,000 cells/ml). The most common parlour types were swing-over herringbones (59.1%) and herringbones with recording jars (22.2%). The average number of units across herringbone parlours was 15, 49 in rotary parlours and two boxes on automatic milking system (AMS) farms. The most common parlour technologies were in-parlour feeding systems (84.5%), automatic washers on the bulk tank (72.8%), automatic cluster removers (57.9%), and entrance or exit gates controlled from the parlour pit (52.2%). Veterinary professionals, farming colleagues and processor milk quality advisors were the most commonly utilised sources of advice for SCC management (by 76.9%, 50.0% and 39.2% of respondents respectively).

Conclusions In this study, we successfully utilised a national survey to quantify farm management practices, parlour management practices and technology adoption levels, milking management practices, SCC control strategies and farmer demographics on 376 dairy farms in the Republic of Ireland. Rotary and AMS parlours had the most parlour technologies of any parlour type. Technology add-ons were generally less prevalent on farms with smaller herds. Despite finding areas for improvement with regard to frequency of liner changes, glove-wearing practices and engagement with bacteriology of milk samples, we also found evidence of high levels of documentation of mastitis treatments and high use of post-milking teat disinfection. We discovered that Irish dairy farmers are relatively content in their careers but face pressures regarding changes to the legislation around prudent antimicrobial use in their herds.

*Correspondence:

Alice Uí Chearbhaill

alice.walsh@teagasc.ie; aliceuichearbhaill@gmail.com

Full list of author information is available at the end of the article



© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

Keywords Parlour technologies, Milking management, Farm management, SCC control

Background

Dairy farming contributes hugely to the Irish economy, providing €16 billion of economic value and around 85,000 jobs [1]. In order for the Irish dairy sector to remain competitive in the highly risk-sensitive global food market, it is imperative that animal health and milk quality are prioritised and optimised [2]. Mastitis, defined as inflammation of the mammary gland, is one of the greatest economic costs to dairy farmers [3, 4]. A bulk tank somatic cell count (BTSCC) below 400,000 cells/ml is currently the minimum requirement when supplying milk for human consumption according to European Law [5]. Irish legislation defines an 'SCC breach' as a geometric mean SCC value exceeding 400,000 cells/ml, based on all sample results over the previous three-month period, with at least one sample per month [6]. A further three-month recovery period is provided for corrective action and, if the bulk tank geometric mean SCC still exceeds 400,000 cells/ml, deliveries of milk from that holding must be suspended [6]. A threshold of 200,000 cells/ml is used at the herd level where $BTSCC > 200,000$ cells/ml is often suggestive of a subclinical mastitis problem in the herd [7]. However, it can also indicate contamination of the bulk tank with high SCC milk from lack of identification of clinical mastitis cases [8]. Recent estimates are that 65% of Irish dairy farms have an unadjusted geometric mean BTSCC of $< 200,000$ cells/ml [9]. Milk processors increasingly apply incentives and penalties across a wide range of different milk quality parameters, so it is of utmost importance to producers to maintain low levels of BTSCC [10].

In 2022, the number of dairy cows in the Republic of Ireland amounted to 1.51 million [11], collectively producing 8.8 billion litres of milk [12]; an increase of 7.9% and 20.5% respectively on 2017 figures [13]. In general, as dairy farms grow larger, staff time spent per cow decreases and the throughput of cows at milking increases. Farmers who monitored and participated in milking themselves were found to be an important factor associated with reduced BTSCC [7]. With increasing herd size, there is a pressing need for improved parlour efficiency on Irish dairy farms [14, 15]. However, it is imperative that any future changes in herd size and its impact on parlour efficiency do not contribute to compromised udder health or general husbandry of individual animals. The Irish dairy production system is one of mostly seasonal, pasture-based dairy production to suit the temperate climate [16]. In an Irish study by O'Donovan et al. [17], milking (including herding the

cows to and from the parlour, milking and washing the parlour after the milking process) accounted for 34% of average annual dairy labour input for an average herd size of 77 cows. As labour accounts for one of the highest costs of pasture-based systems [18], technology can be adopted to automate some of the more mundane tasks of dairying. In fact, a reduction of labour is likely the key motivator for farmers to adopt automation technologies [19].

