Communication preferences and social media engagement among Canadian dairy producers

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ABSTRACT

The objective of this study was to determine communication preferences of dairy producers in Canada. A secondary objective was to evaluate social media engagement of dairy producers. A survey was administered to Canadian dairy producers between March and April, 2015 to collect information on current management practices on their farms. A total of 1,373 Canadian dairy producers responded to the survey, representing a response rate of 12%. The survey consisted of 192 questions; however, only questions regarding producer demographics, importance of information sources, and internet and social media use were evaluated in this study. The primary outcome variables of interest included use of the internet to access dairy information, importance of different sources of information about dairy herd health and management, and use of online search engines and social media platforms. For each outcome, logistic regression analyses were used to investigate associations between the outcome and demographic variables. Veterinarians were viewed as a “very important” source of information by the majority of respondents (79%), whereas milk recording and dairy producer organizations were viewed as a “very important” source of information by 36% of respondents. Other producers (46%) and magazines or newspapers (51%) were commonly viewed as an “important” source of information. Online search engines were commonly used by respondents (94%). Social media was viewed as less important, and had mixed levels of use. YouTube (70%), Facebook (63%), and Twitter (18%) were the most commonly used social media platforms. Eighty

percent of Twitter users reported using the platform to interact with and obtain or share information about herd health management online, which was the highest reported interactivity regarding herd health among all social media platforms. This exploratory study offers insight into the communication preferences of Canadian dairy producers and can be used to facilitate future communication strategies aimed at engaging rural farming audiences across Canada.

Key words: communication, social media, veterinarian, internet

INTRODUCTION

A substantial amount of knowledge exists on prevention and treatment of diseases occurring on dairy farms. However, how to effectively and consistently translate new and existing knowledge into action that leads to the implementation or alteration of management practices remains a challenge on dairy farms (LeBlanc et al., 2006; Ritter et al., 2017). With the rise of electronic communication tools, namely the internet and social media, more modes of communication and dairy-specific information sources exist today than ever before. However, few studies have evaluated how dairy producers seek information online, and it is unclear whether they value or use these information sources to make decisions regarding herd health and management (Franz et al., 2010).

The internet is widely used as a method to communicate information to producers. However, the internet can be a source of misinformation and may not be trusted by all or some producers (Ashlock et al., 2009). It also appears that producers, such as those who participated in recent surveys of California and Kentucky dairy producers, prefer more traditional mechanisms of information dissemination such as newsletters or magazine articles (Russell and Bewley, 2011; Martins et al., 2019). Additionally, there are concerns regarding avail-

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ability of the internet to dairy producers, especially in rural areas (Russell and Bewley, 2011). A component of the internet that has expanded in recent years is social media, which can support the communication of a variety of messages to producers and a variety of other agricultural stakeholders across the supply chain (Hawley et al., 2018; Kaushik et al., 2018). Recent work on the use of social media in agriculture has focused on how different stakeholder groups have used various devices (e.g., smartphones, tablets, computer) and platforms (e.g., Facebook, Twitter) to engage with their respective audiences (Van Dalsem, 2011; Hawley et al., 2018; Kaushik et al., 2018). This growing body of work has demonstrated that social media is innovating online communication for agricultural stakeholders, whereby it widens the scope of peer-to-peer communication, farmer-industry networking, relationships within agribusiness, and engagement with consumers (Chowdhury and Odame, 2013). However, very few studies have explored its use and engagement among producers specifically (Van Dalsem, 2011).

Producers have access to many other sources of information, including veterinarians, extension agents, researchers, other producers, and dairy producer organizations. Many studies have identified that veterinarians are viewed by producers as a reliable and credible source of information (Gunn et al., 2008; Jansen and Lam, 2012; Ritter et al., 2015). Veterinarians also play a key role in implementing changes to improve disease control (Lam et al., 2011; Jansen and Lam, 2012). It is unclear, however, how these additional internet-based sources of knowledge are valued by producers as a source of information for dairy herd management.

To improve the understanding of how Canadian dairy producers access information, a survey was designed to directly ask dairy producers about their preferences. The objectives of this study were to (1) determine communication preferences of dairy producers in Canada and (2) evaluate social media engagement of Canadian dairy producers.

MATERIALS AND METHODS

This project was part of a larger multi-institutional study, the Canadian National Dairy Study (NDS), conducted in collaboration with investigators from 4 Canadian veterinary colleges. Research ethics approval was received from the University of Calgary (Calgary, AB, Canada; REB no. 14-2481), University of Guelph (Guelph, ON, Canada; REB no. 14DC025), Université de Montréal (Montréal, QC, Canada; 15-007-CERES-D), and University of Prince Edward Island (Charlottetown, PE, Canada; REB no. 6006095).

