Adoption Rates of Recommended Practices by Cow-Calf Operators in Canada

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EXECUTIVE SUMMARY

One of the objectives listed in the Canadian Beef Research and Technology Transfer Strategy 2018-23 is to "Measure and monitor adoption of innovations by compiling known adoption rates of various innovations through existing data collection means and enhance measurement of innovation adoption levels where necessary and possible." The Beef Cattle Research Council (BCRC) is committed to achieving this objective through collaboration with provincial and national groups in the National Beef Technology Transfer Network.

Many practices and technologies have been recommended for beef cow-calf producers across Canada for improved productivity, reduced costs, increased profitability and stability for individuals at the farm-level and the Canadian beef sector as a whole. This report is the first of its kind amalgamating adoption rates from various surveys and research studies across Canada. It endeavors to provide a comprehensive understanding as possible on adoption of various cow-calf production and management practices in Canada. This report identifies data gaps, current adoption levels, and trends in order to inform future beef cow-calf extension efforts.

This report examines production benchmarks and adoption of different practices for reproduction, calf management, herd health management, forage and grazing management, environmental factors, feed and nutrition, marketing methods, and on-farm record-keeping. This analysis also identifies producer demographics and preferred sources of information. Potential opportunities for extension are included for each recommended practice, by region, as well as identification of perceived or actual barriers for adoption.

It must be recognized that all survey results are subject to volunteer bias and are not representative samples of the industry. Hence, the adoption rates reported here may be higher than actual given the characteristic of producers that fill out the survey. In addition, response rates are lower in recent surveys compared to historical; while this reflects consolidation and fewer operations there is potentially a larger impact from selection bias. Even studies based on on-farm individual animal audited data, while more reliable, still suffer from volunteer bias in the selection of the farms participating. This does not invalidate the results. Those participating in surveys and studies do provide a trend to guide industry efforts on technology transfer and communication.

Highlights of Canadian Cow-Calf Production and Management Practices

- Over the past thirty years, there has been an increasing percentage of producers utilizing pregnancy checking. There remains an opportunity for even greater uptake, particularly in Atlantic Canada.
- Most calves are polled (86-89% of herds), and castration is generally performed shortly after birth (53-69% of producers).
- The use of pain control is increasing. Those who always use pain control when dehorning ranged between 27-31% and those who use it depending on age and method used ranged from 14-23% in the most recent cow-calf surveys; up from 9% in 2014. Those who used pain control when castrating (either always or depending on age and method) ranged between 10-28% in the most recent cow-calf surveys; up from 4% in 2013/14.
- While most producers use traditional separation at weaning (48-67%); western Canada has seen a shift towards low-stress weaning (two-stage, fenceline, natural combined) from 30% in 2014 to 52% in 2017.
- The proportion of herds reporting vaccination for at least one disease varied by region (70-95%)

- Managing for external parasites is relatively stable across Canada (84-91%) and varies by animal types (73-91%). Internal parasite management is lower (63-82%) across regions and again varies by animal type (63-74%).
- Use of off-site watering systems has increased from 26% in 2001 (Canada) to 43% in Alberta (Alberta Agriculture and Forestry, 2018), 31% reported off-site watering in the 2017 Western Canadian Cow-calf Survey (WCCCS II), and 54% pump water to cattle in Ontario (2015/16). In addition, implementation of riparian area protection has also increased from 46% in 2001 (Statistics Canada, Farm management Survey) to over 70% in Alberta (Alberta Agriculture and Forestry, 2018).

SUGGESTED EXTENSION PRIORITIES BY REGION

It is important that management practices are not used as blanket recommendations for all regions; but where there are geographies with lower adoption rates, investigations into the underlying reasons are explored to explain why.

Across Canada, *Heifer management* on a cow-calf operation can make a significant difference in profitability. Heifer management is one of the areas on a cow-calf operation that can make a significant difference in profitability. Recommended practices such as a breeding season that is no more than 63 days in length, breeding two weeks before cows and feeding heifers separate from cows during the winter, are designed to address rebreeding challenges on heifers. Open three and four-year olds represent a significant opportunity cost as they are either given a grace year and kept in the herd or culled after only producing one calf. Evaluating the cost:benefit and potential changes from adopting one or more of these practices could encourage adoption. Addressing producers who have not experienced the expected results from these practices and having a greater understanding of why could also inform next steps. Heifer management shows opportunity for improvement in all regions across Canada.

Body Condition Scoring (BCS) by visual assessment has increased, while reports of hands-on approaches have declined over the last four years. In Western Canada, the most (73%) producers manage females based on body condition. But in Atlantic Canada, only 33% manage based on body condition, instead preferring to manage based on age. It is recognized that visual assessment is better than none at all. The purpose of BCS is that producers' sort and manage cattle differently to better manage nutritional requirements (i.e. lower BCS cows receive a higher plane of nutrition). Producers that do not manage females separately or see that as a practical option are unlikely to perform BCS. It may be useful to illustrate the accuracy of hands-on BCS compared with visual appraisal, and also promote the ability to combine it with other routine practices. Suggesting producers target a handful of cows to BCS instead of the entire herd may help improve uptake; trialability is a key element of persuasion.

Injection site lesions - the National Beef Quality Audit (2018) suggests that increased use of cattle dart guns may be responsible for the increase in lesions in non-fed cattle from 2010-11 to 2016-17. There was also an increase in lesions in other locations of the carcass (e.g. shoulder) compared to previous years. This presents an opportunity to promote best practices for dart gun use by livestock producers as well as continue efforts aimed at injection best practices. It may be useful to strategically promote these practices prior to vaccination season (pre-calving for cows, spring/fall processing for calves) and during the summer grazing season when cattle may be being treated on pasture with dart guns.

Available data, though limited, would suggest that *forage rejuvenation* has decreased in frequency. More producers reported extending the period between reseeding, or not reseeding at all. Rejuvenation methods such as fertilizer and manure are used on only a small proportion of farms and acres. Producers

are increasingly relying on rented pasture and hay land, which poses barriers to rejuvenating forages. There remains an opportunity to highlight the value of maintaining and improving the productivity of pastures, in addition to hay stands. Producers in eastern regions are more likely to reseed, apply fertilizer, and apply manure, than their western counterparts. This is not unexpected given the risk of reseeding being unsuccessful with higher vulnerability to drought and winter kill on new stands in western Canada reducing the return on investment. In Atlantic Canada, where forage stands have a lower percentage of legumes, there is an opportunity to support inclusion of persistent legumes in extension materials.

Feed testing is employed by 25-60% of producers, with lower rates in Ontario and Atlantic Canada. Communicating the risks associated with feeding low levels of toxins (e.g. nitrate, sulfur, mycotoxin and molybdenum) or not accounting for variations in nutrient quality on cattle performance (e.g. body condition; growth) could address current complacency. Encouraging producers to feed test regularly, even if not annually, may improve uptake – this needs to start with how to take a representative feed sample so that producers are confident in the test results. Providing tools to ensure that producers understand how to utilize feed test results in ration development and demonstrating the benefits of feed testing is key for increased adoption and continued use of this practice.

Most beef farmers do not regularly *test water quality*, although rates are higher in Ontario and Quebec (~30% tested in the last 3-5 years). Livestock illness and death due to poor surface stock water quality in western Canada can fluctuate with drought and other weather events. Creating awareness in producers regarding cumulative effects of nitrate, sulfate, and total dissolved solid levels in water is also critical to prevent toxicities or mineral deficiencies.

Practices with high rates of adoption need to have continual communication on the benefits and drawbacks to provide justification for continued usage. *Extensive winter feeding* is a key example, with increases in adoption nationally from 2006 to 2011. However, the 2016 Census of Agriculture indicates that in-field feeding increased in Ontario, Quebec and British Columbia between 2011 and 2016, but declined in the Prairie provinces where most beef cattle are located. Recent harsh winters requiring more feed, bedding, and shelter likely had an impact on the number of producers undertaking extended grazing, along with a renewed focus on reproductive performance and importance of maintaining BCS over the winter. Or potentially, switching from swath grazing to silage which provides greater nutritional quality and control while still providing a cost savings compared to confinement.

Understanding the drivers of practice change and clearly indicating trade-offs or cost:benefit for various practices allows producers to choose the most appropriate options for their operation at any point in time. Continual evaluation of practice adoption means that ongoing communication is necessary.

In ***Atlantic Canada***, there are a number of practices that have lower adoption rates than Ontario and Quebec. In particular, *restricted breeding seasons, pregnancy checking, and breeding soundness exams*. Use of year-round breeding and therefore a longer calving seasons are evident. Providing strategies to move to a defined calving season and shortening the calving season (to 60-80 d) without negatively impacting conception rates is key. There are several pre-existing extension materials that provide practical strategies to accomplish this goal. Murray et al. (2016) also found that a longer calving season increased risk of pre-weaning calf mortality. Reasons behind the lower adoption of preg-checking could be explored to ensure the existing decision-making tool has winter feeding practices and costs that are appropriate for each region.

Maritime producers cited reasons such as lack of expertise and equipment as barriers to on-farm *breeding soundness examinations*. An alternative is to take bulls to the vet where there are appropriate facilities.

In the Maritimes, one beef test station manages the bulls that 26% of respondents purchase. In 2014, the test station introduced breeding soundness examinations to their protocol. This may have provided an opportunity to motivate producers to explore this practice by demonstrating value and ease of testing.

In ***Ontario***, there is a higher calf death loss due to *scours* in calves born to heifers. At the same time there is a low rate of scour vaccination. The use of *breeding soundness exams* was lower in Ontario than western Canada. Other bull selection criteria (e.g. breed, pedigree) were generally more important than whether or not a breeding soundness examination was performed.

In ***Western Canada***, most calf deaths are due to *dystocia* (calving difficulties) in heifers and unknown causes in cows. There is an opportunity for post mortems of cows to inform the cause of death. However, the low death rate in cows makes it less of a priority for producers.

NEXT STEPS

For the first time significant momentum has been made in completing cow-calf surveys across Canada. This has provided a solid starting point for extension groups to focus on practices that have low or decreasing adoption rates, and to collect missing data. Greater coordination is needed on future cow-calf surveys to develop a list of core questions that can be asked in all regions that would also have consistent analysis and reporting that would allow for comparisons to be made between regions. Response rates have also been dropping with consolidation in the industry. Renewed focus on improving survey responses is needed.

When looking at past trends it becomes apparent that selecting a couple of practices for extension agents to focus attention on can be very effective in raising awareness and increasing adoption over the short term. However, long term communication needs to be maintained and delivered on all practices. Regional variation in environments and production practices result in the cost:benefit of any given practice fluctuating from being positive to negative, potentially changing with market prices, and subsequently appropriate adoption rates will vary across the country. Consequently, producers are continually evaluating if a practice is appropriate for their operation. Messages shared by industry should be distributed through a variety of communication channels on a regular basis. Collaboration with regional extension groups will allow for greater emphasis on topics that have particular relevance to each region. Communication materials developed and "aimed at non-adopters should depend upon the [various] reasons for non-adoption" (Gillespie, Kim and Paudel, 2007).

INTRODUCTION

One of the objectives of The Canadian Beef Research and Technology Transfer Strategy 2018-23 is: "Measure and monitor adoption of innovations by compiling known adoption rates of various innovations through existing data collection means and enhance measurement of innovation adoption levels where necessary and possible." The BCRC is committed to achieving this objective through collaboration with provincial and national groups in the National Technology Transfer Network.

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A variety of technologies and management practices have been available to Canadian cow-calf producers for decades. However, adoption levels vary across the country due to a number of factors, including regional differences such as climate, soil zone, and environmental conditions, which make some practices non-applicable to producers in particular regions (Pruitt et al., 2012). An improved understanding of the adoption of technology and recommended management practices along with the actual or perceived barriers to adoption provides research and extension experts with guidance for improving programs and communications.

General barriers to adopting any practice identified in previous studies include economic constraints, lack of awareness, inadequate labour, perceived non-applicability (Jelinski et al. 2018), and lack of available pasture (Small and McCaughey 1999). Jelinski et al. (2018) suggested producers must perceive a positive economic, environmental, or social benefit from the practice in order to adopt it. Micheels and Nolan (2016) note that a producer's social capital, knowledge network, and absorptive capacity influence adoption rates on Canadian farms. Specifically, knowledge networks have a significant effect on the rate at which agricultural innovations get adopted. Roger's Diffusion of Innovation Theory notes that people's previous practice, felt needs, innovativeness and the norms of their social system will impact the extent to which they will become knowledgeable about the innovation; potential adopters evaluate an innovation on its relative advantage, its compatibility with the pre-existing system, its complexity or difficulty to learn, its trialability or testability, and its observed effects. (BCRC, 2016; Rogers 1983).

Adoption rates can vary within a single region as different management practices influence the cost:benefit. For example, the BCRC "Economics of Pregnancy Testing Beef Cattle" Model shows that adoption of the practice will be influenced by a number of factors including winter-feeding practices and whether cow weight will be maintained or increased. Historical communication effort focused on cost of feed and seasonal price changes for cull cows because they assumed a specific winter-feeding system (confined feeding) and performance for all cow-calf producers - failing to recognize the changes and diversity within the cow-calf sector today.

In addition, it should be recognized that there are diminishing returns from adopting certain practices beyond a certain threshold. For example, the cost:benefit for improving conception rates from 90% to 95% may be positive; but increasing conception above 95% may come at a cost that proves to be more costly than beneficial. Determining where realistic adoption levels are for each practice is difficult as it requires evaluation for individual operations. Decision making tools and calculators can help inform

extension staff about the pros and cons of each practice so that discussions with producers can be valuable even if they are not completely tailored to each operation.

Adoption rates of some recommended practices has remained fairly stable over time, while others, such as extensive winter-feeding in western Canada, have experienced a dramatic increase in adoption in the decade following the discovery of Bovine Spongiform Encephalopathy (BSE) in 2003. This increase was primarily due to economic constraints forcing producers to cut costs. New technology is being introduced, such as the use of drones and remote water station cameras, which will continue to evolve, and metrics to measure adoption have yet to be developed.

AVAILABLE DATA SOURCES

The most comprehensive data sets are the 2016 Census of Agriculture (COA) and the Farm Management Survey (FMS) (2011, 2017 data was largely unavailable for this report), as they are administered by Statistics Canada across all provinces using a consistent questionnaire that captures either 100% of producers or a representative sample across Canada.

In the past, there have been few examinations of adoption rates among Canadian cow-calf producers over time and across management topics. Recent producer surveys including the Western Canadian Cow-Calf Survey (2015 and 2018), the Ontario Cow-Calf Production Survey (2018), and the Atlantic Cow-Calf Production Survey (2018) provide an opportunity to compare current adoption levels to historical benchmarks. The western provinces are reported as one region due to the small sample size of the WCCCS preventing individual provincial analysis, similarly for the Atlantic provinces.

Historical benchmark survey sources include the Alberta Cow-Calf Audit, 1997-98 (including data reported from 1986-88), a survey conducted by Small and McCaughey examining beef cattle management in Manitoba based on data collected in 1997, a questionnaire administered to Ontario cow-calf producers in 1983 by Rogers et al., Statistics Canada data, and several studies suited to specific management topic areas (e.g. calf mortality) (see Table 1 and 2).