Work practices and technologies that are known to offer the largest labour savings for milking include having one person in the milking pit during mid lactation (i.e. one person conducting and observing milking), with added benefit if entrance or exit gates can be controlled from the pit, and automatic cluster removers (ACRs) [20]. Automation of post-milking teat disinfection may award farmers more time for observing and ensuring proper attachment of clusters on un-milked cows; an intervention which would be of benefit to the overall udder health of the herd if automated to perform in an optimal manner [21, 22]. Other technologies most commonly adopted by Irish dairy farmers include automatic parlour feeders, milk meters and automatic washers of the milking machine and bulk tank [23].

There is a lack of data in the Republic of Ireland on which are the most common milking practices. Internationally, it has been established that good milking management practices are associated with reduced BTSCC [7, 24–26]. Both pre- (washing and/or drying, stimulation and disinfection of teats) and post-milking management practices (disinfection of teats following teat cup removal and rinsing or flushing of clusters) influence the likelihood of contamination of teats with mastitis-inducing pathogens before, during and after the milking process [27]. Therefore, with increased pressure on farmers to reduce their reliance on antibiotic use [28], ensuring hygienic milking practices [26, 29, 30] and appropriate adoption of parlour technologies is imperative. In addition to milking management practices, studies have shown that self-reported farmer attitudes and behaviour can account for as much as 48% of the variation in BTSCC between herds [31].

The objective of this cross-sectional study was to document the farm management, parlour management including parlour technologies, milking management practices, SCC control strategies and farmer demographics on a sample of commercial Irish dairy farms. The resulting survey database, consisting of milk quality data, farm technology and farm management data,

is described in the current paper. The database will be used to assess the impacts of various technologies and management practices on BTSCC in subsequent work.

Materials and methods

Farm technology and management survey

Survey design

A survey was developed and hosted on the SurveyMonkey online platform (Momentive Global Inc., CA USA). The survey was developed in collaboration with a subset of the Animal Health Ireland (AHI) CellCheck Technical Working Group, ensuring systematic development of each section in accordance with the study objectives. Relevant experts and stakeholders were consulted and feedback was acquired at multiple stages throughout the development process. The survey was circulated to experts in the fields of academia, veterinary practice, and behavioural science to ensure that it was fit for purpose in answering the study objectives. The survey was also scrutinised using cognitive interviews with six commercial dairy farmers who had never been exposed to the survey previously and provided feedback and insight into how it would be interpreted by the target audience. Inclusion of a question about whether farms were managed as a partnership was included in the survey as a result of these cognitive interviews. The survey was created in a format compatible with both desktop and mobile devices, and followed Dillman's tailored design survey protocols [32].

The survey consisted of 66 questions across 13 pages with a mixture of multiple choice, check-box, dropdown menu, rating scale and 'textbox' questions. It was divided into five sections pertaining to (i) general contact information, (ii) farm-specific management, (iii) parlour-specific management, including parlour technologies, (iv) cow-specific management, including milking management and SCC control strategies, and (v) farmer-specific questions. Mandatory consent was obtained for sharing herd milk recording, bulk milk and stock data via the Irish Cattle Breeding Federation database (ICBF, <https://www.icbf.com/>).

The farm management section included information on parlour type, parlour manufacturer, mastitis treatment records, numbers of milking cows in 2021 and 2022, frequency of milking and the number of cows culled in 2021 specifically for high SCC. The parlour management and parlour technology information section included questions regarding the normal morning and evening milking times and durations, the number of people milking during peak lactation and the relation of these people to the farmer, the age and characteristics of the milking system, information on technological add-ons, parlour servicing, frequency of liner changes and cluster disinfection practices. The SCC and milking management section

included information on fore-milking, California mastitis testing (CMT), pre- and post-milking management, teat disinfection products, glove-wearing practices and antibiotic and teat sealant application during the 2021 dry-off season. The farmer-specific section included questions about their gender, age, level of education, years spent in the dairy industry, and information regarding their personal feelings towards udder health problems, such as SCC on their farms, who they obtain SCC advice from, their attitudes towards the changing legislation on antibiotic usage at dry-off and their overall satisfaction with the profession of dairying.