Survey Design and Administration

A survey was administered to all Canadian dairy producers between March and April, 2015 to collect information on current management practices on their farms. Bauman et al. (2018) and Belage et al. (2017) provide a detailed description of the survey design and administration. Briefly, the survey was created to understand key management and disease priorities based on a previously conducted industry-needs assessment (Bauman et al., 2016). The final bilingual (English and French) survey consisted of 192 questions that were divided into sections on producer and farm demographics, biosecurity practices, disease prevalence, calf health, animal welfare, lameness, milking hygiene, reproduction, importance of information sources, and internet and social media use. For the purpose of this study, only questions pertaining to producer demographics, importance of information sources, and internet and social media use were used. The full survey is available online at <http://www.nationaldairystudy.ca/s/NDS-Survey-English.pdf>.

A recruitment letter describing the scope and objectives of the study was mailed to every licensed dairy producer in Canada through their provincial milk marketing organization. Reminders to complete the survey were announced at dairy producer meetings, advertised in dairy organizational magazines and newsletters, and posted on organizational websites and social media (e.g. Facebook and Twitter). The survey was available to be completed online (Qualtrics; <https://www.qualtrics.com/>), as a paper copy, or by telephone. Paper surveys and telephone interviews were entered manually into Qualtrics.

Twitter Data

For respondents who voluntarily shared their Twitter identities, data on all self-reported public Twitter profiles were obtained through a third-party social media analytics company (FollowersAnalysis, Algomom Media LLC; <https://www.followersanalysis.com>). Individual data sets were provided for the 72 Twitter accounts, containing unique data on each individual tweet [unique identification, original tweet URL, date and time stamp, tweet content, type of tweet (original tweet, retweet, reply), type of device used, retweets and likes received, profile URL]. Additional details were provided for each Twitter profile, including verbatim profile biography, a complete list of the unique profiles that were following and being followed by each account, the week-day usage pattern (indicating the frequency of engagement by day of week and time of day), and

the top 7 most mentioned hashtags and usernames. Data, consisting of up to 3,200 verbatim tweets, were available for each account (a limit imposed by Twitter and FollowersAnalysis). Tweets that occurred between March 2014 and June 2016 (1 yr before and 1 yr after survey administration) were requested for each account in an effort to capture a large volume of data for exploratory analysis; the first 3,200 tweets from March 2014 and on were captured.

Statistical Analyses

Data from the survey were downloaded from the survey software (Qualtrics), imported, and cleaned in a Microsoft Excel (Microsoft Corporation, Redmond, WA) spreadsheet. The cleaned data set was then imported into STATA IC16 (StataCorp LP, College Station, TX) for analysis. The primary outcome variables of interest included use of the internet to access dairy information (yes or no), importance of different sources of information about dairy herd health and management (5-point scale ranked from “very important” to “very unimportant”), use (yes or no), and frequency (daily, weekly, < once per week) of online search engines (e.g., Google) and social media platforms (YouTube, Facebook, Twitter, LinkedIn, Instagram), as well as type of use of these platforms (interact with producers; yes or no, and obtain or share information about herd health and management; yes or no). The specific survey questions for these variables are included in Supplemental File S1 (<https://doi.org/10.3168/jds.2020-19039>). For analysis, importance of different sources of information were recategorized to compare positive preferences (“very important” and “important”) to the combination of neutral and negative responses (“neutral,” “unimportant,” and “very unimportant”). Farm characteristics of interest that were evaluated included herd size (≤ 38 , 39–54, 55–87, ≥ 88 lactating cows), use of milk recording (yes or no), and region [Western Canada (British Columbia, Alberta, Saskatchewan, Manitoba), Ontario, Quebec, Atlantic Canada (New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador)]. Respondent demographic characteristics of interest included age (<30, 30–49, and >49 yr) and level of education [high-school diploma or lower, college or Collège d’enseignement général et professionnel (CEGEP), or university degree, and postgraduate degree].

Descriptive statistics were produced for all primary outcome variables, and farm characteristics were descriptively analyzed. A chi-squared test was used for categorical outcome variables if each cell in the contingency table had a value >5; otherwise, a 2-sided Fisher’s exact test was used. Multivariable logistic

regression models were constructed to explore relationships between farm and respondent demographic characteristics of interest and the following outcome variables: importance of different sources of information (“very important” and “important” vs. “neutral,” “unimportant,” and “very unimportant”), use of social media (yes vs. no), and frequency of use of social media platforms (weekly use vs. less than once per week). The assumption of linearity of continuous predictor variables (e.g., herd size) was assessed by plotting the logarithmic odds of the outcome against the variable. If a variable failed to meet the linearity assumption, the variable was categorized. For each model, univariable logistic regression analyses were first conducted to detect differences between each primary outcome variable and characteristics of interest (farm region, herd size, use of milk recording, age, education), with a P -value of <0.20 considered to be significant. Those significant in univariable analyses were included in multivariable models using a manual backward stepwise process ($P < 0.05$). A variable was deemed to be a confounder and retained in the model if it was not an intervening variable and the logs odds of a significant variable in the model changed by at least 20%. Interaction was tested between biologically important variables and remained in the model if significant ($P < 0.05$). Model fit was evaluated using Pearson and deviance chi-squared tests.