Table 1. Cow-Calf Survey Details

Survey	Production year	Responses	Publication Year
Atlantic Cow-Calf Survey (ACC)	2016/17	65	2018
Ontario Cow-Calf Production Survey (OCC)	2015/16	83	2018
Northern Beef Study (Ontario and Quebec)	2015/16	99	Lamothe, 2018
A questionnaire on the health, management and performance of cow-calf herds in Quebec	1995 calving	330	Dutil et al. 1999
Reproductive Efficiency and Calf Survival in Ontario Beef Cow-Calf Herds	1983	225	Rogers et al. 1985
Western Canadian Cow-Calf Survey (WCCCS II)	2016/17	261	2018
Western Canadian Cow-Calf Survey (WCCCS)	2013/14	411	2015
Alberta Cow-Calf Audit	1997-98 1986-88	1,974	1999
Beef Cattle Management in Manitoba	1997	507	Small and McCaughey, 1999

It must be recognized that all survey results are subject to volunteer bias and are not representative samples of the industry. Hence, the adoption rates reported here maybe higher than actual given the

characteristic of producers that fill out the survey. In addition, response rates are lower in recent surveys compared to historical, while this reflects consolidation and fewer operations there is potentially a larger impact from selection bias. Even studies based on on-farm individual animal audited data, while more reliable, still suffer from volunteer bias in the selection of the farms participating. This does not invalidate the results. Those participating in surveys and studies do provide a trend to guide industry efforts on technology transfer and communication.

Cow-calf survey methods are not fully comparable, not only between regions, but within regions historically. Production and management practices have changed in response to market pressures, contributing to differences in animal performance and issues that need to be addressed. Therefore, comparisons made in this report should be considered within the whole scope of the industry at the time data was collected. Existing data gaps and reporting between regions for different recommended practices are identified in the respective sections of this report when possible.

Table 2. Other survey details

Survey	Production year	Responses	Publication Year
Environmentally Sustainable Agriculture Tracking Survey. Alberta Agriculture and Forestry	2015, 2017	500	AAF, 2016, 2018
A typological characterization of Canadian Beef Cattle farms based on a producer survey	2011	1005	Alemu et al. 2016
Examining Record Keeping and Benchmarking Effects	2015	67*	Manglai, 2016
Calf management practices and associations with herd-level morbidity on beef cow-calf operations in Alberta	2013	267	Murray et al. 2016
A benchmarking study of animal care practices related to cattle pain and stress in cow-calf operations in Western Canada	2015/16	109*+15 interviews	Moggy, 2016
Record Keeping and Management on Western Canadian Farms and Ranches	2017/18	62*	Micheels et al. 2018
Beef cattle husbandry practices across Ecoregions of Canada in 2011	2011	1,009	Sheppard et al. 2015
Survey of Saskatchewan beef cattle producers regarding management practices and veterinary service usage	Nov 2012-April 2013	537 total 362 long 175 short	Jelinski et al. 2015
Survey of western Canadian beef producers regarding calf-hood diseases, management practices, and veterinary service usage	June 2010	310	Waldner et al. 2013
Cow attributes, herd management, and reproductive history events… in Western Canada	‘01 breeding ‘02 calving	203 ~30,000 cows	Waldner and Guerra, 2013

*Studies that were part of the Western Canadian Cow-Calf Surveillance Network

Readers are directed to the full survey results in the source documents for definition of terms and details for each.

FARM AND PRODUCER DEMOGRAPHICS

The 2016 Census of Agriculture reported 59,784 of farms have beef cattle with a mix of 89% cow-calf (53,236 farms), 5% stocker (2,921 farms), and 6% finishing (3,627 farms), although some farms may be integrated with multiple stages of beef production. While the Canadian beef herd inventory has remained relatively steady, there are fewer farms reporting beef cattle than in 2011 which means farms are larger with an average number of cattle per farm at a high of 255 head per farm in Alberta and a low of 55 head per farm in Atlantic Canada (Canfax Research Services, 2017).

Table 3. Beef cow herd size

Herd Size	Farms Reporting	Beef cows	% of Farms Reporting	% of Beef Cows
<47 head	20,856	235,250	39%	6%
47-122 head	14,351	544,531	27%	15%
122-272 head	9,745	854,111	18%	23%
273-527 head	5,052	866,248	10%	24%
>528 head	2,797	1,154,088	5%	32%

Source: 2016 Census of Agriculture

According to the 2016 Census of Agriculture, most of Canada's beef cattle operators are over age 55, male, and sole operators (Canfax Research Services, 2017). Multi-generational farms represent 12% of beef cattle farms reporting in 2016, but only 6.8-19% of these multi-generational farms have a written succession plan. While this is higher than the average of 6.7% for all beef farms, it is still low. Among the beef farms with written succession plans, 97% of the successor(s) were family members. The highest rates of written succession plans were on multi-generation farms in Quebec (31-35%), followed by Alberta (8.5%) and Saskatchewan (7%). The proportion of farms with a sole operator under 35 years of age, at 6.8%, is almost equal to the percentage of farms with written succession plans (6.7%).

Table 4. Age of beef producers by province

% of Beef Cattle Farms Reporting	Canada	BC	AB	SK	MB	ON	QC	AP
<35 years of age	6.8%	3.7%	6.8%	8.4%	8.1%	6.4%	4.7%	4.4%
35-54 years of age	30.7%	24.0%	31.2%	32.9%	33.7%	28.1%	33.4%	25.6%
>55 years of age	50.6%	58.0%	50.0%	47.5%	46.0%	53.9%	47.8%	60.4%
Multi-generational operators by age								
<35 years & 35-54 years	1.8%	2.1%	1.8%	1.8%	1.9%	1.7%	2.2%	1.4%
<35 years & >55 years	1.7%	1.7%	1.5%	1.4%	1.8%	1.7%	2.5%	1.7%
35-54 years & >55 years	8.1%	10.0%	8.2%	7.5%	8.1%	7.8%	9.0%	6.3%
<35 years, 35-54 years & >55 years	0.4%	0.5%	0.4%	0.5%	0.5%	0.4%	0.5%	0.2%
<35 year of age (on all operations)	**10.7%**	**8.0%**	**10.6%**	**12.1%**	**12.2%**	**10.2%**	**9.8%**	**7.7%**

Source: 2016 Census of Agriculture

An older demographic of producers means there is expected to be a large shift in operators in the next two decades, leaving the millennial generation (born between 1982 and 1994[1]) to manage farms (Jelinski et al., 2018). Millennial operators have a preponderance for technology and are considered to be digitally savvy. Veterinarians have noted that millennials tend to research disease or production issues before

[1] There is disagreement on when the next generation (Gen Z) starts with dates proposed of 1995, 2000 and 2004. Statistics Canada defines generation Z starting in 1993 although other researchers define it loosely as mid-1990s to the mid-2000s.

seeking advice (Jelinski et al., 2018). Extension organizations may wish to leverage the characteristics of this future demographic in order to create effective strategies.

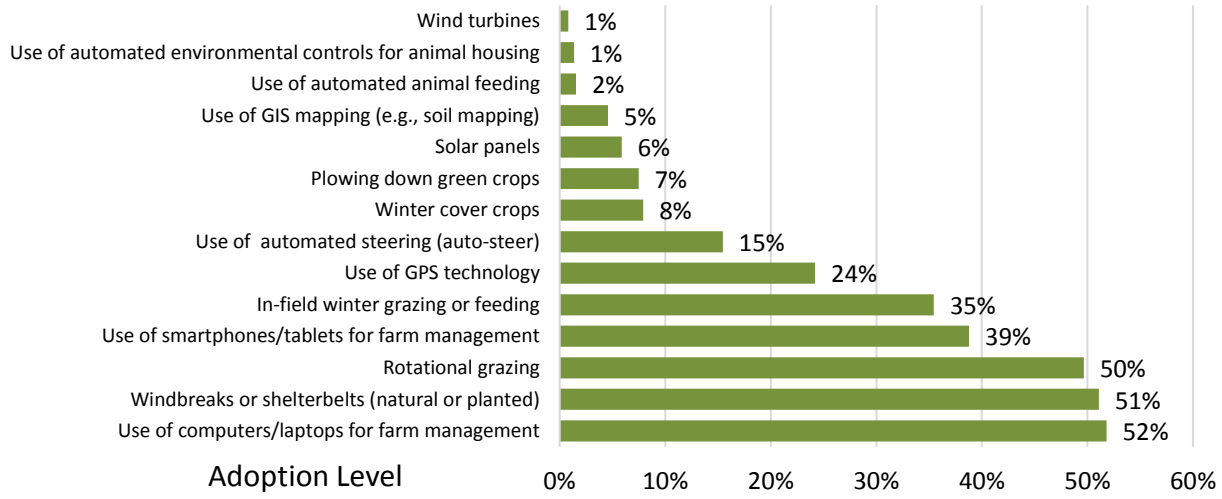
USE OF TECHNOLOGY

In 2016 over half (52%) of beef cattle farms indicated that they use computer or laptops for farm management (COA, 2016). Over one third (39%) of beef farms indicated they use smartphones or tablets for farm management. GPS technology - used in precision farming for field and yield mapping guide tractors, variable rate application allows producers to work during low visibility conditions such as fog and at night - is being used on 24% of beef cattle farms. Auto-steer technology, which saves energy and time by reducing the overlap between machinery passes, is used on 15% of beef cattle farms.

Farms with operators over 55 years of age account for the largest number of farms (50.6%) but have the lowest technology adoption rates. Farms with operators under 35 years of age, both on farms with single and multiple operators (10.7%), have higher rates of technology adoption.

In general, Alberta and Saskatchewan have the largest proportion of beef cattle farms (31% and 22% respectively) and the highest rates of technology adoption. In contrast, British Columbia (7%), Quebec (7%), and the Atlantic provinces (3%) have the smallest proportion of beef cattle farms and lower rates of adoption.

Figure 1. Adoption levels on Canadian beef cattle farms



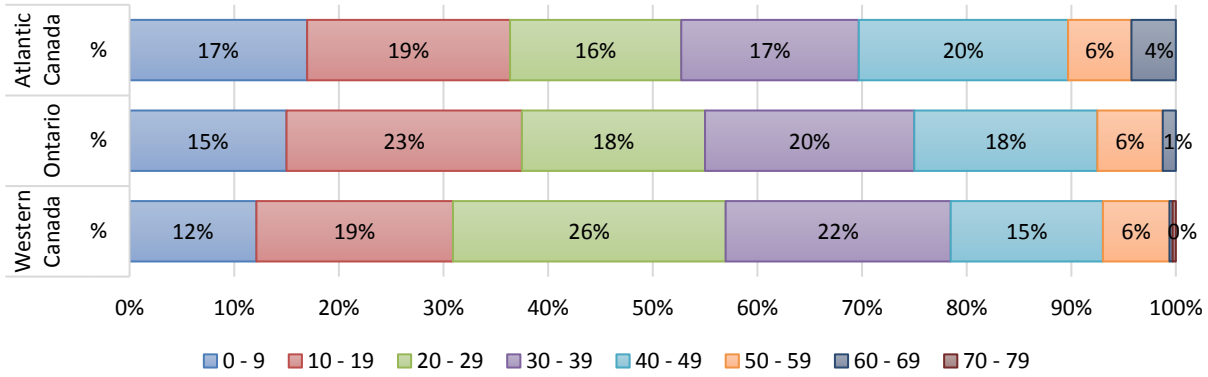
Source: Census of Agriculture, 2016

Farm size, age of operator, and years of experience all affect a producers' willingness to adopt a practice (Pruitt et al., 2012). Larger farms tend to have economies of scale that encourage adoption. However, this is not always confirmed in the literature. Older and younger producers tend to have lower adoption rates of recommended production and management practices (Jelinski et al. 2018), potentially due to labour challenges when younger producers are working off-farm and older producers are slowing down for retirement.

Figure 2 explores the number of years of experience respondents had in the three survey regions. Pruitt et al. (2012) suggested that a producer's self-expectation of whether or not they would be farming for ten more years as impacting adoption levels of US cow-calf producers. If producers are not planning on farming for the next ten years (also known as the 'horizon problem'), they are less likely to adopt some

practices, such as rotational grazing, that require a longer time to pay off the upfront investment of fence and water infrastructure.

Figure 2. Producer years of experience by region



Sources: ACC, 2018; OCC, 2018; WCCCS II, 2018.

In the recent WCCCS II, the highest level of education attained was fairly even across all decision makers, with 36% of operators reporting completing grade school/high school/GED, 32% having a diploma or certificate from a technical or business college, and 32% holding a university undergraduate and/or graduate degree (other surveys did not ask this). Pruitt et al. (2012) stated that in the U.S., the next generation of producers is anticipated to be more educated, which will provide new opportunities and challenges for technological transfer and extension as new practices emerge. Ward et al. (2008) found age, education and farm objectives positively impact adoption on cow-calf operations. Henderson's (2014) habitat conservation survey supported the idea that young ranchers with some formal education and greater awareness of conservation practices were more willing to adopt practices.

The 2016 Census of Agriculture noted that the percentage of beef producers with off-farm work has declined to 47.1% in 2015 compared to 50.1% in 2010 (Canfax Research Services, 2017). The proportion of producers with off-farm work is largest for those under 35 years old (65.6%) and lowest for those over 55 years old (35.6%). It's unclear what effect off-farm employment has on adoption rates. Additional capital may enable producers to adopt some practices, however a lack of time may discourage producers from adopting others.

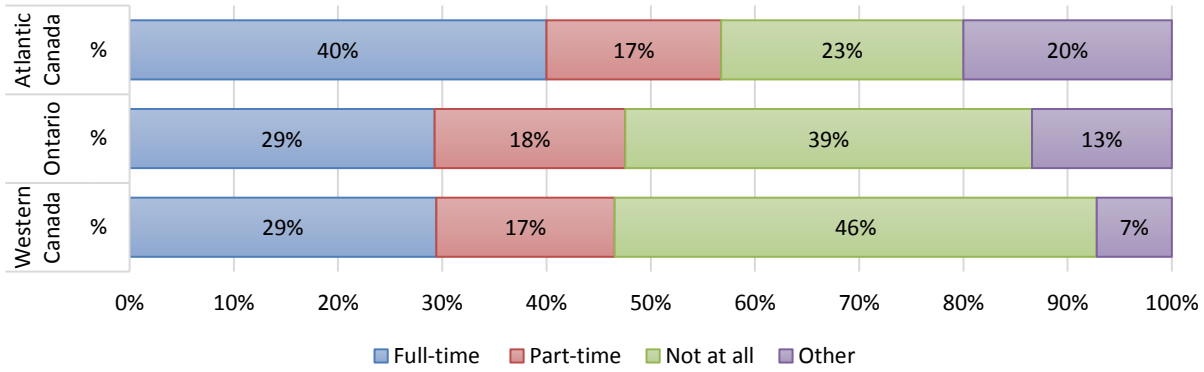
Table 5. Percentage of cattle operators' time contributed to the agriculture operation

	More than 40 hours /week	30 - 40 hours /week	20 to 29 hours /week	Less than 20 hours /week	Received off-farm income
All age classes	43.3%	16.4%	17.1%	23.2%	47.1%
Under 35 years of age	37.1%	15.1%	18.4%	29.4%	65.6%
35 - 54 years of age	42.2%	15.5%	18.0%	24.3%	60.2%
55 years of age and over	45.0%	17.2%	16.3%	21.5%	35.6%

Source: 2016 Census of Agriculture

Figure 3 demonstrates a breakdown of full-time, part-time, no off-farm employment, and other (e.g. contract work) from recent cow-calf surveys. In northern Ontario, survey responses showed that 40% work full-time and 36% work part-time; in northern Quebec, 43% and 52% producers work full- and part-time, respectively (Lamothe, 2018).