A full list of questions and number of responses to each question can be found in Supplementary Materials 1.

Survey circulation

Communications were made via phone and email with members of major Irish milk processors (Arrabawn, Aurivo, Bandon, Barryroe, Clonakilty, Centenary Thurles, Dairygold, Drinagh, Tirlán, Lakeland, Limerick Liquid Milk Producers, Lisavaird, Mullinahone, Kerry, Tipperary). The survey link was circulated to all of their suppliers by text message. The survey was circulated in July 2022 and farmers were given two months to respond. The circulation population considered for the survey were approximately 15,300 specialist dairy farms across 26 counties in the Republic of Ireland [33].

In total, 666 dairy farmers responded to the survey. Of this, 432 respondents fully completed the survey; the remainder submitted surveys which were partially completed. Complete surveys accounted for 64.9% of the total survey responses. The average time spent completing the survey was 22 min and 46 s.

Farm production and BTSCC data

Monthly bulk tank data from January 2021 to August 2022 (processor name, milk supplied in litres (L), fat (%), protein (%), bulk tank somatic cell count (BTSCC, $\times 1000$ cells/ml), total milk solids (kg), and total number of dairy cows) were requested from the ICBF database for the 432 farmers who completed the survey. These data were acquired from respondents' respective milk processors. For the purpose of this paper, these data will be referred to as 'processor data'. Mandatory consent was acquired for this from all respondents at the beginning of the survey. Without granting consent, farmers were unable to access the survey.

Data pre-processing

Data collected from the online survey were exported to spreadsheets for analysis. Responses from the survey were individually reviewed, and answers which were incomplete or implausible were identified and removed

(see data removal). All addresses were inspected and awarded a general county-based data label. Any farms which did not offer adequate address details or postal codes were input into ICBF using their herd number and their county of occupancy was extracted. Specific address information was removed from the dataset prior to analysis.

Data removal

Cleaning of processor data was conducted to identify errors. Three farms were identified as supplying milk to more than one processor and therefore had duplicate milk data. Data for both processors were combined into one record; the data for most columns were identical and averages of the two values were taken where this was not the case. These processor data were then merged with the survey data.

Of the 432 completed responses, 34 farms were removed due to inadequate herd number or contact information in their survey response preventing the extraction of their information on ICBF, 14 were removed as there was no processor data provided to correspond to their survey answers, and one was removed due to inappropriately answered survey questions. Two farms responded to the survey twice. The most recent response for each of these herd numbers was taken as the final response. A total of 376 herds in the dataset supplied milk for 2021 and 381 supplied milk in 2022. Only herds present in the dataset across both years were included in the final analysis, hence, our final dataset contained 376 herds (7,090 monthly observations). A total of 13.0% of respondent herds were removed from the survey dataset during this processing step.

We checked the monthly values for BTSCC that would fall outside the parameters set by O'Connell et al. [34]. These included herds that supplied milk for less than six months of the year (though we corrected this to less than four months for 2022 given that we only had data for eight months), monthly BTSCC values of <20,000 cells/ml and monthly milk volumes of <227.5 L (corresponding to the minimum milk volume collected by milk processors in Ireland). No records were removed for herds milking less than six (less than four for 2022) months of the year nor for having an SCC <20,000 cells/ml, though two farms had one month each where SCC was 20,000 cells/ml exactly. Removing records below the minimum monthly milk collection volume reduced the number of monthly observations by 5.8%.