Content Analysis

The qualitative data analysis software ATLAS.ti (ATLAS.ti Scientific Software Development, Berlin, Germany) was used to analyze data from Twitter. The WordCruncher tool within ATLAS.ti was used to conduct content analysis to determine the frequency and type of words the respondents used within their personal tweets, retweets, and replies. A specific focus was placed on evaluating the frequency and use of hashtags within the tweets, which are applied by the user writing the tweet as an applicable category or label. The WordCruncher tool processes all verbatim tweets for the frequency of all words used in a given data set, and automatically generates an output describing the frequency of each word. Two of the authors from the present study (S. R. and R. G.) independently reviewed the tweets associated with the top 4 most frequently used hashtags to understand the context and capture the primary themes relating to how each hashtag was used. The coauthors discussed their impressions on the primary themes surrounding the use of each hashtag, came to a mutual agreement on the primary themes, and summarized them in the text; verbatim tweets are not provided to protect the identity of respondents.

RESULTS

Respondents

A total of 1,373 Canadian dairy producers responded to the survey, which corresponds to a response rate of 12% of the Canadian dairy farm population. Approximately 87% (1,202), 9% (119), and 4% (52) of responses were completed online, by paper copy, and over the phone, respectively. A total of 297 (22%) respondents were removed from the analysis because they did not provide information on the number of lactating cows in their herd. The resulting 1,077 respondents (78% of respondents) were retained for analysis. As respondents were permitted to skip any questions they wished, frequency counts were lower for certain questions (descriptive results include the number of producers responding to a question as the denominator).

Demographic Information

Respondents were from across Canada, with 35% (401), 44% (509), 8% (87), and 14% (160) from Ontario, Quebec, Atlantic Canada, and Western Canada, respectively. Farms were larger and produced more milk than the average Canadian farm, with the respondents milking on average 77 cows and producing 837,000 L of milk per year. Most respondents (58%; 674) milked cows in a tiestall barn, and the remainder used loose housing for their lactating-cow housing (42%; 480). With respect to age, most respondents were between 30 and 49 yr of age (49%; 564), followed by >49 yr of age (37%; 435), and <29 yr of age (14%; 163). The majority of respondents had postsecondary education (college or university; 63%; 730), and the remainder had high school or less (35%; 402) or a graduate level degree (2%; 21) as their highest level of education.

Internet and Computer Use

The internet was commonly used to access dairy information, with 87.1% (911/1046) of respondents using the internet for this purpose in 2014. In a univariable analysis, the use of the internet differed by region ($P < 0.001$), with 85.9% (122/142), 80.5% (293/364), 91.7% (424/462), and 92.3% (72/78) of respondents using the internet for dairy information in Western Canada, Ontario, Quebec, and Atlantic Canada, respectively. Internet use also differed in a univariable analysis by education level ($P < 0.001$), with 72.9% (263/361), 94.9% (627/661), and 95% (19/20) of respondents using the internet to access dairy information in an education level of high school or less, college or university, and postgraduate education, respectively. Univariable

analysis showed that herd size was also associated with internet use for dairy information ($P = 0.001$), with 81.4% of producers (205/253) milking ≤ 38 cows, 84.1% of producers (206/245) milking 39 to 54 cows, 92.3% of producers (228/247) milking 55 to 87 cows, and 92.8% of producers (219/236) milking ≥ 88 cows using the internet for dairy information. No differences were present with respect to age ($P = 0.38$). In a multivariable logistic regression model, region, education level, and herd size were associated with internet usage for dairy information. Quebec (odds ratio; **OR**: 3.04; 95% CI: 1.88 to 4.93; $P < 0.001$) had a higher odds of internet usage when compared with Ontario, college- or university-educated respondents (OR: 6.06; 95% CI: 3.84 to 9.55; $P < 0.001$) had a higher odds of internet usage when compared with high school or lower educated respondents, and respondents that milked 55 to 87 cows (OR: 2.81; 95% CI: 1.52 to 5.19; $P = 0.001$) or ≥ 88 cows (OR: 3.69; 95% CI: 1.82 to 7.48; $P < 0.001$) had a higher odds of internet usage compared with respondents that milked ≤ 38 cows.

Importance of Sources of Information

Veterinarians were viewed as a “very important” source of information by the majority of respondents (Figure 1). Respondents’ views on the importance of veterinarians as a source of information (“very important” and “important” vs. “unimportant” and “very unimportant”) did not differ with respect to region, age, or education level. However, responses varied by herd size ($P = 0.04$) in the univariable analysis. Of herds that milked ≤ 38 cows, 39 to 54 cows, 55 to 87 cows, and ≥ 88 cows, veterinarians were viewed as “important” or “very important” sources of information by 93.8% (213/227), 97.8% (224/229), 97.5% (233/239), and 97.8% (230/235) of respondents, respectively. Only herd size was significant in the univariable analysis, with herds milking ≥ 88 cows having higher odds (OR: 3.02; 95% CI: 1.01 to 10.89; $P = 0.04$) of viewing their veterinarians as an “important” source of information when compared with respondents milking ≤ 38 cows.