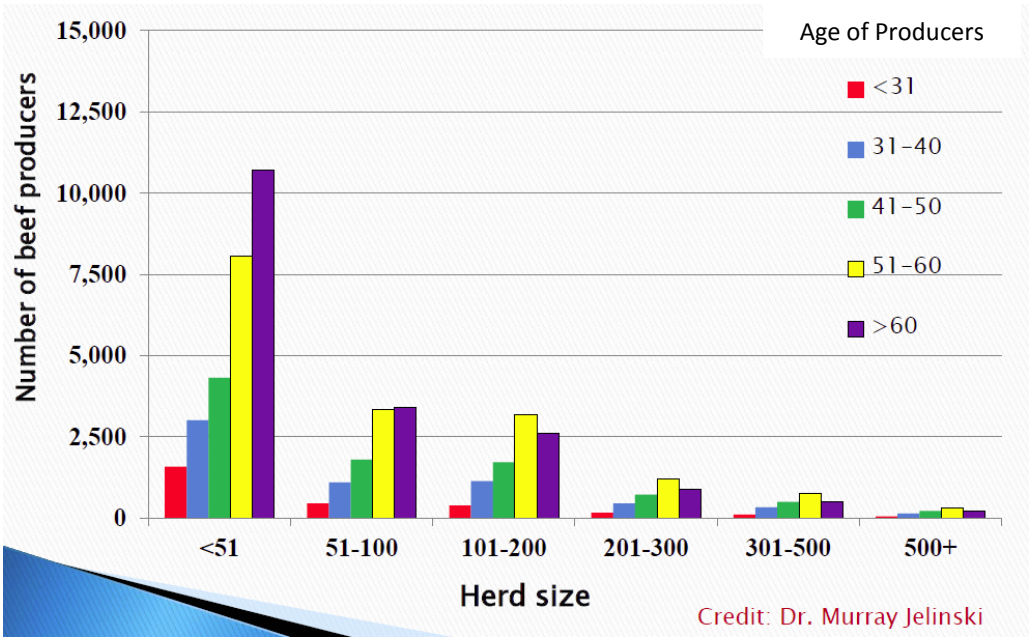
Figure 3. Proportion of off-farm employment across regions



Sources: ACC, 2018; OCC, 2018; WCCCS II, 2018.

Farms that had an increased herd size and farms with two or more operators showed an upward trend of adoption rates (Jelinski et al. 2018). Jelinski et al. (2018) suggested that economies of scale as well as a greater availability of labour could encourage greater adoption of practices.

Figure 4. Western Canadian beef producers by herd size and producer age, 2016



MOTIVATORS AND BARRIERS FOR ADOPTION

Information on the pros and cons of technology adoption and extension efforts by a variety of organizations is important because producers are heterogeneous; they come with different levels of experience and knowledge entering the industry or looking to make improvements to their operations. Insufficient information about technology limits producers' ability to determine the impact a technology or practice may have on profit, which leads to uncertainty on how it will impact production and its relationship with other inputs (Gillespie et al., 2008). Adoption can be constrained by the current phase of the operation, such as starting out or expanding when the availability of capital investment is limited.

A study in the early 1980s concluded that producers may be well-informed and even eager to adopt a new technology, but economic constraints may preclude adoption – for example, limited working capital to make an upfront investment in new technology or an inability to cashflow the investment before it pays for itself. This is a challenge particularly for smaller operations where economies of scale work against them investing in infrastructure due to long pay-off periods. Gillespie et al. (2008) also noted that even if a practice was economically viable, producers need to be motivated to adopt. Specifically, three things are needed for adoption: (1) a positive impact on net return; (2) a willingness to alter management practices; and (3) applicability to the operation. If a producer is perceived to be no better off after adopting the technology (economically, environmentally, or socially), there is little incentive to change the status quo. Since producers face multiple options and trade-offs within their operation, there must be a favourable attitude present and willingness to alter current practices. There is tremendous diversity within the cow-calf sector, and some practices are simply unsuited for certain operations.

Sheppard et al. (2015) reported that some practices, for example winter grazing, are adopted by producers and forms a basis that leads to adoption of other practices, such as later calving. For example, later calving operations (May to August) are 2-5x more likely to finish their own cattle than producers who reported calving before May (Sheppard et al. 2015).

Concurrently, producers must have a willingness to alter current practices, which may be related to their perception of applicability. Examples of non-applicability would be unsuitable forage or too few animals to make rotational grazing effective. Unfamiliarity with the technology or practice, a lack of economy of scale (which results in new investments being paid off more quickly), and the availability of labour (unable to effectively utilize the new technology) also contribute to the lack of adoption of new technologies and management practices.

Producers' Sources of Information

According to the 2016 BCRC producer survey (506 responses, 58% producers across all sectors), the information sources most frequently accessed were: *magazines and newspapers, websites and blogs, social media, and BeefResearch.ca*. Producers reported being most influenced by veterinarians, peers, and producer associations (BCRC, 2018b). Jelinski et al (2015) surveyed 362 cow-calf producers in Saskatchewan and found that veterinarians were seen as the primary source of nutritional information and animal health advice.

Lamothe (2018) reported that 71% of producers in both northern Ontario and northern Quebec participate in workshops, training or conferences. Producers in both provinces selected the internet as their preferred source of information. Northern Ontario producers next favoured extension services, industry or specialty company representatives, and finally agronomists, as their preferred information sources (Lamothe, 2018). Following the internet as the top source, Quebec producers chose industry magazines, agronomists, veterinarians, and lastly, extension services, as their preferred information resources (Lamothe, 2018).

Producers preferred sources of information has shifted over the last decade. Sheppard et al. (2015) surveyed 1,009 beef operations across Canada (based on 2011 production practices). As of 2011, the preferred sources of information were: producers' own experience, farm print media, other beef producers, newsletters from producer organizations and beef producer meetings. The least preferred sources were webinars, university/colleges, email, animal health companies and supplier meetings. Henderson (2014) looked specifically at adopting rangeland management and conservation practices and found results similar to those of Sheppard: 69% of Saskatchewan ranchers looked to their friends and

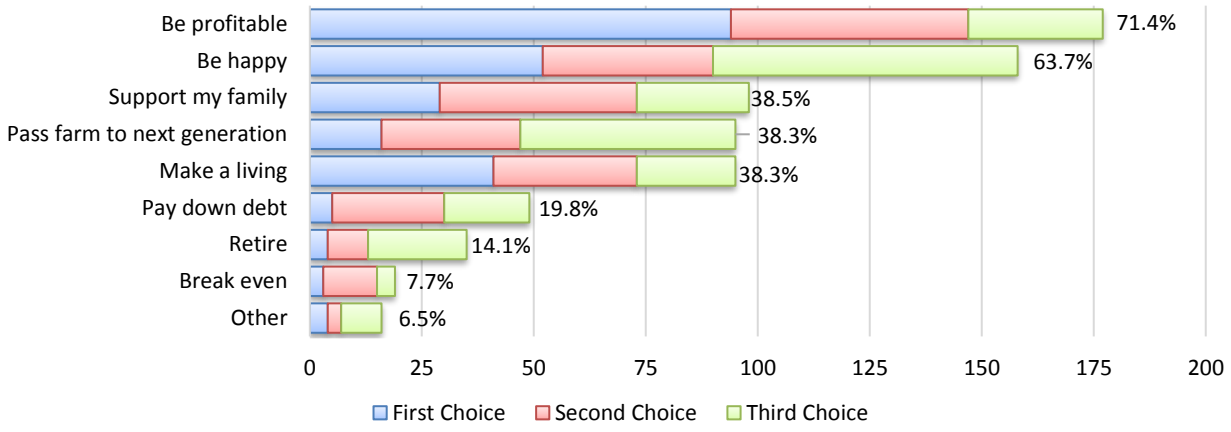
family as a source of information, 67% used their own experience, 48% chose internet/newspapers/magazines, and 40% used workshops or education as their preferred source of information.

It is recognized that producer adoption of technology for communication (e.g. internet, email and webinars) has seen a significant improvement since 2011 as indicated in the 2016 Census of Agriculture, where over half (52%) of beef cattle farms indicated that they use computer or laptops for farm management. Thirty-nine percent of beef farms indicated they use smartphones or tablets for farm management. The more current survey's (BCRC, 2018b, Jelinski et al. 2015) do see an increase in digital delivery of information that can be customized to address individual producer interests.

OPERATIONAL GOALS AND RISK TOLERANCE

The WCCCS II (2018) surveyed producers about their operational goals, and responses are seen in Figure 5. More than half of the producers cited being profitable followed by being happy as their main goals.

Figure 5. Operational goals in order of preference, Western Canada



Source: WCCCS II, 2018

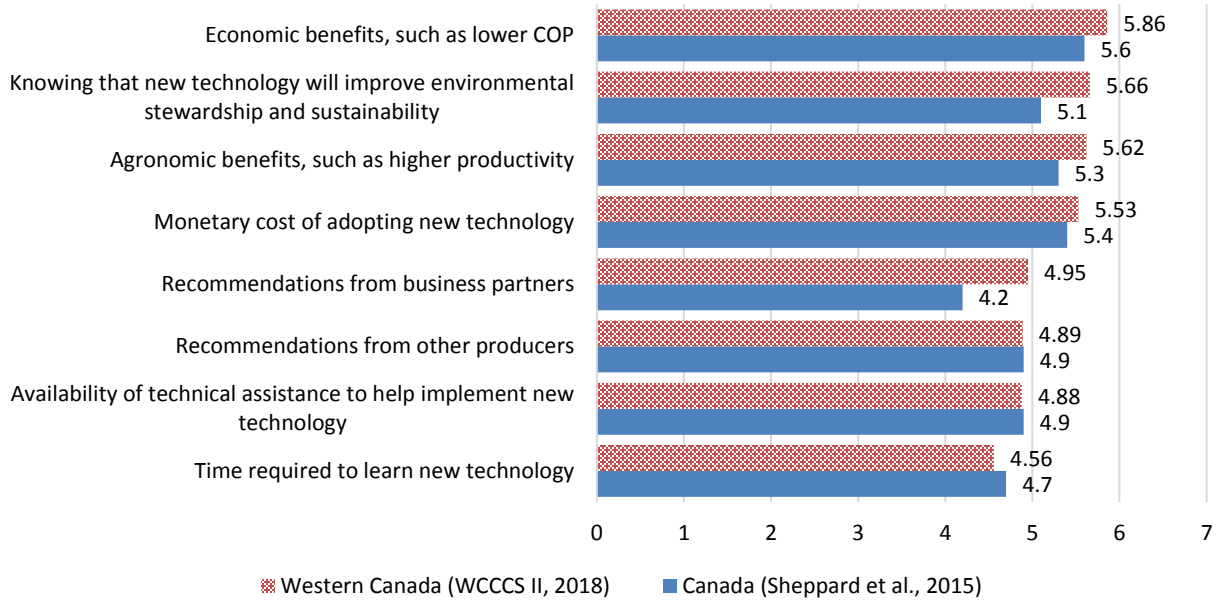
Figure 6. Producers self-ranked risk factors

(1 = completely disagree, 4 = neutral, 7 = completely agree)
*Response differed by operation type and this was a lower value for non-finishing beef operations; a simple average of the regions is provided
Sources: Sheppard et al., 2015; WCCCS II, 2018

Sheppard et al. (2015) reported that factors affecting adoption were based on risk tolerance. The WCCCS II (2018) also assessed risk tolerance, and a comparison of results from both surveys are depicted in Figure 6.

In general, Sheppard et al. (2015) found most producers are willing to take risks to be successful; but are cautious about new ideas. There is a greater focus on preventing large losses than missing substantial gains which may result in a reluctance to adopt new things until they have been seen working for others. Results from WCCCS II (2018) indicate producers are more willing to take risks and still concerned about large losses, but generally less cautious and less worried about waiting to see how other producers adopt practices. Producers also identified factors governing change in surveys analyzed by Sheppard et al. (2015) and WCCCS II (2018), as shown in Figure 7.

Figure 7. Producers self-ranking change factors



Sources: Sheppard et al. 2015; WCCCS II 2018 (1 = completely disagree, 4 = neutral, 7 = completely agree)

Results from both surveys are relatively similar and demonstrate that producers place a lot of emphasis on the potential economic and environmental benefits when deciding whether to adopt new practices. Respondents from the WCCCS II (2018) place greater emphasis on whether a practice is recommended by a business partner than respondents from Sheppard et al. (2015). Similarly, producers from the Sheppard et al. (2015) demonstrated more concern about the time it may take to learn a new technology.

The WCCCS II (2018) survey also asked producers to self-rank additional approaches to operational changes, other than those identified in Figures 6 and 7. The results are in Table 6.

Table 6. Producers self-ranked approach to operational change, Western Canada

Approach to change	***Rank****
I actively seek out information to continually learn about new ideas or ways of doing things.	5.8
I trust recommendations based on scientific studies and research results.	5.2
I would like to adopt new practices to benefit my operation but can't because of time, labour, facilities, financial constraints	4.9
I am concerned about negative perceptions if I adopt a new or uncommon way of doing things	2.7

Source: WCCCS II, 2018 **1 = completely disagree, 4 = neutral, 7 = completely agree*

It's useful to note that WCCCS II (2018) respondents ranked learning and developing awareness of new ideas or methods highly at 5.8, just slightly less than their self-ranking value of 5.9 for economic benefits. Producers also tend to trust recommendations that are science-based. All of these producer-identified rankings validate current BCRC and others' extension strategies which include providing information on new ways of doing things that are backed by scientific research.[2]

Sheppard et al. (2015) provides a general overview regarding risk and change in 1,005 beef operations, however there is tremendous diversity in the beef industry with a variety of operation sizes, commodities grown (e.g. beef and grain), sectors (e.g. cow-calf, backgrounding, finishing), and reliance on beef as a revenue stream that all impacts adoption rates. Alemu et al. (2016) analyzed Sheppard et al. (2015) data classified producers into eight different types of beef farms. He assessed adoption factors for new production technologies by farm type, which is below in Table 7.

Table 7. Factors affecting adoption of practices by farm-type

ID#	Farm Description	Monetary cost of adoption*	Knowing that adoption will improve environmental stewardship and sustainability	Time required to learn the new technology
	Mean (n=1005)	**5.4**	**5.1**	**4.7**
1	Small-scale, part-time cow-calf	5.2	5.0	4.5
2	Cow-calf to finish	5.8	5.1	5.0
3	Larger backgrounding & finishing	5.2	4.4	4.7
4	Diversified cow-calf	5.4	5.3	4.9
5	Extensive cow-calf backgrounding	5.5	5.2	5.1
6	Large cow-calf backgrounding	5.6	5.1	4.6
7	Crop-beef mixed	5.3	5.2	4.9
8	Large finishing	6.0	5.0	4.5

*Ranked on a scale of 1 to 7, where 1= "least important" and 7= "most important". All results were significant.
Source: Alemu et al., 2016

[2] While producers may not go directly to university or college when seeking information (in Sheppard's survey producers ranked university and college second last for a source of information), they do trust information from academic institutions.

Generally, monetary cost of adoption was more important for all farm types than time required to learn the new technology. Environmental benefits derived from adoption were the next most common factor affecting adoption for all farm types, except for larger backgrounding and finishing operations, who prioritized time required to learn the technology over environmental benefit.

Environmental Farm Plans (EFP) were a provincial and federal concept initiated in the mid-2000's and were designed to encourage all Canadian farmers, regardless of sector, to identify and address environmental concerns on their farms. Table 8 shows uptake of EFPs by all farmers in 2011 across Canada.

Table 8. All Canadian farms with a completed Environmental Farm Plan as of 2011

Region	***Completed EFP***
Canada	**35%**
Atlantic Region	53%
Quebec	72%
Ontario	38%
Manitoba	28%
Saskatchewan	26%
Alberta	23% (43% had an EFP in 2018; AAF, 2018)
British Columbia	21%

Source: Statistics Canada, 2011 (Farm Environmental Management Survey)

If producers completed an EFP through a provincial-federal cost share program (e.g. Farm Stewardship Program), they were often eligible for financial assistance to implement environmental best management practices. Cost-sharing programs motivated producers who viewed expensive improvements as a barrier to implement improved environmental stewardship. For beef producers, financial assistance was offered for those choosing to make improvements to soil management, wintering practices, wildlife habitat, grazing management, water and wetland habitat conservation, species at risk habitat, and invasive species management, to name a few. Table 9 demonstrates the proportion of Canadian farmers, irrespective of sector, with an EFP who received financial assistance to implement a practice. At 39% nationally, there are many producers who are eligible for financial assistance who are not necessarily taking advantage of it.