Data processing

Data were processed using SAS OnDemand for Academics (<https://welcome.oda.sas.com/>). Herds were identified as seasonal calving, split calving or 'other' as per

O'Connell et al. [34]. Seasonal calving herds were defined as herds which calved all cows between February and April and peak milk production occurred in May or June and exceeded the herd's minimum monthly milk production in the herd year by >700%. Split calving herds supplied milk throughout December and January and had peak milk production that exceeded herd minimum milk production for any month by <300%. Any herds that did not meet either of these requirements were classified as 'Other'.

Using the PROC Univariate procedure (SAS OnDemand), herd size quartiles (Q1, Q2, Q3, Q4), from the average total dairy cow numbers of 20 months data (i.e. average number of lactating animals of parity one or greater), were determined from the monthly processor values.

It is important to note that there was no obligation for respondents to answer every question, resulting in varying levels of response rates per question. All percentage response figures presented in the results were calculated on a question-by-question basis. A full list of questions and relative responses can be found in Supplementary Materials 1. Some questions had an 'other' or manual text box input option and these are generally not specifically mentioned in the results section in the interests of highlighting the main survey results.

Results

Respondent overview

The geographical distribution of survey respondents across 24 out of 26 counties in the Republic of Ireland can be observed in Fig. 1.

The average herd size of respondent farms was 131 cows (Table 1). Quartiles by herd size were as follows; Q1 herds had an average of 55 cows (range 9–73), Q2 herds had an average of 88 cows (range 74–105), Q3 herds had an average of 127 cows (range 105–159) and Q4 herds had an average of 253 cows (range 159–847), see Table 2.

Production and BTSCC data

Table 1 shows the average monthly milk production and BTSCC for 2021, 2022 and for both years (20 months) combined ($n=376$). For the 20 months combined, monthly average herd milk production was 5,591 kg of milk solids and average monthly BTSCC was 145,000 cells/ml (Table 1). Milk production data by herd size quartiles can be observed for both years combined in Table 2. Figure 2 shows the temporal trends in monthly BTSCC by herd size quartile showing nadir BTSCC from April to June each year and a rise in BTSCC from September–October onwards.

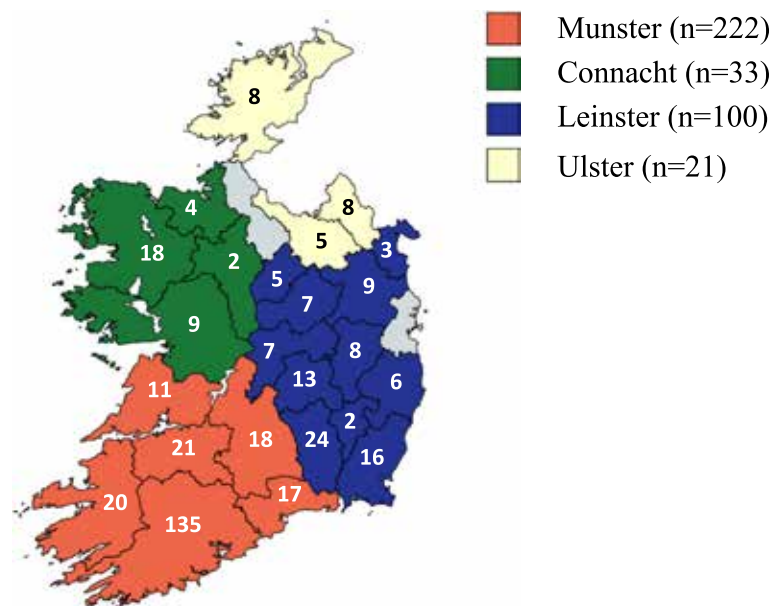


Fig. 1 Distribution of survey respondents by county

Table 1 Monthly average farm bulk milk production data for 12 months of 2021, 8 months of 2022 and combined 20 months (from processor dataset)