The majority of respondents viewed milk-recording (e.g., CanWest Dairy Herd Improvement, Valacta; now known as Lactanet) and dairy-producer organizations (e.g., Dairy Farmers of Canada) as “very important” sources of herd health and management information. No differences were found with respect to age, region, herd size, or education levels of respondents.

Other producers were commonly viewed as an “important” source of information. This view differed by region in the univariable analysis ($P < 0.001$), with 72.9% (97/133), 74.3% (228/307), 57.3% (229/400), and 66.7% (48/72), of respondents in Western Canada,

Ontario, Quebec, and Atlantic Canada, respectively, viewing other producers as “very important” or “important” sources of information. It also differed by age in the univariable analysis ($P < 0.001$), with respondents aged <30 yr, 30 to 49 yr, and >49 yr viewing other producers as “important” or “very important” sources of information by 82.5% (104/126), 68.2% (309/453), and 57.1% (188/329) of respondents, respectively. Both region and age of the respondents were significant in the final multivariable model. Quebec respondents had lower odds (OR: 0.40; 95% CI: 0.28 to 0.55; $P < 0.001$) of viewing other producers as an “important” or “very important” source of information when compared with Ontario. Respondents aged 30 to 49 yr (OR: 0.43; 95% CI: 0.26 to 0.72; $P = 0.001$) and >49 yr (OR: 0.24; 95% CI: 0.14 to 0.40; $P < 0.001$) had lower odds of viewing other producers as “important” or “very important” sources of information when compared with respondents <30 yr.

Magazines and newspapers were commonly viewed as an “important” source of information. This view differed by region ($P = 0.001$) and herd size ($P = 0.006$) in the univariable analyses. In Western Canada, Ontario, Que-

bec, and Atlantic Canada, magazines and newspapers were viewed as a “very important” or “important” source of information by 70.6% (89/126), 77.3% (243/314), 63.8% (257/403), and 63.4% (45/71) of respondents, respectively. Those milking ≤ 38 cows, 39 to 54 cows, 55 to 87 cows, and ≥ 88 cows viewed magazines and newspapers as “important” or “very important” sources of information by 68.6% (144/210), 62.0% (127/205), 72.1% (160/222), and 77.2% (173/224) of respondents, respectively. Both herd size and region were offered to the multivariable logistic regression model; however, only region was retained in the final model. Respondents in Quebec (OR: 0.51; 95% CI: 0.37 to 0.72; $P < 0.001$) and Atlantic Canada (OR: 0.51; 95% CI: 0.29 to 0.88; $P = 0.02$) had lower odds of viewing magazines and newspapers as “important” or “very important” sources of information when compared with Ontario.

Social Media Use

Survey respondents were asked to report on their use of search engines and a variety of social media platforms (YouTube, Facebook, Twitter, LinkedIn, YouTube,

Figure 1. Ratings on level of importance that Canadian dairy producer respondents (n = 990) placed on each of the following information sources for obtaining information on dairy herd health management. Respondents were permitted to skip any questions they wished; frequency counts were lower for certain answer options.

Table 1. Frequency and proportion of Canadian dairy producer respondents ($n = 915$) using each social media platform, the type of use (interact with producers, obtain or share information about herd health and management), and frequency of use (daily, weekly, less than once per week)

Platform	Use % (n)	Interact with producers % (n)	Obtain or share information about herd health and management % (n)	Frequency of use % (n)		
				Daily	Weekly	Less than once per week
Google (and other search engines)	93.8 (858/915)	NA	53.5 (438/819)	66.0 (70/106)	25.5 (27/106)	8.5 (9/106)
YouTube	70.4 (634/901)	NA	33.5 (212/632)	26.9 (21/78)	35.9 (28/78)	37.2 (29/78)
Facebook	62.7 (572/913)	68.0 (374/550)	35.2 (192/545)	79.9 (294/368)	15.8 (58/368)	4.4 (16/368)
Twitter	17.9 (159/887)	80.0 (116/145)	61.4 (89/145)	60.9 (70/115)	24.4 (28/115)	14.8 (17/115)
LinkedIn	7.7 (67/915)	25.8 (16/62)	13.3 (8/52)	6.2 (1/16)	18.8 (3/16)	75.0 (12/16)
Instagram	6.6 (57/806)	34.7 (17/49)	22.9 (11/48)	50.0 (9/19)	44.4 (8/18)	5.6 (1/18)

Instagram), and whether they used each platform to interact with producers or to obtain or share information about herd health and management (Table 1). Approximately 94% (858/915) of respondents reported that they used Google and other search engines. YouTube (70.4%), Facebook (62.7%), and Twitter (17.9%) were the most popular social media platforms used. Twitter was most commonly used as the platform to interact with producers (80.0%; 116/145) and to obtain or share information about herd health and management (61.4%; 89/145).