Table 9. Farmers with an Environmental Farm Plan who adopted practices with financial assistance

Region	***Received Assistance to Adopt Practice***
Canada	**39%**
Atlantic Region	39%
Quebec	22%
Ontario	48%
Manitoba	49%
Saskatchewan	53%
Alberta	34%
British Columbia	45%

Source: Statistics Canada, 2011 (Farm Environmental Management Survey)

It would be useful, in a future study, to identify how programs such as the EFP/Farm Stewardship Program effected and maintained change over time for beef producers implementing environmentally-based recommended practices and producer attitudes toward the programs.

INTERPRETING TEXT, TABLES, AND CHARTS

The remainder of this report deals with production benchmarks and adoption levels of recommended practices for reproduction, calf management, herd health management, forage and grazing management, environmental factors, feed and nutrition, marketing methods, and on-farm record-keeping. Within each distinct section are tables, figures, and a discussion of barriers and opportunities for each category.

REFERENCE YEARS

Please note that when surveys are referenced within text (e.g. Alberta Agriculture and Rural Development, 1997-98), that is the reference to the year the information was published as per standard citation methods. When surveys are referenced within tables (e.g. Alberta 1986-89) the year(s) refer to the production season being reported on. This table citation method was modified to reflect data from multiple years published in one resource, such as the Alberta Agriculture Cow-Calf Audit. This also allows the reader to distinguish between the years the study was published (i.e. Alemu et al., 2016) and when the survey data was gathered (2011).

In the following charts, where possible, arrow symbols are included to show a general trend for adoption of a recommended practice in a particular region or in all regions if data allows.


The trend is increasing, a desirable outcome (e.g. increased weaning weights)


The trend is decreasing, a desirable outcome (e.g. calving season length)


The trend is increasing, an undesirable outcome (e.g. death loss)


The trend is decreasing, an undesirable outcome (e.g. parasite control)


The trend is stable


The trend is uncertain due to insufficient data

PRODUCTION BENCHMARKS

In the late 1980's, Alberta Agriculture and Rural Development established a set of production metrics that followed the acronym GOLD:

- **Growth -** reported as weaning weight or adjusted weaning weight as a percentage of dam weight; initial target to strive for was 40-45%
- **Open Rate**; reported as unbred females divided by females exposed based on preg-checking results; initial target was less than 5%
- **Length of Calving Season -** reported as the length (in days) of the calving season or breeding season; initial target was 60-80 days for calving or 63 days for breeding
- **Death loss** - reported as the number of calf deaths divided by the number of live calf births; initial target was less than 5%

These four indicators were used to examine the productive efficiency of cow-calf operations and helped to establish an industry benchmark for western Canada nearly thirty years ago. Table 10 and 11 identify GOLD metrics of cow-calf operations over time and by region.

Weaning weights have been increasing across all regions, this is not surprising given the trend toward larger cows. This indicator leaves much to be desired. Reported weaning weights in the surveys are not all adjusted to a 205-day weaning weight (due to lack of data) to provide consistency. The unanswered question is whether *weaning weight as a percentage of mature cow weight* is being maintained between 40-45% as cows remain right sized for their environment. This measure favours smaller cows, regardless of environment, and doesn't necessarily mean they are right sized. Alternatively, the use of something like pounds weaned per cow exposed combines the first two indicators of growth and open rates.

Open rates have a substantial impact on per unit cost of production. While open rates have been decreasing in Ontario, they have been increasing in western Canada – this suggests that producers are willing to accept a higher open rate as long as they are able to reduce costs elsewhere.

Abortion rates are calculated by taking the cows that were pregnant when calculating conception rate and subtracting those that are open after the calving season and those that lost a calf in the first 24 hours after birth. These numbers are not always captured by producers or survey information. Abortion rates in Western Canada were 1.3% in 2017, in Ontario (2015/16) they were 1.0% for cows and 0.6% for heifers. While abortion rates are reported separately from open rates many producers are unable to distinguish between them and therefore measure an overall reproductive performance of calves born as a percentage of females exposed.

Table 10. Comparison of GOLD Indicators by region and trend

	Weaning Weight				
Benchmark	*Western Canada*	*Ontario*	*Atlantic Canada*	*N. Ontario /N. Quebec*	*Trend*
578 lb (1997-98 Alberta) 556 lb (1988-91 Alberta)	611 lb steer calves; 662lb bull calves; 584lb heifer calves (2017, WCCCS II) actual weights from calves born from cows 559 lb (2014, WCCCS) 595lb (2011, Sheppard et al.)	647lb male calves; 609lb heifer calves (2017) actual weights from calves born from cows 540lb (2011, Sheppard et al.)	659lb male calves; 596lb female calves (2017)* *weights reported as "average" and most were estimates, not actual	444-587lb male; 360-534lb female calves - N. Ontario (2016, Lamothe) 607-708lb male; 589-680lb female calves - N. Quebec (2016, Lamothe)	↑ Across Regions
	Open Rate				
Benchmark	*Western Canada*	*Ontario*	*Atlantic Canada*	*N.Ontario/N. Quebec*	*Trend*
4.4% open (1997-98 Alberta) 6.5% open (1988-91 Alberta) 13% open Ontario (1983, Rogers et al.) based on females producing a live calf per females exposed	7.3% (2017, WCCCS II) cows only 7% open (2014, WCCCS)	10.9% open rate (2017, OCC) based on conception rate for cows	Unavailable	Unavailable	↓ East ↑ West

The recommended length of calving season is 60-80 days, in order to provide adequate time for females to recover post-partum and rebreed to produce one calf per year. This also assists with efficient use of labour, a more uniform calf crop, and supporting long-term reproductive efficiency. While the average calving season has been decreasing in western Canada, it is still longer than 80 days (Table 11). Ideally this would be measured as the percentage of producers with a calving season of 80 days or less. Eastern Canada (Ontario, Quebec and Atlantic provinces) has an even longer calving season where data is available. In general, heifer calving seasons are shorter than cows (see Table 14 for more details).

Calf death losses have been increasing across most regions where historical data is available. A more detailed look is required to see when (with first 24 hours or after 24 hours and before weaning[3]) and how calf deaths occur. See Figures 9 and 10 for more details.

Table 11. Comparison of GOLD Indicators by region and trend

	Calving Season Length				
Benchmark	*Western Canada*	*Ontario*	*Atlantic Canada*	*N.Ontario/N. Quebec*	*Trend*
93 days (1997-98 Alberta) 107 days (1988-91 Alberta)	86.5 days (2017, WCCCS II) 92 days (2014, WCCCS) 79 days (2013, Murray et al.) 2.2 mo or 67 days (2011, Sheppard et al.)	119 days (2017, OCC) 2.8 mo or 85 days East (2011, Sheppard et al.)	121 days (2017, ACC) 3.5 mo or 107 days Atlantic (2011, Sheppard et al.)	Unavailable	? Across regions ↓ Western Canada
	Calf Death Loss				
Benchmark	*Western Canada*	*Ontario*	*Atlantic Canada*	*N. Ontario/N. Quebec*	*Trend*
4.4% (1997-98 Alberta) 5.6% (1988-91 Alberta) 6% plus 1.7% stillbirth - Ontario (1983, Rogers et al.)	5.4% (2017, WCCCS II) 6.9% (2014, WCCCS)	8.2% (2017, OCC)	Unavailable	4-11% Northern Ontario, depending on season of calving (2016, Lamothe) 4-5% Northern Quebec (2016, Lamothe), depending on season of calving	↑ Across most regions

[3] Calf death loss excludes abortion rates, which are calculated separately.

ADOPTION RATES OF RECOMMENDED PRACTICES

REPRODUCTIVE MANAGEMENT

Reproductive management is fundamental to the profitability of beef cow-calf operations across Canada. Practices vary across regions as well as between different types of beef farms.

BREEDING SEASON, CALVING SEASON AND CALVING DISTRIBUTION

According to WCCCS II (2018), the calving season for mature cows in western Canada generally started in March and ended in May, while the calving season for heifers generally started in February and ended in April. Respondents to OCCS (2018) indicated the calving season for cows started in March and ended in June, while the calving season for heifers started in March and ended in May. Lamothe (2018) reported a shift away from winter calving toward calving in late May, with heifer calving starting a few weeks earlier than cows in northern Ontario and northern Quebec. In a study assessing results from 267 Alberta producers surveyed, Murray et al. (2016) reported most producers started calving in March (36.7%) and April (26.3%), followed by February (19.5%) and January (10%). Historically, Western Canadian producers reported starting calving in late February (Alberta Agriculture and Rural Development, 1997-98) or January and February or Manitoba (Small and McCaughey, 1999), so there appears to be a trend toward later calving start dates at least in western Canada.

Table 12. Cow breeding season and calving distribution over time

Recommended Technology/Practice	***Benchmark***	***Current***	***Trend***
Breeding Season Length ≤ 63 Days	Data is limited 60% of Manitoba producers >90 days (1997, Small and McCaughey) 69% Ontario producers had ≤90 days (1983, Rogers et al.)	20% producers had ≤63 day season; 86.5 days cows (2017, WCCCS II) 25% producers had ≤63 day season; 92 days cows (2014, WCCCS) 119 days cows (2017, OCC) 136 days cows (2017, ACC)	? Across regions. ⟺ Western Canada
Calving Distribution ***% Calves Born in the first 21 Days***	47.6% of calves born in the first 21 days (1997-98 Alberta) 42.5% of calves born in first 21 days (1988-91 Alberta)	55% of females calved in first 21 days (2014, WCCCS) 54% of calves born from cows in the first 21 days (2017, OCC)	? Across regions ↑ Western Canada

As well, Alemu et al. (2016) examined subsets of beef producers and found that small-scale, part-time operators as well as diversified and crop/beef farmers tended to start calving March through May. Larger cow-calf and/or backgrounder/finisher producers as well as those who were classified as “extensive” producers (i.e. practiced extensive grazing on large landholdings) typically calved in April and May.

Opportunities and Barriers to Adoption

Reducing the breeding season length contributes to a more uniform calf crop, higher weaning weights, and improved reproductive efficiency in cows and heifers.

WCCCS II (2018) respondents indicated that only 20% adhere to a ≤63 day breeding season. The top reasons for having a breeding season greater than 63 days included: being happy with conception rates (24%), lack of facilities (21%), and being busy with other farm activities (i.e. lack of time; 20%).

Reducing the breeding season length to 63 days provides substantial economic return for little capital investment other than labour, time, and basic facilities required to remove and hold bulls at the end of breeding season. Producers in Central and Atlantic Canada appear to have a much longer breeding and calving season than producers in western Canada so there may be a particular interest in strategizing extension efforts toward those producers who would benefit most economically from a condensed calving season.

However, reducing the breeding season can also negatively impact conception rates, at least initially, until selection pressure for improved fertility and the benefits of improved nutritional management permeates the herd. The percentage of females that calve were similar in western Canada (89% cows; 86% heifers) and Ontario (89% cows; 87% heifers) according to the WCCCS II (2018) and OCC (2018), despite the longer calving season in Ontario.

PREGNANCY CHECKING

Pregnancy checking is a recommended practice that allows producers to make management (e.g. utilization of winter feed) and marketing decisions based on the reproductive status of their herd.

Table 13. Prevalence of pregnancy checking over time

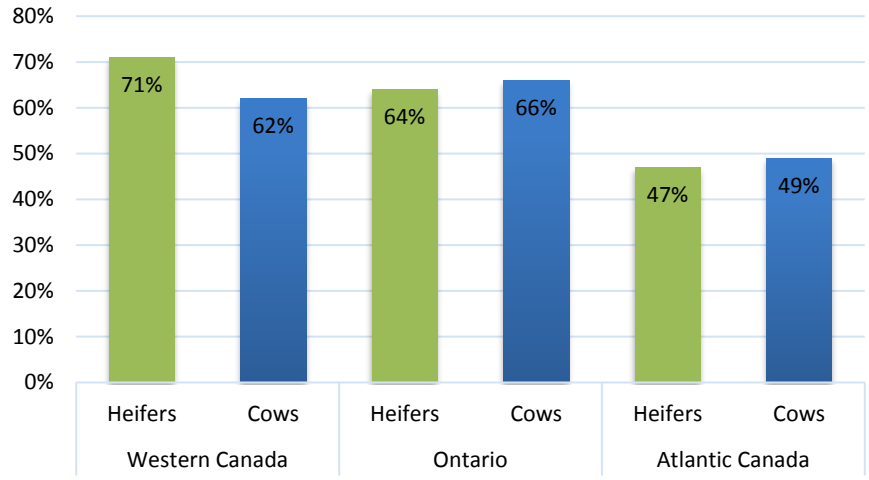
Recommended Technology/Practice	***Benchmark***	***Current***	***Trend***
Pregnancy Checking Females	49% preg-check herd (1997-98, Alberta) 34% preg-check (1987-89, Alberta) 12% preg-check in Ontario (1983, Rogers et al.) Quebec 46% of herds <40 hd, 58% >40 hd **some** females / 18% of herds <40 hd, 16% >40 hd **every** female (1995, Dutil et al.)	62% always preg-check cows, 71% preg-check heifers (2017, WCCCS II) 60% preg-check some or all cows, 66% preg-check heifers (2014, WCCCS) 49% in SK (2012, Jelinski) 50% preg-check cows/heifers Western Canada (2010, Waldner et al.) 66% producers preg-check cows, 64% of producers preg-check heifers* (2017, OCC) 71% use ultrasound to preg-check N. Ontario (2016, Lamothe) 75% of respondents use ultrasound to preg-check N. Quebec (2016, Lamothe) 49% preg-check cows, 47% preg-check heifers (2017, ACC); 68% rectal palpation, 32% ultrasound	 Across Regions

*Note: the 2017 OCC indicated that the manner in which the question was asked may have resulted in under-reporting of the proportion of heifers preg-checked

Opportunities and Barriers to Adoption

Over the past thirty years, it appears that there is an upward trend in producers adopting pregnancy checking. There still remains an opportunity for even greater uptake, with existing data demonstrating that approximately one-third of producers in Western Canada and half of the producers in Atlantic Canada have yet to regularly adopt this practice on their farms.

Figure 8. Percent of farms that pregnancy checked females



Sources: ACC, 2018; OCC, 2018; WCCCS II, 2018 *(includes responses of 'almost always')*

WCCCS II respondents that indicated they rarely or never pregnancy check mainly provided reasons such as preferring to sell open cows when prices are higher in the spring; can "tell" which females are open; the financial benefit doesn't outweigh the cost; and "other" reasons. Other barriers to adoption were reported (to a lesser extent) as being busy with other farming activities, a lack of labour, and a lack of facilities.

Rectal palpation remains the most common method of pregnancy detection, with 76% of Ontario and 68% of Atlantic producers who pregnancy check using this method. The next most common method is ultrasound, with 22% of Ontario and 32% of Atlantic producers using this technique. Information on the preferred detection method in western Canada is unavailable.

Pregnancy checking enables producers to make best use of their feed resources and marketing decisions. Existing tools, such as the BCRC "Economics of Pregnancy Testing Beef Cattle" Model,[4] address economic motivations. To increase adoption further, promoting preg-checking as part of an already existing routine (i.e. when gathering cow herd to vaccinate or wean calves, consider preg-checking at the same time) could address concerns about lack of time and additional labour. It may be valuable to point out that sometimes pregnant cows behave as though they are dry (i.e. mount other cows) and that observation alone may not be effective.