Variable Label	2021		2022		Combined	
	Mean / Median ^a	Std Dev / IQR ^b	Mean / Median ^a	Std Dev / IQR ^b	Mean / Median ^a	Std Dev / IQR ^b
SCC (× 1000 cells/ml)	150	103	137	108	145	105
Milk volume (L)	65,082	56,031	75,159	60,745	69,087	58,155
Fat %	4.5	0.5	4.2	0.4	4.4	0.5
Protein %	3.7	0.3	3.5	0.2	3.6	0.3
Total Milk Solids (kg)	5,332	4,561	5,983	4,919	5,591	4,717
Total Dairy Cows	129	92	134	96	131	93

^a Median values for SCC
^b Interquartile range values for SCC

Seasonality

We identified 309 herds as seasonal calving, 29 herds as split-calving and 38 herds as ‘other’. Figure 3 shows the temporal trends in average monthly BTSCC by calving pattern. The median monthly bulk tank somatic cell count for seasonal calving systems was 137,000 cells/ml (range 20,000 – 1,269,000 cells/ml), 170,000 cells/ml for split-calving systems (range 46,000 – 644,000 cells/ml) and 186,000 cells/ml for ‘other’ herds (range 20,000 – 664,000 cells/ml). Median monthly BTSCC varied across all seasonal-calving herds from a minimum of 108,000 cells/ml in late spring/early summer to a maximum of 209,000 cells/ml in autumn/winter. In contrast, median monthly BTSCC fluctuated between 149,000 cells/ml

and 200,000 cells/ml across all split-calving herds and between 137,500 cells/ml and 229,500 cells/ml across all ‘other’ herds. Figure 4 shows the percentage of herds with a monthly BTSCC equal to or below 100,000 cells/ml, between 101–200,000 cells/ml, between 201–399,000 cells/ml and equal to or above 400,000 cells/ml across 12 months of 2021 and 8 months of 2022. The percentage of herds with a BTSCC of ≥ 400,000 cells/ml was greatest in the months of January (6.3%), February (4.9%) and December (7.4%) for 2021 and January (7.8%) and February (4.3%) of 2022. A monthly BTSCC of < 100,000 cells/ml was most commonly achieved in the months of April (40%; 41.2%), May (35.9%; 37.8%) and June (34.6%; 37.5%) for 2021 and 2022, respectively.

Table 2 Monthly average farm bulk milk production data by herd size quartiles across 12 months of 2021 and 8 months of 2022 combined (from processor dataset)

Average Annual Herd Number	Q1 <73 cows				Q2 cows				Q3 106–159 cows				Q4 >159 cows			
	Mean / Median ^a	Std Dev / IQR ^b	Min	Max	Mean / Median ^a	Std Dev / IQR ^b	Min	Max	Mean / Median ^a	Std Dev / IQR ^b	Min	Max	Mean / Median ^a	Std Dev / IQR ^b	Min	Max
Variable Label (Monthly Average Values)																
SCC (x 1000 cells/ml)	134	119	20	1,269	139	110	20	1,072	149	102	29	1,006	152	91	41	770
Milk volume (L)	28,091	15,939	313	78,751	47,419	21,919	230	118,021	68,170	32,260	372	149,420	131,490	75,141	334	554,816
Fat %	4.3	0.4	3.4	6.9	4.3	0.4	3.4	6.2	4.4	0.5	3.4	6.2	4.5	0.5	3.4	6.5
Protein %	3.5	0.3	2.9	4.9	3.6	0.3	2.9	4.7	3.6	0.3	3.0	4.8	3.7	0.3	3.1	4.7
Milk Solids (kg)	2,231	1,224	26	5,854	3,774	1,671	20	9,442	5,486	2,457	31	11,693	10,774	6,066	29	46,617
Total Dairy Cows ^c	55	16	9	73	88	9	74	105	127	15	105	159	253	105	159	847

n = 376; 1,743 herd observations for Q1, 1,779 herd observations each for Q2 and Q3, 1,789 herd observations for Q4

^a Median values for SCC

^b Interquartile range values for SCC

^c Annual average values; 187 herd observations for Q1, 188 herd observations each for Q2 and Q3, 189 herd observations for Q4