Use of social media platforms differed by region ($P = 0.006$), age ($P < 0.001$), and use of milk recording ($P = 0.02$). Social media was reportedly used by 57.9% (62/107), 63.6% (189/297), 71.7% (286/399), and 77.4% (48/62) of respondents from Western Canada, Ontario, Quebec, and Atlantic Canada, respectively. Approximately 88% (107/122), 72.2% (314/435), and 53.1% (162/305) of respondents aged ≤ 30 yr, 30 to 49 yr, and > 49 yr reported using social media, respectively. Social media was also used by 69.1% (518/750) and 58.3% (67/115) of respondents that do and do not use milk recording, respectively. Region, age, and use of milk recording were significant in the final multivariable model. The odds of respondents from Atlantic Canada using social media were 2.3 times (95% CI: 1.16 to 4.38; $P = 0.017$) higher than those from Ontario. Respondents aged ≤ 30 yr were 2.7 times (95% CI: 1.51 to 4.85; $P < 0.001$) and 6.1 times (95% CI: 3.40 to 11.07; $P < 0.001$) more likely to use social media than respondents aged 30 to 49 yr and > 49 yr, respectively. Respondents that used milk recording were 1.6 times (95% CI: 1.07 to 2.52; $P = 0.023$) more likely to use social media than those that did not.

Respondents also provided information on how frequently they used each platform (Table 1). Among all social media platforms, Facebook and Twitter were most frequently used, with approximately 80% (294/368) and 61% (70/115) of respondents reporting

they used each respective platform daily. Frequency of use of social media platforms (daily or weekly vs. less than once a week) differed by region ($P < 0.001$) and age ($P < 0.001$). Social media platforms were reportedly used weekly by 29.9% (32/107), 40.1% (119/297), 46.8% (29/62), and 51.6% (206/399) of respondents from Western Canada, Ontario, Quebec, and Atlantic Canada, respectively. Approximately 66.0% (81/122), 49.9% (217/435), and 28.5% (87/305) of respondents aged ≤ 30 yr, 30 to 49 yr, and > 49 yr reported using social media, respectively. Region and age were significant in the final multivariable model. The odds of respondents from Atlantic Canada and Quebec using social media weekly were 2.2 (95% CI: 1.11 to 4.22; $P = 0.02$) and 2.2 times (95% CI: 1.38 to 3.55; $P = 0.001$) higher than those from Western Canada, respectively. Respondents aged ≤ 30 yr were 1.9 times (95% CI: 1.27 to 2.97; $P = 0.002$) and 4.7 times (95% CI: 2.95 to 7.35; $P < 0.001$) more likely to use social media than respondents aged 30 to 49 yr and > 49 yr, respectively.

Twitter Profiles

Seven percent (72/1,078) of survey participants provided a Twitter username for further analysis. Table 2 presents a comparison of survey participants that provided a Twitter username and the remaining survey respondents in the Canadian NDS by personal and farm-level demographic characteristics. Those that provided their Twitter account tended to be younger, had larger herds, completed a higher level of education, and more likely to be from Ontario.

Approximately 88% (63/72) reported using Twitter to interact with producers, 72% (52/72) reported using Twitter to obtain and share information about herd health and management, and 71% (51/72) reported using Twitter on a daily basis. Upon comparison with respondents that reported their Twitter use but not their username for analysis ($n = 73$), Twitter users

Table 2. Comparison of survey respondents identified as Twitter users ($n = 72$) and the remaining respondents from the Canadian National Dairy Study ($n = 1,077$) by personal and farm-level demographic characteristics

Demographic variable	Twitter users ($n = 72$) % (n)	Study population ($n = 1,077$) % (n)
Region		
Western Canada (British Columbia, Alberta, Saskatchewan, Manitoba)	15.3 (11)	12.6 (136)
Ontario	47.2 (34)	36.7 (395)
Quebec	12.5 (9)	43.5 (468)
Atlantic Canada (Nova Scotia, New Brunswick, Prince Edward Island, Newfoundland and Labrador)	16.7 (12)	7.2 (78)
Unknown	8.3 (6)	0.0 (0)
Age (yr)		
<30	20.8 (15)	13.7 (148)
30–39	40.3 (39)	49.7 (535)
>39	16.7 (12)	36.2 (390)
Unknown	8.3 (6)	0.3 (3)
Education		
High school diploma (or lower)	19.4 (14)	34.9 (376)
College, Collège d'enseignement général et professionnel (CEGEP)	48.6 (35)	47.4 (510)
University, postgraduate degree	23.6 (17)	17.6 (190)
Unknown	8.3 (6)	0.3 (3)
Milk recording		
Yes	83.3 (60)	86.1 (927)
No	16.7 (12)	13.9 (150)
Herd size		
<30	20.8 (15)	25.0 (269)
39–54	11.1 (8)	25.2 (271)
55–87	18.1 (13)	25.4 (274)
≥88	41.7 (30)	24.4 (263)
Unknown	8.3 (6)	0.0 (0)