Aiming for 100% of producers to pregnancy check every year is not realistic as economic drivers will vary from farm to farm depending on winter-feeding practices and market prices for feed and cull cows. See the Economics of Preg-Checking[5] Fact Sheet for more details.

[4] http://www.beefresearch.ca/economicmodel/pregnancy-detection.cfm?type=advanced#part-a
[5] http://www.canfax.ca/samples/Preg%20Checking%20April%202017.pdf

REPLACEMENT HEIFER MANAGEMENT

Heifers require special management to ensure they are bred early, calve successfully, and are rebred within an acceptable time to ensure one calf each year. According to survey results, heifers generally have a shorter breeding interval, start calving earlier than cows, and have a shorter calving season.

Table 14. Breeding season and calving distribution for heifers over time and across regions

Recommended Technology/Practice	*Benchmark*	*Western Canada*	*Ontario*	*Atlantic Canada*	*Trend*
Breeding Season Length ≤63 Days for Heifers	Data is limited >90 days Manitoba (1997, Small and McCaughey)	85.9 days (2017, WCCCS II) 89 days (2014, WCCCS)	100.4 days (2017, OCC)	112 days (2017, ACC)	? Across Regions ↓ Western Canada
Calving Season Length for Heifers		57 days (2017, WCCCS II) 66 days (2014, WCCCS)	81 days (2017, OCC) 64% of calves from heifers born in first 21 days	49 days (2017, ACC)	? Across Regions
Breeding Heifers prior to Cows	19% breed heifers earlier than cows Manitoba (1997, Small and McCaughey) Heifers are bred "one week before the main cow herd on average" (Alberta, 1998-99)[6]	14% breed heifers at least 14 days earlier than cows (2017, WCCCS II) 11% breed heifers at least 14 d earlier than cows (2014, WCCCS)	Quebec 22% of herds <40 hd, 16% >40 hd (1995, Dutil et al.)		? Across Regions
Feeding Heifers separate from cows	55.2% feed replacements separately (Alberta Ag 1986-89) 55% Alberta Ag 1997-98				?

Opportunities and Barriers to Adoption

Heifer management is one of the areas on a cow-calf operation that can make a significant difference in profitability. Recommended practices such as a breeding season that is no more than 63 days in length,

[6] Average breeding date start for heifers was May 12 and cows was May 16 (4 days)

breeding two weeks before cows and feeding cows and heifers separately during the winter, are designed to address rebreeding challenges with heifers. Open three and four year olds represent a significant opportunity cost as they are either given a grace year and kept in the herd or culled after only producing one calf. Evaluating the cost:benefit and potential changes from adopting one or more of these practices could encourage adoption. Addressing producers who have not experienced the expected results from these practices and having a greater understanding of why could also inform next steps.

BULL AND BREEDING MANAGEMENT

Most producers recently surveyed across Canada indicated that they had a minimum of one bull on their farms for beef breeding.[7] Breeding practices varied between using natural service, artificial insemination (AI) and renting or leasing bulls. There is no benchmark for bull selection criteria, however producers generally consider breed, conformation, and pedigree.

Table 15. Top three bull selection criteria

Western Canada (2014)	Ontario (2015/16)	N. Quebec (2015/16)	Atlantic (2016/17)
Breed	Breed	Purebred with EPDs	Breed
Conformation	Conformation	Physical appearance	Conformation
Birth Weight	Pedigree	Performance	Pedigree
	Birth Weight	Temperament	EPDs

In 2017, Atlantic producers reported culling herd sires due to physical soundness, age, and change in genetics. In 2017, Ontario producers cited calf performance, reproduction, physical soundness, and improving genetics as reasons for culling bulls. In 2014, the WCCCS respondents indicated physical soundness, age, production, and progeny performance as reasons for culling herd sires.

Alemu et al. (2016) looked at data from 1,005 farms and determined that the cow-to-bull ratio varies by farm size (large or small), farm type (crop and livestock or livestock only), and production type (extensive or backgrounding). Cow-to-bull ratios varied from a low of 15:1 on diversified cow-calf operations to a high of 25:1 for large cow-calf/backgrounding operations but that the general average was 20:1. Rough terrain and younger bulls typically justify a lower cow-to-bull ratio.

WCCCS II respondents indicated lower cow-to-bull ratios for both smaller *and* larger herds. For smaller herds, this may be because you need at least one bull for any number of cattle up to 25. In larger herds with multiple sires, producers may run a lower cow-to-bull ratio to reduce the risk of cows not being bred due to bull injury or low libido. Anecdotally, producers may reduce their cow-to-bull ratio in response to higher calf prices and a desire to increase conception rates. However, conception will not increase if cows are not cycling and bulls are not fertile. More bulls in a multi-sire pasture may increase the risk of injury due to fighting, especially if bulls are similar in age.

[7] 250/261 (96%) WCCCSII respondents reported having bulls on farm; 101/111 (91%) ACC respondents indicated they had at least one bull on farm; 78/82 (95%) OCC respondents indicated at least one bull on farm

Table 16. Average cow-to-bull ratios across regions over time

Benchmark	*Western Canada*	*Ontario*	*Atlantic Canada*	*Trend*
25:1 AB 1997/98 27:1 AB 1986/89 24:1 Ontario 1985	21:1 cows (2017) 18:1 heifers (2017) 24:1 cows (2014) 17.5:1heifers (2014)	24:1 cows (2017) 14:1 heifers (2017)	Unavailable	? Across regions ↓ Western Canada

Potential Opportunities

With advances in genomic technology, including parentage, genetic defect, and desirable trait testing, there may be opportunity to understand which breeding bulls are siring the most calves with the most beneficial characteristics.

BREEDING SOUNDNESS EXAMS AND REPRODUCTIVE DISEASES

Bull infertility and reproductive diseases can lead to reproductive failure and be very costly to cow-calf operators. Producers can prevent costly problems by having a veterinarian test their bulls for fertility and disease. Jelinski et al. (2015) found that respondents who preg-checked breeding females and tested bulls for breeding soundness tended to have similar characteristics: they were larger producers, who tended to analyze forages and located in the brown soil zone.

Table 17. Breeding Soundness Exams and reproductive diseases

Technology/Practice	*Benchmark*	*Current*	*Trend*
Breeding Soundness Examinations	27.9% (1988/91, Alberta) 50.7% (1997/98, Alberta) 10% Ontario (1983, Rogers et al.) Quebec 10% of herds <40 hd, 11% >40 hd (1995, Dutil et al.)	72% "always" and 13% "rarely" conduct BSEs, (2017, WCCCS II) 64% conduct BSEs (2014, WCCCS) 69% in Sask (2012, Jelinksi) 60% conduct BSEs (2010, Waldner et al.) 17% conduct BSEs (2017, OCC) 7% of purchased bulls had a BSE (2017, ACC)	? Quebec / Atlantic ↑ Western Canada & Ontario
Reproductive Disease Testing	13.7% of herds vaccinated cows for Leptospirosis in 2001 and 8.4% in 2002 in Western Canada study (Van De Weyer et al. 2011)	25% "always" and 14% "rarely" test bulls for Trichomoniasis; 22% "always" and 14% "rarely" test bulls for Vibrio (2017, WCCCS II) 11.9% test for Trichomoniasis; 9.5% test for Vibrio (2014, WCCCS) 1% test for Trichomoniasis (2017, OCC) 21.3% in Sask tested for Trichomoniasis (2012, Jelinski)	? Across Regions

Opportunities and Barriers to Adoption

Western Canadian producers seem to test bulls more frequently than their eastern counterparts, and the practice has increased over time in the west. A lack of Central and Atlantic respondents and a difference in the way survey questions were worded makes data noncomparable.

Herd commingling may result in regional differences in reproductive disease-related problems. For example, respondents from western Canada may have a greater likelihood of participating in community pastures compared to eastern Canadian producers, which may or may not have a requirement for breeding soundness examinations and reproductive disease testing.

Ontario survey respondents indicated that a breeding soundness examination was less important than other bull selection criteria. Producers who did not complete breeding soundness examinations in western Canada reported being happy with conception rates, and thus didn't see value in a breeding soundness examination.

Opportunities exist to demonstrate the value of testing breeding bulls through case studies[8], particularly in scenarios where bulls are shared between farms, leased, rented, or bought from auction markets; situations where the potential for the spread of disease is high. Regions where consolidation is also happening faster, may also be at a higher risk of venereal diseases. A potential strategy may also be to remind producers that a breeding soundness examination covers more than just breeding, it is an opportunity for veterinarians to inspect bulls for other health and production issues.

In Northern Quebec, 15% of producers sourced breeding bulls from performance test stations while only 2% of Northern Ontario producers sourced from bull test stations. Test stations are focused on evaluating growth performance, not breeding soundness.

Maritime producers cited reasons such as lack of expertise and equipment as barriers to on-farm breeding soundness examinations. An option would be having producers take bulls to the vet where there are appropriate facilities. In the Maritimes, one beef test station manages 26% of the bulls that respondents purchased herd-sires. In 2014, the test station introduced breeding soundness evaluations to their protocol. This may provide an opportunity to motivate producers by demonstrating the value and ease of testing. However, there is still a need for ongoing annual testing. A pre-sale test is insufficient to determine long-term breeding soundness.

[8] The following Case Study examined a vibrio outbreak when a bull was bought to replace one that was injured. Waldner et al (2013). Application of a new diagnostic approach to a bovine genital campylobacteriosis outbreak in a Saskatchewan Beef herd. Can Vet J 54:373-376.

BREEDING TECHNOLOGIES

Artificial insemination has been available to Canadian beef producers for decades, and while it has been popular in the dairy industry, there is little indication that commercial beef producers are increasing their use of this technology in spite of the potential benefits. Potential benefits of artificial insemination include greater calf crop uniformity with a shorter calving season, heavier weaning weights as more calves are born in the first 21 days, greater reproductive longevity as females are less likely to be open with a longer recovery period between calving and rebreeding as well as accessing superior genetics by using proven bulls. However, there are greater equipment needs, estrous synchronization drugs, requires both semen and clean up bulls as well as more labour and management.

Table 18. Use of breeding technologies over time across Canada

Technology/Practice	*Benchmark*	*Current*	*Trend*
Artificial Insemination (AI)	In Ontario, 7% AI only, 9% AI + natural (1983, Rogers et al.) Quebec 25% of herds <40 hd, 31% >40 hd (1995, Dutil et al.) Western Canadian benchmark unavailable, US data estimates 13% (Whittier, 2010) or 7.6% of beef operations used AI (2007-08, USDA-NAHMS)	18% producers bred at least one cow via AI (2017, WCCCS II and 2014, WCCCS) 32% producers bred at least one cow via AI and 10% use AI exclusively (2017, OCC) 8% N. Quebec and 11% N. Ontario (Lamothe, 2016) 53% producers (n=49) bred at least one cow via AI and 9% use AI exclusively (2017, ACC)	 Across Regions
Estrus Synchronization (ES)	Unavailable Quebec 3% of herds <40 hd, 10% >40 hd heat synchronization (1995, Dutil et al.)	11% producers use ES (WCCCS, 2014) 27% of producers use ES (OCC, 2017) 12% N. Ontario (Lamothe, 2016) 14% N. Quebec (Lamothe, 2016) 29% of producers use ES (ACC, 2017)	 Across Regions
Embryo Transfer (ET)	Unavailable	5% producers use ET (2017, WCCCS II) 15% producers use ET (2017, OCC) 12% producers use ET (2017, ACC)	 Across Regions

Opportunities and Barriers to Adoption

Perceived and tangible drawbacks, such as increased requirements for technical skills, management, labour, and facilities, and higher costs are potential reasons why producers are not adopting this technology. There are risks with these technologies as conception rates can vary greatly (even when using the same protocol) due to weather, semen quality, donor and recipient nutrition, etc. Given that adoption of artificial insemination has been stable for several decades, further extension efforts may not be effective at increasing adoption.

While there is where potential for rapid genetic improvement though genomics technologies, it is recognized that the differences between commercial and seedstock production systems must be taken into account and will influence adoption levels of these practices.

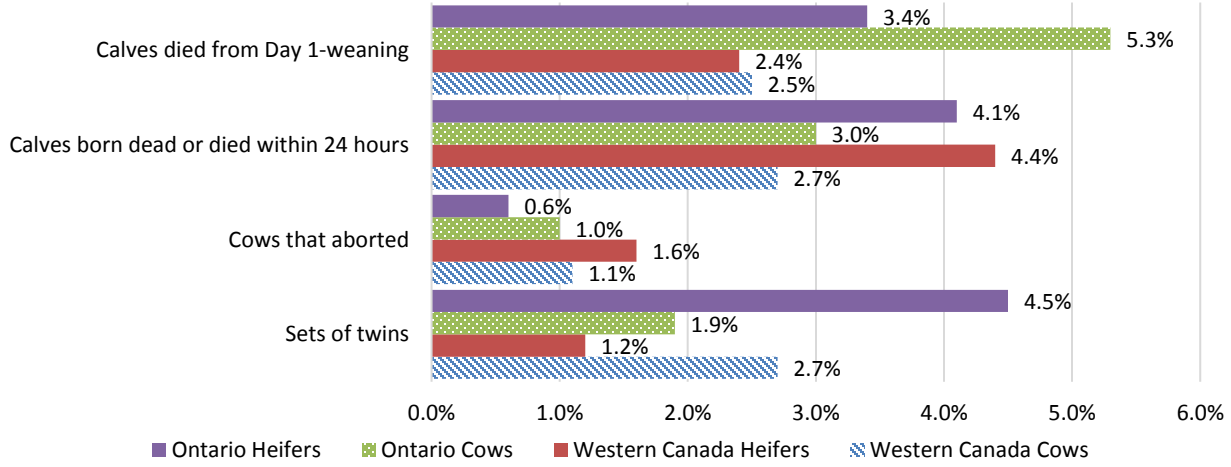
CALF MORTALITY

Calf mortality and morbidity levels can greatly impact economics on both the farm and industry-wide level. Data is unavailable for all areas of Canada, however historical records from Alberta indicate calf death loss rates of 5.6% (on 459,563 calves in 1988-91) and 4.4% (on 181,936 calves in 1997-98). More recently, the WCCCS and WCCCS II reported death losses on calves born from cows of 6.9% (on 76,000 breeding females in 2014) and 5.4% (on 34,479 exposed females in 2017) on calves from birth to weaning. This does not include cows that aborted. In Ontario, recent survey data suggests calf mortality of calves born from cows is 8.2% on calves from birth to weaning (again, not including cows that aborted). These percentages must be interpreted with caution as calf death loss can fluctuate from year-to-year on farms and survey results are based on a calf crop from a year, when extraneous factors (e.g. weather, predation) may have different effects.

While calf mortality levels fluctuate by region and year, the reported level of calf loss has the potential to greatly reduce profitability. Reducing calf mortality may be a high priority area to target extension efforts. Calf mortality is typically measured in two periods: (1) first 24 hours after birth and (2) from Day 1 to weaning. Causes of mortality and time-frame of death may indicate extension opportunities. Historically in Alberta, calf death loss happened most frequently at birth, followed by 1 to 14 days after birth (Alberta Agriculture and Rural Development, 1997-98).[9] Premature births (abortion) and pre-weaning calf death (up to 6 months of age) were the next most common periods of mortality.

According to recent data from WCCCS II and the Ontario Cow-Calf Survey, calves born to heifers had greater mortality rates during the first 24 hours after birth than calves born to cows, although the opposite was true in calf death loss from Day 1 to weaning. This suggests that practices that support early (first 24 hours after birth) monitoring during calving and recognizing appropriate intervention points when heifers are calving may be most helpful to reduce calf mortality. It should be noted that early intervention can be harmful as well therefore recognizing when to intervene is key.