that provided profile information were more likely to use Twitter to interact with producers [88% vs. 73% (53/73); $P = 0.02$], to obtain or share information about herd health and management [72% vs. 51% (37/73); $P < 0.001$], and to use the platform on a daily basis [71% vs. 44% (19/43); $P < 0.01$]. No differences ($P > 0.05$) between these groups with respect to farm or demographic characteristics were found.

Twitter Engagement

Between March 1, 2014 and June 1, 2016, all 72 respondents sent 70,740 tweets; 42.7% (30,198), 28.8% (20,382), and 28.5% (20,160) were replies, retweets, and originally authored tweets, respectively. On average, respondents tweeted a total of 1,393 times (SD = 2,444; range = 89–3,200; 11 respondents were capped at 3,200 due to a data limit imposed by Twitter and FollowersAnalysis); 30.8% ($n = 429$, SD = 627, range = 79–2,923), 22.1% ($n = 308$, SD = 424, range = 66–2,230), and 20.2% ($n = 282$, SD = 352, range = 45–1,500) were replies, retweets, and originally authored tweets, respectively. Content analysis was used to explore the 70,740 tweets for the frequency of use of different hashtags (Table 3). The top 4 hashtags used were #farm365, #cdnpoli, #dairy, and #bellletstalk, and were found in 3.7, 2.3, 1.8, and 1.7% of all tweets,

respectively. Generally, producers attached #farm365 to tweets that depicted life on their dairy farm or to advocate their pride for dairy farming. Producers used #cdnpoli to contribute to several online conversations happening at the time relating to national and international trade policy and potential concessions Canada would make in their dairy market. Producers tended to use #dairy as a generic hashtag when discussing or commenting on various aspects of dairy management (e.g., economics of the industry, field work, dairy products). Last, producers used #bellletstalk to participate

Table 3. Frequency and proportion of all tweets ($n = 70,740$) from Twitter users in the Canadian National Dairy Study ($n = 72$) posted between March 2014 and June 2016 that included the following most popular hashtags, advisor terms, and herd health terms

Twitter hashtag	No. (%) of tweets
#farm365	2,642 (3.7)
#cdnpoli	1,600 (2.3)
#dairy	1,250 (1.8)
#bellletstalk	1,198 (1.7)
#supplymanagement	734 (1.0)
#ontag	654 (0.9)
#cdnag	498 (0.7)
#agchat	424 (0.6)
#milk	400 (0.6)
#tpp	378 (0.5)
#mentalhealth	360 (0.5)

Figure 2. Line plot depicting the proportion of all tweets ($n = 70,740$) from 72 Canadian dairy producer Twitter profiles that occurred in the morning (0500–1200 h UTC), afternoon (1200–1700 h UTC), evening (1700–2300 h UTC), and overnight (2300–0500 h UTC). Time zone is shown as UTC+0 (coordinated universal time) to account for differences in time zones. Letters a and b are significantly different ($P < 0.05$).

in the popular mental health social media campaign, where they voiced their support for, and concern over, mental health in agriculture.

The time stamp for individual tweets was used to chart the frequency and proportion of tweets made for every hour of every day of the week. Figure 2 provides a visual representation of Twitter engagement in the morning (0500–1200 h UTC), afternoon (1200–1700 h UTC), evening (1700–2300 h UTC), and overnight (2300–0500 h UTC). Time zone is shown as UTC+0 (coordinated universal time), to account for differences in time zones. Twitter engagement was fairly consistent across the days of the week ($P > 0.05$), with the highest on Wednesdays and lowest on Sundays. The morning was consistently the period of least engagement and was significantly lower than the evening and afternoon periods ($P < 0.05$), which had the highest level of engagement.

DISCUSSION

The internet was commonly used among survey respondents (87%) in this study, which is significantly higher than previously reported estimates on internet use that were made from online US surveys conducted in 2005 (38%; Gillespie et al., 2009) and 2013 (47.5%; USDA, 2014). This estimate is likely influenced by the fact that the survey was mainly completed online

(though paper and telephone options were available). Given the increasing rate at which internet-based technology is being adopted in most areas of day-to-day life, it is perhaps not surprising to see increased adoption of the internet on dairy farms. Online access to information was highest among college- or university-educated respondents and those with larger herds.