Figure 9. Calf mortality and multiple births according to female type in western Canada and Ontario



Sources: OCC, 2018; WCCCS II, 2018

[9] Some studies have evaluated 0-72 hours and 3 days to weaning. It would be informative to understand 0-24hr, 24-72hr and 3 days to weaning

Studies have reported calf mortality from 24 hours to weaning at 3.1% in western Canada (Elghafghuf et al. 2014), 3.3% in Alberta (Waldner et al. 2001) in Ontario historically 3.3% for heifers and 2.6% for mature cows (McDermott et al. 1991) and Quebec 5.4%-5.6% (Dutil et al. 1999). Quebec had slightly lower perinatal mortality rates at the time 4.9-5.2% (Dutil et al 1999). It is possible that regions with smaller herds are less likely to cull problem cows and that would explain larger losses in the first 24 hours if there were more older cows.

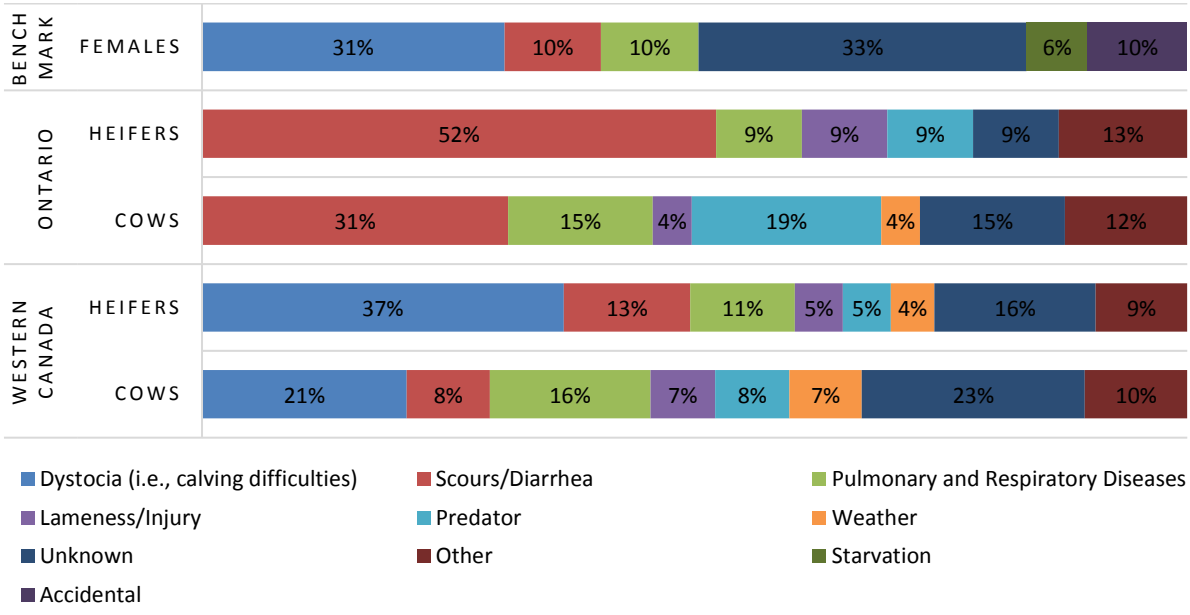
Causes of Calf Mortality

In order to reduce calf loss, one must understand the cause of death. Waldner et al (2010) reported historical causes of calf mortality from the 2002 calf crop in 203 beef herds across western Canada. It should be noted that selection bias is a serious limitation of retrospective studies based on laboratory diagnostics.

- *Aborted calf causes*: thyroid gland lesions, pneumonia, developmental anomalies, placentitis, and myocardial necrosis or myopathy.
- *Stillborn calf causes*: dystocia, thyroid gland lesions, myocardial necrosis or myopathy, developmental anomalies, and skeletal myopathy or necrosis.
- *Neonatal calf (<3 days old) death causes*: pneumonia, skeletal myopathy or necrosis, myocardial necrosis or myopathy, accident or trauma, and septicemia.
- *Older calf (3 days to 3 months old) death causes*: starvation, abomasal ulcer or perforation, enteritis or colitis, pneumonia, and intestinal volvulus, obstruction, or perforation.

Figure 10 outlines reported causes of death in neonatal calves. Note, benchmark levels are from Alberta in 1997-98, and are not separated by calves born from cows or heifers. Also, the Ontario Cow-Calf Survey (2018) did not include dystocia as a possible cause for calf death.

Figure 10. Causes of calf mortality, by region



Sources: Alberta Agriculture and Rural Development, 1997-98; OCC, 2018; WCCCS II, 2018
Survey results are based on producer estimates and not necessarily confirmed

Due to inconsistent survey methods, it's impossible to fully compare data across regions however death due to dystocia (calving difficulties), scours, respiratory illness, and "unknown" causes seem to be the most prolific across regions and time. Waldner et al. (2013) reported that 50.3% of western Canadian survey respondents identified scours or coccidiosis as the most important calf disease, followed by respiratory disease at 33.9%. Lamothe (2018) reported that death due to birthing complications, followed by scours, were the most common causes of calf mortality in northern Ontario and northern Quebec. This is a big change since 1995 in Quebec where mortality was related to diarrhea (19-28.5% for small and large operations respectively) and pneumonia (13-17.5% for small and large operations respectively); incidence also varied by region in the province.

In Ontario, 51% of herds are housed in barns, covered sheds, or drylot pens/corrals, and in Atlantic Canada, 65% of the herd is confined in similar conditions (OCC, 2018; ACC, 2018). This may partially explain why scours is among the top cause of calf loss in both Ontario and Atlantic Canada. This scenario presents an opportunity for those producers who have cattle confined, as they are likely able to better monitor, and intervene earlier, to mitigate calving issues.

In Ontario, calf death loss due to predation was also a common response, which may be worth exploring further (OCC, 2018). Lamothe (2018) also found predation to be a concern, being in the top five causes of death in northern regions of Ontario and Quebec. Mitigating predation effects in areas where predation is common presents an opportunity for extension efforts.

Murray et al. (2016) examined calf management practices and effects on calf mortality. Timing of calving season was identified as impacting calf morbidity and mortality, with herds calving in January and February, experiencing higher calf mortality from seven days of age until weaning, and a higher treatment rate for diarrhea and pneumonia. Murray et al. (2016) also found that a longer calving season also increased the risk of pre-weaning calf mortality.

DYSTOCIA

Survey responses indicated that while most calves were born unassisted, the trend has been towards more assistance during calving. Quebec's 1995 benchmark of dystocia rates were 22% in heifers and 4.8-5.8% in cows (Dutil et al. 1999). In western Canada this decreased from 84% of heifers and 96% of cows calving unassisted in 2014 to 63% of heifers and 79% of cows calving unassisted in 2017 (WCCCS, WCCCSII). Waldner (2014) reported the risk of stillbirth (2.6%), dystocia (8.5%) and severe dystocia (3.7%) from 29,970 cows during the 2002 calving season, for a combined risk of dystocia at 12.2% in western Canada – suggesting that dystocia events have increased over the last 15 years. The National Health Monitoring System in the United States reported hard pulls in heifers decreased from 7.4% in 1992-93 to 3.4% in 2007-08 (Waldner, 2014). This explains why birth weight is the main bull selection criterion.

Moggy et al. (2016) identified dystocia, or difficult calving, as a painful event that affects both calf and cow. Cows may breed back more slowly and have less milk for the calf after hard calvings, but use of pain mitigation such as non-steroidal anti-inflammatory drugs (NSAIDs), may alleviate pain and allow the cow to return to normal behaviour sooner. Murray et al. (2016) reported that 6.1% of producers surveyed administered lidocaine epidural to cow, 15% administered non-steroidal anti-inflammatory drugs to cow at calving (it was not recorded if these were in dystocia situations).

Opportunities and Barriers to Adoption

Intervening with difficult calvings, adequate colostrum intake, and providing prompt treatment for respiratory illnesses and scours can reduce calf morbidity and mortality, while also improving a cow's ability to breed back early. Extension activities that support producers' understanding of when and how to intervene during calving may be a useful way to mitigate calf death loss. Particularly, understanding of major calfhood diseases such as scours, septicemia, pneumonia and others (e.g. navel ill, injuries, etc.). There is an opportunity to encourage producers to: use the calf recovery position when resuscitating calves (as opposed to hanging them over a gate); separate cows that have calved from pregnant cows (e.g. the Sandhills or modified Sandhills calving system); and consult with a veterinarian about using a long-acting NSAID on cows after dystocia. Asking producers to quantify difficulty of calving and use of pain control in future surveys will provide additional insight into post-natal pain management.

EARLY LIFE INTERVENTIONS

Murray et al. (2016) reported that only 8.2% of the 256 operations surveyed in Alberta did not record anything at calving. A number of other factors were recorded (birth date, visual identification, calving score, RFID tag number, cow teat and udder score, etc.); 36.7% of respondents recorded birth weights primarily with a scale (58%), estimate (48%) or weight tape (11.8%). However, 41.4% of producers in Ontario indicated they collect weight information at birth, either with a scale (28%) or using a weight tape (13.4%)(OCC, 2018). In the northern regions of Ontario and Quebec, 13% and 29% weigh calves, respectively (Lamothe, 2018). In Atlantic Canada, 45.7% of producers surveyed indicated they collect birth weight data using a scale (17.1%), a weight tape (10%), and estimation (18.6%) (ACC, 2018).

Murray et al. (2016) reported interventions at birth on 267 Alberta operations. Respondents indicated 53.4% administered a vitamin/mineral injection to the calf, 16.6% provided navel disinfectant and 13% a non-steroidal anti-inflammatory to the calf.

Rogers et al. (1985) recorded production data from Ontario in 1983, finding that assisting calves to ensure colostrum intake was an intervention practiced by 67% of producers, 28% administered antibiotics prophylactically, 12% vaccinated for scours, 33% injected both vitamins A and D, and 33% provided selenium injections.

Dutil et al. (1999) reported that Quebec producers with herds less than 40 head provided a first (68%) and second (22%) injection of vitamin E-selenium to calves in 1995. While producers with herds more than 40 head were slightly more likely to provide a first (87%) and second (34%) injection of vitamin E-selenium to calves.

Ontario and Atlantic producers reported early calf-hood interventions including vaccinating for respiratory diseases at 12% and 14%, respectively (see Table 19). In Ontario, 22% of producers vaccinated for scours and in Atlantic Canada, a quarter of calves received a scours vaccination (OCC, 2018; ACC, 2018). Lamothe (2018) reported that in northern Ontario and Quebec, 7% and 12% vaccinate calves for respiratory diseases, respectively. Other calf-hood procedures and interventions were recorded in Ontario and Atlantic Canada as specified in Table 19. While the survey samples were small, this provides an indication that producers in some regions closely monitor and manage post-natal calves, and this is a useful time to promote existing or future best management practices to producers who have close contact with young calves.

Table 19. Early calf-hood interventions currently practiced in Ontario and Atlantic Canada

Early Life Intervention	Ontario (2017)		Atlantic Canada (2017)	
	# of respondents	%	# of respondents	%
Intranasal Respiratory Vaccine	10	12.2%	9	14.1%
Colostrum Supplementation	17	20.7%	17	26.6%
Oral Calf Scours Vaccine	18	22.0%	16	25.0%
Iodine Naveal Dip	22	26.8%	22	34.4%
Castration of Bull Calves	28	34.1%	26	40.6%
Vitamin A, D, E	45	54.9%	28	43.8%
Weight and Sex	47	57.3%	30	46.9%
Selenium injection	58	70.7%	56	87.5%

It should be noted that the source (e.g. own herd, neighbour, dairy or purchased powder) of colostrum for supplementation has biosecurity implications (e.g. Johne's).

Spring Processing

Waldner, Jelinski and McIntyre-Zimmer (2013) reported the average percent of calves treated for all diseases with oral antibiotics (5.5%), parenteral antibiotics (8.9%) and oral electrolytes (2.2%) in 310 operations across western Canada; a number of other calf treatments were used by 17.6% of herd owners. Large commercial operations in western Canada would typically vaccinate calves at spring processing or branding when calves are still less than three months of age (see Table 20 with calf vaccination). According to the WCCCS II (2018) the most comment vaccines administered to calves were for Clostridial diseases (93%) followed by BRD (84%).

Table 20. Vaccination Used by Animal Type, WCCCS II 2017

% of responding operations	Calves
7,8,9-Way Clostridial Disease	93%
Reproductive Diseases	52%
Bovine Respiratory Disease (BRD)	84%
Scours	21%
Vibrio	7%
Anthrax	5%

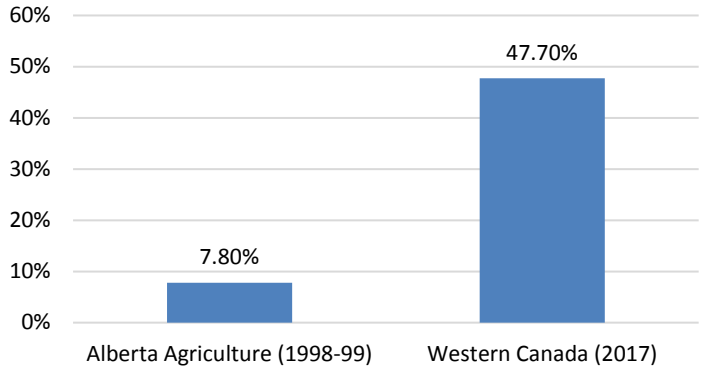
PAINFUL PROCEDURES

Dehorning, branding, and castrating calves have historically been considered routine calf-hood management procedures in Canada. While necessary, how and why these procedures take place are an area of continued interest for the industry. Dehorning, branding, and castration are painful. Attention has been placed on pain management during such procedures with recommendations and requirements in Canada's Code of Practice for the Care and Handling of Beef Cattle. Horns and brands can also cause reductions in beef carcass and processing quality; however, the proportion of cattle with brands at slaughter has decreased from 50% in 1998-99 to 12.6%, and the number of cattle with horns at slaughter has also decreased according to the 2016-17 National Beef Quality Audit[1] (2018).

DEHORNING

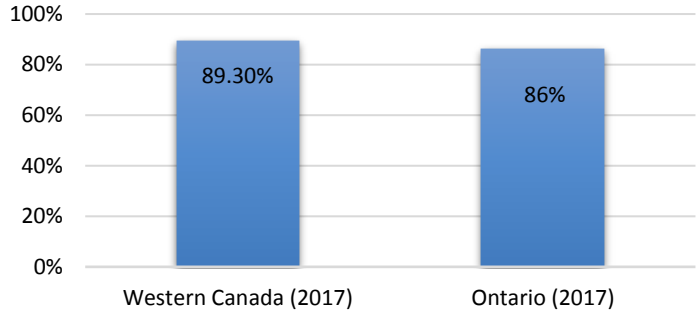
The number of cattle with horns at slaughter has decreased from 40% in 1994-95 to 9.5% in the 2016-17 (National Beef Quality Audit[1], 2018). Producer surveys indicate a similar trend, as demonstrated in Figures 11 and 12.

Figure 11. Proportion of operations with an entirely polled beef herd



Sources: Alberta Agriculture and Rural Development, 1997-98; WCCCS II, 2018

Figure 12. Proportion of herds across regions with a majority of polled animals *(>75% calves)*



Sources: OCC, 2018; WCCCS II, 2018

While the need to dehorn calves is decreasing due to an increased emphasis on polled genetics, there is no current comparison across regions of *when* producers dehorn calves over time, in spite of an industry recommendation that calves be dehorned as soon as possible (National Farm Animal Care Council, 2013). As of January 1, 2016, producers are to use pain control, in consultation with their veterinarian when dehorning calves after horn bud attachment. Table 21 demonstrates how early dehorning has changed over time in western Canada. Northern regions of Ontario and Quebec indicated that 29% and 33% of producers dehorn shortly after birth, and 54% and 50%, respectively, reported dehorning at weaning (Lamothe, 2018). Lamothe also reported that respondents had an average of 94% polled cattle in northern Ontario and 85% in northern Quebec (2018).

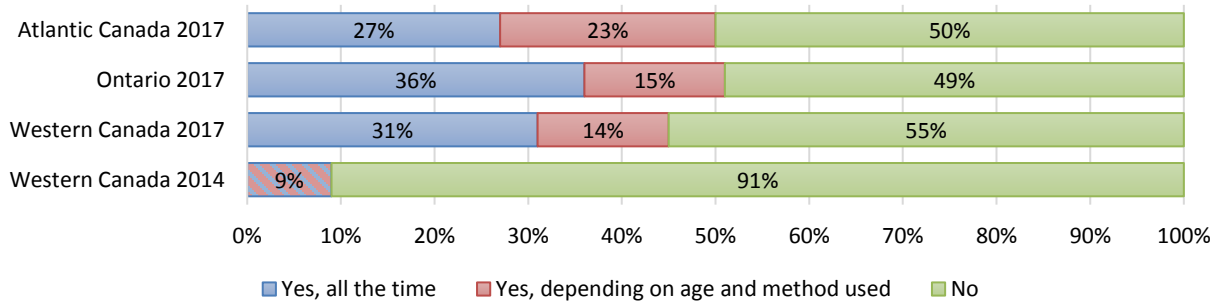
While there is some disparity in survey methods, the surveys indicate fewer calves in general require dehorning. However, the data points to a need for continued producer communications related to the value of early dehorning and there is an extension opportunity to communicate about dehorning at weaning.

Table 21. Proportion of animals dehorned at different times

Technology/Practice	*Benchmark*	*Current*	*Trend*
Dehorn calves ≤ 2-3 months of age	51% dehorned shortly after birth (Alberta Agriculture, 1998-99) Quebec 53% of herds <40 hd, 70% >40 hd (1995, Dutil et al.)	43% dehorned shortly after birth, 37.5% at spring processing; 10.5% at weaning, 9% other times (WCCCS, 2014) 54% dehorned shortly after birth, 34% at spring processing, 9% at weaning, 3% other times (WCCCS II, 2017)	 Western Canada

Recent advances in pain mitigation have provided producers with opportunities to use products that were unavailable in the past. Using pain mitigation, such as NSAIDs and/or anesthetics, during painful procedures is a recommended practice. Benchmark data is unavailable, although Figure 13 demonstrates that nearly half of producers are using pain mitigation some or all of the time. Moggy's 2016 findings where less than 15% of respondents used pain mitigation, was conducted in the same year as WCCCS 2014, indicate that awareness and adoption are occurring rapidly. Lamothe (2018) indicated that 31% and 17% of producers always or sometimes use pain control in northern Ontario, while 15% of producers always or sometimes use pain control in northern Quebec.

Figure 13. Proportion of producers mitigating pain during dehorning



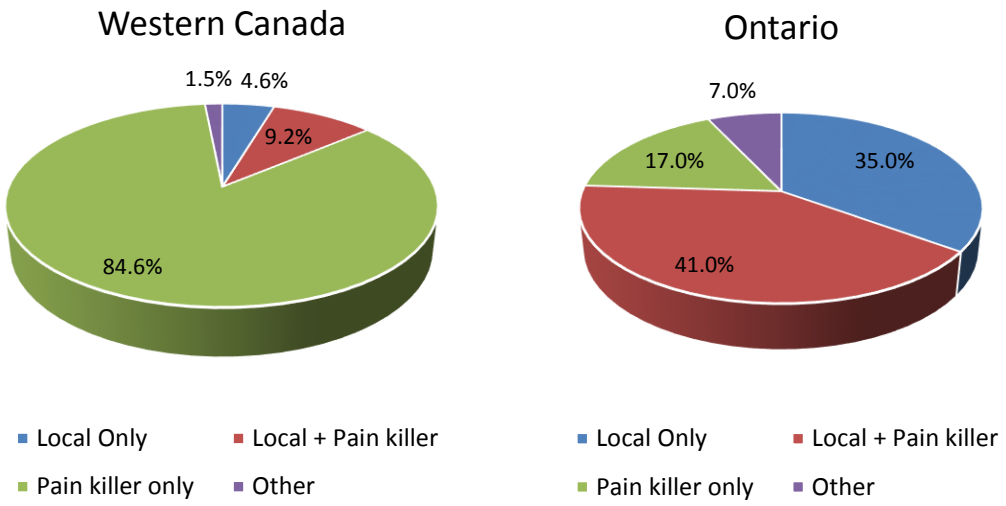
Sources: ACC, 2018; OCC, 2018; WCCCS, 2018

Opportunities and Barriers to Adoption

Uptake of pain mitigation has increased in western Canada from 9% as reported in WCCCS in 2014. Those who always use pain control when dehorning ranged between 27-31% and those who use it depending on age and method used ranged from 14-23% in the most recent cow-calf surveys. There is an opportunity for extension efforts to target those who are dehorning calves without using pain medication. Figure 14 demonstrates the type of pain control used by region, including local anesthetic/nerve block, local anesthetic plus painkiller (e.g. Meloxicam), painkiller only, or other.

It may be useful to explore why survey respondents in western Canada overwhelmingly favour pain killers (e.g. NSAIDs), compared to their eastern counterparts who overwhelmingly choose local anesthetic only or in local anesthetic in combination with a pain killer. Moggy (2016) found producers in the Western Canadian Cow-calf Surveillance Network primarily used NSAIDs (63%) when they did implement pain control for dehorning.

Figure 14. Method of pain mitigation used for dehorning in Western Canada and Ontario



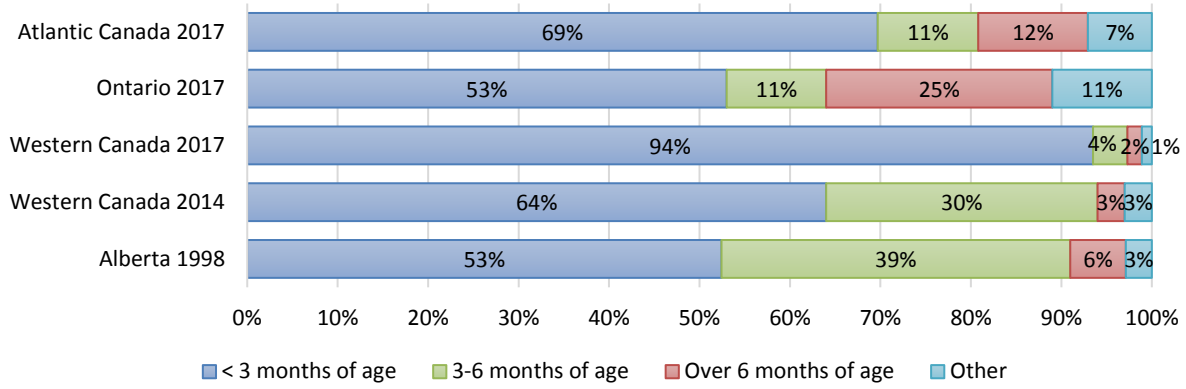
Sources: OCC, 2018; WCCCS II, 2018

Future surveys need to be more precise in language for these questions, anesthetics (e.g. local) and analgesics are both painkillers, just for different types of pain (e.g. acute vs. chronic). They way painkiller is used here implies an anti-inflammatory.

CASTRATION

Castrating calves as young as practically possible is an industry recommendation. There are a variety of castration methods. Effective January 1, 2018 the Code of Practice for the Care and Handling of Beef Cattle requires that pain mitigation be administered when castrating bulls older than six months. Differences in survey methods make direct comparisons challenging, however as demonstrated in Figure 15, it seems as though there is an increasing trend in western Canada for performing castration shortly after birth. Murray et al. (2016) found 99% (250/253 respondents) castrated at birth; 70% used a small elastorator band, 39% a surgical knife, 13% large callicrate band and 7.6% crush cord with burdizzo. In Quebec, 71% of herds with less than 40 head and 82% of herd with greater than 40 head castrated before two months of age in 1995 (Dutil et al. 1999).

Figure 15. Castration timeline by region



Sources: Alberta Agriculture and Rural Development, 1997-98; ACC, 2018; Ontario, 2018; WCCCS

Castration methods vary widely depending on age of animal, skill level of operator, or personal preference. Method used may also be a deciding factor in whether pain control is applied. Failure rate of the burdizzo is an extension opportunity as calves have to be castrated twice.

Table 22. Castration methods over time and region.

Castration Method	***Benchmark***	***Western Canada***	***Ontario***	***N.Ontario/ N.Quebec***	***Atlantic Canada***
Rubber band/ring/elastration	56.7% (1998, Alberta)	77.7% <3 mos 2.7% >3 mos (2017, WCCCS II) 68% <3 mos Alberta (2013, Moggy) 77.6% (2013 Murray, et al.)	54.5% <3 mos 12.5% >3 months (2017, OCC)	79% N. Ontario 94% N. Quebec (2016, Lamothe)	60.6% <3 mos 19.7% >3 mos (2017, AC)
Surgical (e.g. knife cut)	34.4% (1998, Alberta)	15% (2017, WCCCS II) 27% Alberta (2013, Moggy)	17% (2017, OCC)	11% N.Ontario 3% N.Quebec (2016, Lamothe)	9.1% (2017, ACC)
Clamp/Burdizzo*	9.9% (1998, Alberta)	2% (2013, Moggy) 1.6% (2014, WCCCS)	10.2% (2017, OCC)	10% N.Ontario 3% N.Quebec (2016, Lamothe)	4.5% (2017, ACC)

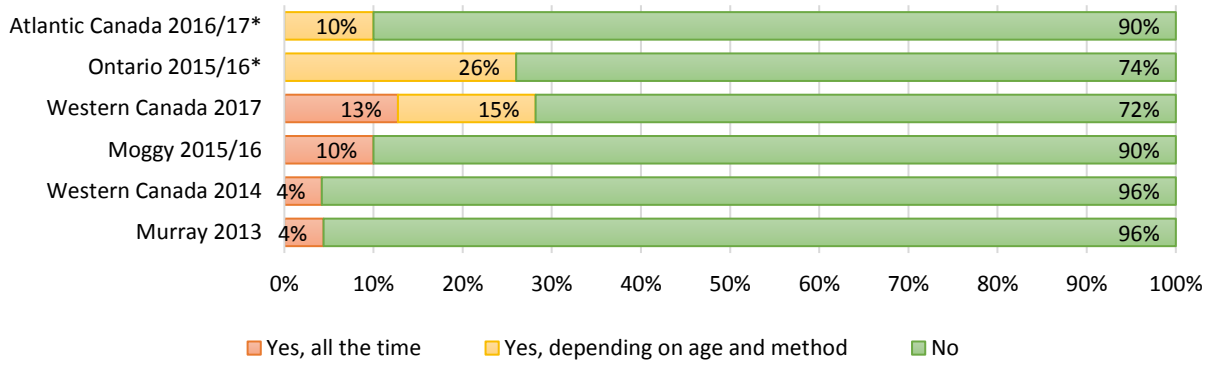
**WCCCS II (2018) did not list burdizzo as a survey response option*

Opportunities and Barriers to Adoption

With advances in pain mitigation being relatively new, historical data is unavailable for pain control during castration. In 2014, 4.2% of respondents from WCCCS indicated they controlled pain during castration in 2014. This was consistent with Murray et al. (2016) with 4.4% using pain control (2013 data) even though they primarily castrated at birth. Moggy et al. (2016) found that 10% of producers generally reported

controlling pain by 2015/16. This jumped to 28% of respondents in the WCCCS II (2017) who mitigated pain during castration. While the use of pain control when castrating seems to be increasing among producers, in general, the use of pain control when castrating is lower than when dehorning.

Figure 16. Use of pain control when castrating



*Regions did not provide information on if pain mitigation was always used or if it depended on age and method

Of those 28% respondents, 79.5% relied on pain killers (NSAIDs) alone to manage pain in calves. Of the 72% of producers who did not provide pain control, 97% of them cited castration at less than three months of age as the reason why they did not manage pain.

Comparable pain control data is unavailable from other regions and this is an opportunity to gain more insight in future surveys. It may also be useful to further examine the use of pain mitigation during dystocia, calf illness, and lameness, as well as promote the use of NSAIDs to producers.

IMPLANTING

While the economic benefits for cow-calf operators to implant calves with synthetic or natural hormones are fairly well documented (Selk, 1997),[10] the level of adoption seems to be relatively static as seen in Table 23.

Table 23. Adoption rate of implanting suckling calves across Canada

Technology/Practice	***Benchmark***	***Current***	***Trend***
Implanting calves	23% implant calves in Manitoba (1997, Small and McCaughey)	26.5% implant (2017, WCCCS II) 24% implant (2014, WCCCS) 2.4% implant (2017, OCC) 0.24% (2017, ACC)	? All Regions ⟺ Western Canada

Opportunities and Barriers to Adoption

Implanting calves improves feed efficiency and growth of the animal (Beef Cattle Research Council, 2018). There are conflicting reports regarding the extent of implant use in all regions of Canada. Producers who reported using implants indicated they used them before weaning and/or at weaning (e.g. when retaining

[10] https://aces.nmsu.edu/pubs/_b/B218.pdf

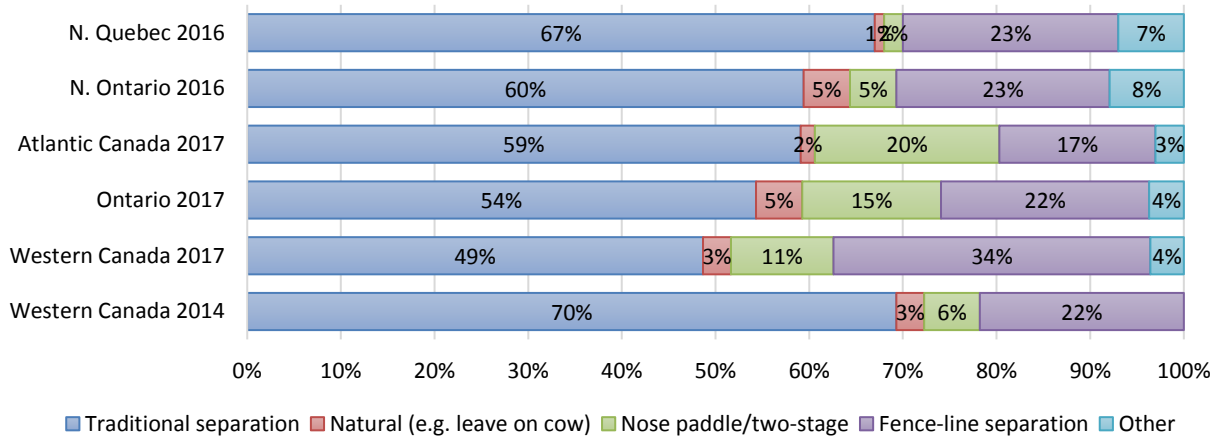
ownership). Interestingly, WCCCS II respondents who did *not* implant stated philosophical opposition to implants as the main reason, making this option nearly as popular as producers that chose to implant calves (2017).

In order for producers to increase the use of this technology, the ease of application, economic benefits, safety, and potential to implant simultaneously as other processing events occur, may need to be clearly communicated. Results highlighted in the WCCCSS II (2018) report indicated that this is a controversial practice. Understanding why they're philosophical opposed will be necessary in order to increase adoption.