Veterinarians, milk-recording (CanWest DHI, Valacta; now known as Lactanet) and producer-representative organizations (e.g., Dairy Farmers of Canada), other producers, and magazines or newspapers were viewed as the most important sources of information in this study. These preferences closely align with studies from several other countries, which are summarized by Ritter et al. (2017). A common conclusion across these studies is that veterinarians were viewed as the most important source of information, a finding of this study as well. Interestingly, respondents with larger herds viewed veterinarians more commonly as an important source compared with respondents with small herds; however, this relationship could be confounded by those with larger herds having more frequent contact with veterinarians. The preference for receiving information from other producers is also well documented (Lam et al., 2007; Roche et al., 2015; Swinkels et al., 2015; Ritter et al., 2017), with studies demonstrating that input from other producers influences producers' decisions. Younger respondents in this study particu-

larly valued other producers as a source of information when compared with older producers. These differences might be expected, as younger producers are less experienced, and it has been suggested that producers prefer obtaining advice from peers who are perceived to be equal and those who understand the realities of farming (Roche et al., 2015; Ritter et al., 2017).

With the emergence and popularity of social media, research has begun to explore its use in agriculture (Van Dalsem, 2011; Chodhury and Odame, 2013; Hawley et al., 2018; Kaushik et al., 2018). Among online tools used by respondents, search engines were most commonly used (94% of respondents), and YouTube, (70%), Facebook (63%) and Twitter (18%) were the most common social media platforms used, with the latter 2 most frequently used on a daily basis. These numbers are higher than a 2010 survey of Canadian producers that reported 54% of producers were using social media (Crowley, 2013). Interestingly, while the reported use of Twitter is relatively small, the platform was most frequently used to interact with other producers and obtain or share information about herd health management. This might be explained by the intended purpose of each platform. YouTube is primarily used to obtain information (not to interact) and Facebook often represents an individual's family and close personal network. Therefore, Twitter may be the most obvious mix of professional, social, and personal information (Crowley, 2013). Given its more recent emergence as a communication platform, it is not surprising to see that younger respondents were significantly more likely to use social media platforms. It is interesting to see that those respondents that use milk recording are more likely to use social media, perhaps suggesting they are more likely to be early adopters of technology in general. Research on other agricultural stakeholders has observed similar findings. Chodhury and Odame (2013) concluded that Facebook and Twitter are the most commonly used platforms by agricultural communicators, and they highlighted the ability to curate a personal network and build strong ties and relationships with stakeholders throughout the supply chain as a particular strength of these platforms. Furthermore, recent reports have demonstrated that agricultural communicators and food organizations prefer social media because it allows them to quickly and conveniently communicate with farmers and consumers (Hawley et al., 2018; Kaushik et al., 2018). This work has also emphasized the importance of building social media strategies to integrate both online and offline interactions into a comprehensive communication strategy (Kaushik et al., 2018).

Most studies outlining communication preferences highlight social media as an emerging tool (Ritter et

al., 2017), yet raise concerns over credibility (Ashlock et al., 2009; Chowdhury and Odame, 2013), accessibility in rural areas (Russell and Bewley, 2011), and its potential to be overwhelming and impractical (Ellis-Iversen et al., 2010; Garforth et al., 2013). Despite these limitations, social media platforms offer producers an opportunity to network, access information, inform others, and interact with fellow producers and consumers (Crowley, 2013; Hawley et al., 2018). Other recent studies explore how social media use is related to on-farm management and outcomes; Winder et al. (2018) reported that the use of local anesthetic when disbudding calves was associated with social media activity and high-speed internet access. These results suggest there is merit in understanding how producers seek information on social media in an effort to influence or inform on-farm practices. However, few studies have explored the characteristics of dairy producer engagement on Twitter.

Overall, Twitter engagement was mixed, with an account tweeting anywhere from 89 to 3,200 times over the 3-yr period (capped at 3,200 due to a data limit imposed by Twitter and FollowersAnalysis). Based on this engagement, and the large range of accounts each respondent account followed (19–2,200) and were followed by (10–2,850), the data set includes several accounts with low to moderate engagement, and several others with very high levels of engagement. Interestingly, 43% of all tweets were replies, which suggest these accounts are actively engaging in online discussion, as opposed to simply sharing information. While Twitter engagement was highest on Wednesdays and lowest on Sundays, there was little day-to-day variation. However, time of day appeared to be an important factor influencing engagement, with the morning (0500–1200 h UTC) consistently having significantly lower engagement than other times of the day. This is perhaps not surprising given the number of chores (e.g., milking, feeding) that must be done in the morning. This is also the most active time for family and other aspects of business functions. Understanding activity patterns on social media can be useful for implementing targeted communication plans that aim to more effectively disseminate information by selectively targeting periods of highest activity.

The content of tweets was explored to try and gain an understanding of the context in which these producers are using this platform. In general, Twitter appears to be a multipurpose platform for producers, with uses ranging from basic social connection and discussion unrelated to dairy, to advocacy, displays of achievement and pride, outlets for anger, connection with all aspects of the value chain (including government and organizational representatives), dairy-specific discussion and

information, and support for rural communities. A US study interviewed 22 producers about their Twitter use and the gratification associated with its use, and summarized these different types of uses, which included information gathering, leadership, community building and engagement, and business development (Van Dalsem, 2011).

The top hashtags (#farm365, #cdnpoli, #dairy, #bellletstalk) provided interesting insights into some of the more common themes and context. A common use of Twitter among producers in this study was the general commentary on life as a producer. In other cases, tweets were focused on consumers. Twitter was used deliberately as an attempt to reach out to consumers and other stakeholders to inform them about what dairy looks like or to promote dairy products from a nutritional perspective. During the data collection period used in this study, national and international trade and policy discussions were occurring (Trans-Pacific Partnership), which placed dairy as one of the core commodities under negotiation. Not surprisingly, dairy producers were active online by discussing, explaining, advocating, and expressing concern about the latest developments in these trade deals. Another important and interesting hashtag was related to producer mental health. The popular Bell Let'sTalk initiative (<https://letstalk.bell.ca/en/>; #bellletstalk) helped create a platform for mental health globally, and given the research on producer mental health that highlights producers as a particularly high-risk population (Jones-Bitton et al., 2020), it is perhaps not surprising to see the high rate of engagement.

Herd health terms and terms referencing "on-farm" appeared to be used infrequently. However, it is interesting to note that several threads and conversations were found where producers were actively seeking and providing information about herd health management. These were particularly evident when the hashtag #dairy was explored, where commentary on milk quality and animal health was provided.

This exploratory study offers insight into the communication preferences of Canadian dairy producers and how a small subset of producers (a potentially growing population) are engaging in social media (a source of information that should still be considered a secondary source to more traditional methods). As technology becomes more commonplace and innovative, internet access improves in rural communities, and dairy farms become more technologically advanced, our producer population is likely to become more familiar and engaged with online tools. This presents an important opportunity for extension and communication with rural communities, who in some cases, are very isolated. It offers the opportunity for on-farm advisors to support

clients in troubleshooting problems, creating more frequent touchpoints with producers to motivate change and answer questions, and an opportunity to provide support and resources, particularly with respect to issues such as mental health.

There were limitations with this study that may have affected our conclusions. The low response rates may have affected the external validity of this study. However, Bauman et al. (2018) have demonstrated that NDS survey respondents closely match the demographics of the Canadian dairy industry. The survey responses in the NDS are also self-reported and may not necessarily reflect the true practices on the farm due to socially desirable responses and inconsistent question responses. The length of the survey may also have contributed to respondent fatigue, which may have affected the quality of the answers or the respondents' willingness to complete all questions.

The majority (87%) of survey respondents in this study completed the questionnaire online, which may have contributed to selection bias that influenced study results, particularly with respect to preference and use of online and social media methods. While the total number of online, paper, and telephone surveys was documented, a unique variable attributing the method of response to each participant was not created, which prohibited an analysis of the differences between respondents that chose to complete the survey via different means. It is possible that these results may be more inclined to suggest a stronger preference for online communication methods given the proportion of online responses. As a result, these results presented within may not be representative of the broader target population. However, personal and farm-level demographic characteristics for Twitter users and the remaining survey respondents were compared (Table 2) and showed very similar distributions. The personal and farm-level demographic characteristics of nonresponders to questions on preference for different sources of information ($n = 87$) and use of social media platforms ($n = 162$) were also compared with survey responders, and no significant differences were observed, suggesting the results may not have suffered from nonresponse bias within the study. Despite these findings, these results should be interpreted carefully. Further studies investigating the prevalence of use of online tools and platforms are needed corroborate and fully explore the results presented herein.

An additional consideration is that the data presented were 6 yr old at the time of submission of the manuscript. This could be a limitation as it is likely that internet and social media use has changed over time; however, given the relative lack of any information regarding social media and internet use by Canadian

dairy producers, we feel that this serves as an important baseline, even if somewhat historical in nature.

CONCLUSIONS

This study outlines the primary communication preferences of Canadian producers and the level and type of engagement they have with social media. Veterinarians, dairy producer organizations, other producers, and magazines or newspapers were all traditional information sources that were viewed as “very important” or “important.” The rates of internet use for accessing dairy information were higher than previously-reported estimates. This growing engagement online is also reflected in the use of online search engines and social media platforms, although the use of social media platforms is still proportionally low compared with more traditional methods. While the use of social media platforms should still be considered secondary to more traditional information sources, these platforms represent an emerging source of information and online engagement. YouTube, Facebook, and Twitter were most commonly used, and Twitter was most frequently used to interact with and obtain or share information about herd health management online. Producers engaging on Twitter used the platform in different ways, ranging from basic social connection to advocacy, displays of achievement and pride, outlets for anger, connection with all aspects of the value chain, dairy-specific discussion and information, and support for rural communities. This exploratory study offers insight into the communication preferences of Canadian dairy producers, which can facilitate future communication strategies aimed at engaging rural farming audiences across Canada.

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