WEANING & CREEP-FEEDING

Haley (2016) suggested that abrupt weaning is more stressful than two-stage or fenceline weaning, but abrupt separation remains the most popular weaning method in spite of the recommended practice to implement low-stress weaning. Benchmark information is unavailable; however, abrupt weaning appears to have been the preferred technique in the past as cow-calf producers sold at time of weaning. As seen in Figure 17, respondents from western Canada indicated that 70% used traditional separation in 2014, and just three years later, in 2017, that ranged between 49-67% across Canada. Perhaps this indicates an upward trend in low-stress weaning, although monitoring this over a longer time frame is needed.

Figure 17. Weaning method according to region



Sources: ACC, 2018; OCC, 2018; WCCCS, 2014; WCCCS, 2017; Lamothe, 2016.

Respondents from Western Canada and Ontario both reported that October is the most common month to for weaning. Table 24 demonstrates the proportion of operations that sell calves at, or very near weaning.

Table 24. Weaning practices over time and by region

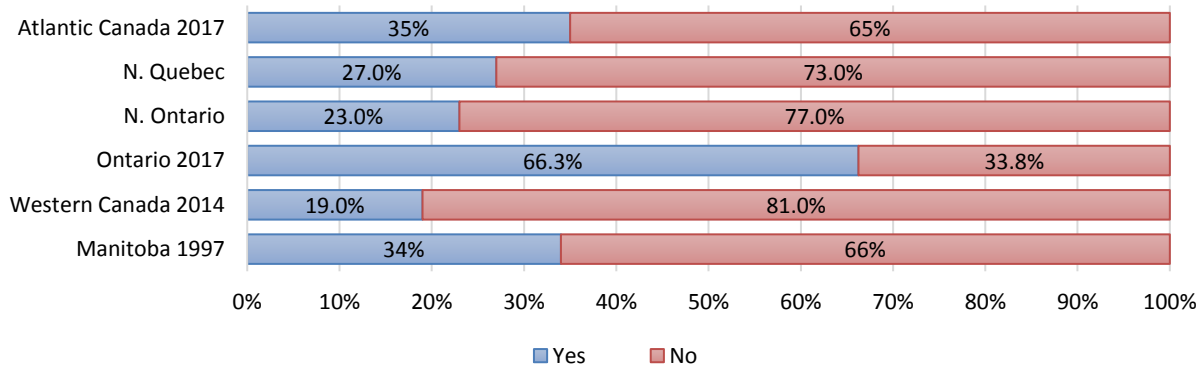
Technology/Practice	*Benchmark*	*Western Canada*	*Ontario*	*Atlantic Canada*	*Trend*
Market calves at, or very soon after, weaning	53.4% (1986/89, Alberta)	52.7% (2017, WCCCS II) 72% (2014, WCCCS)	54% (2016, OCC)	36% sold at weaning, 36% preconditioned, 25% retained ownership and	? Across Canada

				sold yearlings, 3% other (2017, ACC)	

Creep feeding calves is a practice used to introduce calves to grain or prepared feed while they are still nursing the cow. It can be used as a tool to help transition the calf from pre-weaning to post-weaning feeding and backgrounding, and is also used at times of drought to help supplement diets to reduce demands on pastures.

Creep-feeding is a practice that producers may incorporate some years and not others (i.e. during dry years). Depending on the survey method, weather conditions during the year may skew results for that production year.

Figure 18. Adoption of creep feeding by region over time



Source: WCCCS 2014, OCC 2017, ACC 2017, Lamothe 2016, Small and McCaughey 1997

Opportunities and Barriers to Adoption

Reducing the stress of weaning should be an area of high priority for extension as well as survey monitoring across regions going forward. There are numerous BCRC resources available to engage producers about reducing stress at weaning and continuing to promote this message is important. As the industry shifts away from easily accessible antibiotics and moves toward diverse marketing options (e.g. direct sales, retained ownership), low-stress weaning is predicted to be a priority.

Some potential barriers include the need for additional labour and cost for nose-paddles (if using two-stage weaning) and proper facilities for fenceline weaning. Most WCCCS II (2018) respondents indicated they used traditional separation because they sold calves immediately after weaning. If that continues to be a typical market practice, it will also remain a barrier to adopting low-stress weaning.

Creep feeding can be a beneficial practice for producers, however, there is lack of useful survey data to provide full insight on uptake, opportunities, and barriers. Including use of the practice due to weather disruptions (e.g. drought). Future survey questions could be worded so that producers could indicate how many years (e.g. two of the last three) they utilized creep feed or low-stress weaning rather than focus on a single calf crop. Alternatively, they could indicate conditions under which they do creep feed.

Preconditioning is gaining attention throughout the beef supply chain. The precise definition of preconditioning varies by region and selling method although it is a term that includes supportive practices that prepare the calf for the post-weaning/backgrounding/feeding phase. Preconditioning may

include pre-weaning vaccinations, two-stage or fenceline weaning, and creep-feeding and/or bunk-breaking calves. All cow-calf producers will wean calves at some point, but not all producers "precondition" calves. BCRC's existing Preconditioning Calculator is a useful tool to convey the economic costs and benefits.[11] It defines preconditioning as "Calves are typically vaccinated at least 3 weeks prior to sale or shipment and are at least 4 months of age prior to being vaccinated. They are also castrated, treated for parasites and dehorned at least 3 weeks prior to sale (Radostits, 2000). A preconditioning program also requires that calves be weaned for a minimum of 45 days and have some experience eating from a feed bunk prior to leaving their place of origin."

There is a lack of consistent information regarding current prevalence of preconditioning. In 1988-89, 9.3% of calves in Alberta were marketed as preconditioned. More recently, respondents from the WCCCS II indicated 21.8% of producers preconditioned calves, an increase from 9% which reported preconditioning calves for 30-60 days in the 2014 WCCCS. In the Atlantic Canada Cow-Calf survey, 36% of operations sold calves at weaning, 36% preconditioned for 30-60 days then priced at time of sale, 25% retained ownership and sold as yearlings, with the remainder sold in other ways (e.g. locked in price before weaning). Thirty-nine percent of producers indicated they used vaccinations as a strategy to prepare calves for weaning (Moggy, 2016). Murray et al. (2016) reported 45% of producers would consider preconditioning vaccinations if there were incentives or changes to their operation.

[11] http://www.beefresearch.ca/research-topic.cfm/preconditioning-88

ANIMAL HEALTH MANAGEMENT

VACCINATION

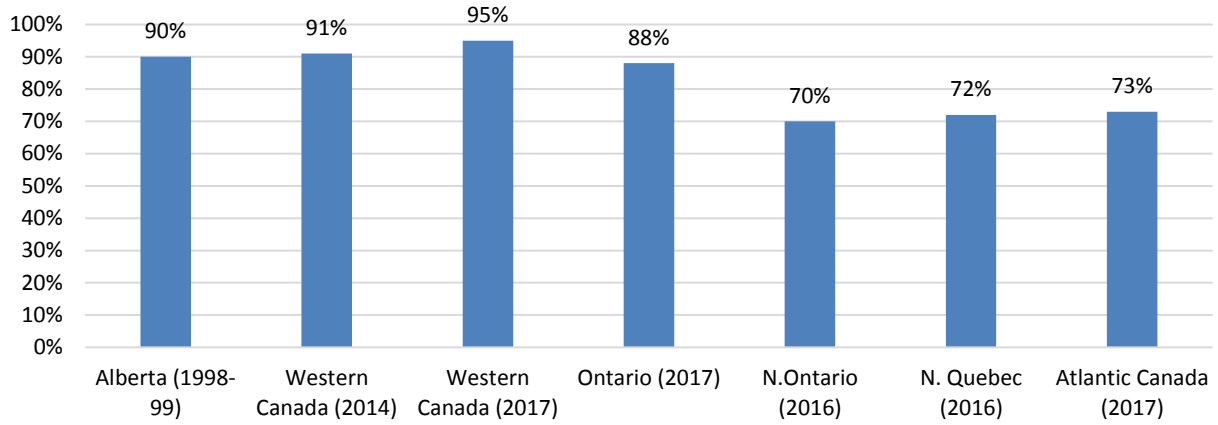
Vaccinating breeding females for reproductive disease and vaccinating calves for respiratory disease are recommended practices. Vaccination requirements vary by region and by farm as production and management practices can increase or decrease the amount of risk cattle are exposed to. Table 25 explains vaccination administration according to disease and animal category and Figure 19 demonstrates how general vaccination rates vary by region and time (where data is available).

Table 25. Vaccination administration over time, by region, and by disease

Technology/Practice	*Benchmark*	*Current*	*Trend*
Vaccinating Breeding Females – Reproductive Diseases	84.3% of cows BVDV/IBR prebreeding Western Canada (2001/02, Waldner and Guerra) 2% BVD, 6% Leptospirosis, Ontario (1983, Rogers et al.) 50-58% vaccinated cows Quebec (1995, Dutil et al.)	73.9% (2017, WCCCS II) 30% Vibriosis; 59% Leptospirosis; 67% BVD (2017, OCC)	↑ Eastern Regions
Vaccinating Breeding Females – Scours	41.9% cows, 41.6% heifers Western Canada (2010, Waldner et al.) 9% Ontario (1983, Rogers et al.)	66% (2017, WCCCS II) 42% Western Canada (2010, Waldner et al.) 30% (2017, OCC) 35% (2017, ACC)	↑ Eastern Regions
Vaccinating Calves – Clostridial	Clostridial diseases 82% (1998-99, Alberta) Clostridial diseases 90% (1987-89, Alberta)	93% (2017, WCCCS II) 85% Western Canada (2010, Waldner et al.)	↔ Western Canada
Vaccinating Calves – Respiratory	IBR 46%, PI3 41%, BVD 40%, and BRSV 32.7% (1998-99, Alberta) IBR 46.3%, PI3 25.4% and BVD 25.5% (1987-89, Alberta)	BRD 84%, BRSV/BVD 77.1% (WCCCS II, 2017) 55.6% BVDV/IBR Western Canada (Waldner et al, 2013)	↑ Western Canada

Comparable benchmark information is challenging to find for vaccinations as disease management and technology has changed dramatically in the past three decades. Survey results all reported information in very diverse ways, but in general, there is room for improvement for BRD, BVD/IBR, scours and reproductive diseases for cows. Vaccination of bulls was typically lower in all regions.

Figure 19. General herd vaccination levels[12]



Sources: Alberta Agriculture and Rural Development, 1997-98; ACC, 2017; OCC, 2017; WCCCS, 2014; WCCCS II, 2017; Lamothe, 2018

The WCCCS II (2018) reported the most common vaccines administered to cows were for reproductive diseases (84%) followed by Bovine Respiratory Disease (BRD) at 75% and Clostridial (e.g., blackleg) diseases (62%). The most common vaccines administered to heifers were for reproductive diseases (82%) followed by Clostridial diseases (80%), and BRD (76%).

Table 26. Vaccination Used by Animal Type, WCCCS II 2017

% of responding operations	Cows	Replacement Heifers	Bulls	Calves	Did not vaccinate
7,8,9-Way Clostridial Disease	62%	80%	51%	93%	2%
Reproductive Diseases	84%	82%	51%	52%	7%
Bovine Respiratory Disease (BRD)	75%	76%	49%	84%	5%
Scours	66%	57%	2%	21%	17%
Vibrio	29%	27%	17%	7%	65%
Anthrax	10%	10%	9%	5%	85%

Opportunities and Barriers to Adoption

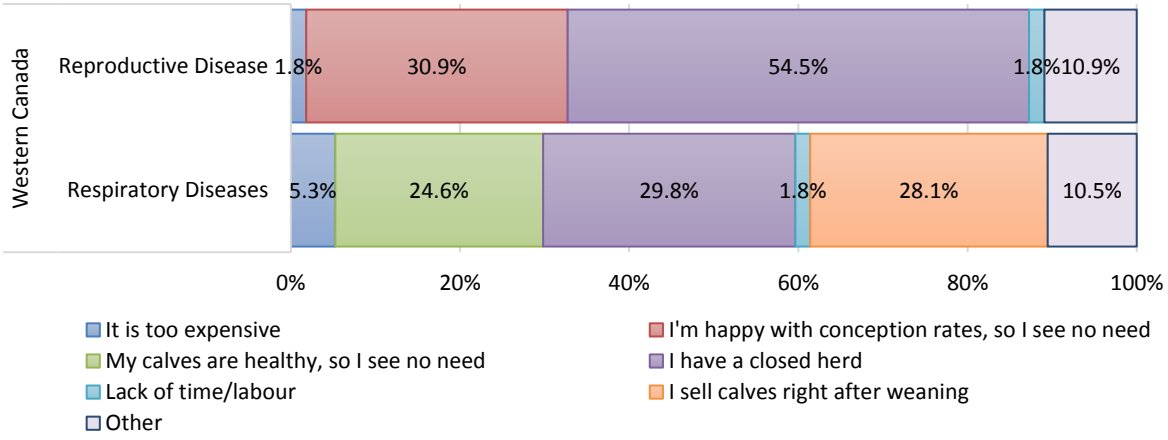
The WCCCS II (2018) reported that the most common reason for not vaccinating was because producers had a closed herd (54.5% for reproductive diseases, 30% for respiratory diseases). Clearly defining a closed herd would clarify if non-vaccination is suitable in certain situations. Closed herds are rare given fenceline contact, purchased bulls, etc. Being happy with conception rates and selling at weaning were the next most frequently stated reasons for not vaccinating for reproductive and respiratory diseases, respectively. A clear benefit for cow-calf producers from vaccinating calves for respiratory diseases when calves are sold at weaning has yet to clearly understood. There is an extension opportunity to communicate about the connection to reproductive performance.

Ideally, 100% of producers would vaccinate for diseases specific to their region. As new information and prevention techniques evolve, vaccination and parasite management should continue to be a high priority for extension. Increased information on intra-nasal and oral vaccines for producers and how to administer the product may support adoption. Future surveys may want to ensure methodology is similar across jurisdictions so that data may be more comparable, particularly for questions regarding vaccinations (i.e. what diseases do you vaccinate for? vs. do you vaccinate for respiratory diseases?)

[12] herds vaccinating at least one class of cattle for at least one disease

Vaccinating herd bulls may be a specific practice to promote to producers as most reported vaccinating females and calves, but at best, approximately 50% of respondents reported vaccinating their bulls (WCCCS II, 2018).

Figure 20. Reasons for not vaccinating



INJECTION LOCATION

Injection site lesions from the administration of vaccines, antimicrobials, or vitamins, causes industry-wide loss due to negative effects on carcass quality. Table 27 demonstrates how the number of injection site lesions has changed over time. The economic cost of injection site lesions was estimated to be $0.07/head in 1994-95 but has increased to $0.56/head in 2016-17 (National Beef Quality Audit, 2018[1]).

Table 27. Injection site lesions

Production Parameter	***Benchmark***	***Current***	***Trend***
Injection Site Lesions	0.56% lesions fed cattle; 7.34% lesions non-fed cattle (2010-11, NBQA[2]) <2% lesions (1998-99, NBQA[1]) <2% lesions (1994-95, NBQA[1])	4.45% lesions fed cattle; 13.7% lesions non-fed cattle (2016-17, NBQA[2])	↑ Across Canada

The National Beef Quality Audit (2018[2]) suggests that increased use of treating cattle with dart guns may be responsible for the increase in lesions in non-fed cattle from 2010-11 to 2016-17. There was also an increase in lesions in different areas of the carcass (e.g. shoulder) compared to previous years. This presents an opportunity to promote best practices for dart gun use by livestock producers as well as continue efforts aimed at injection best practices. It may be useful to strategically promote these practices prior to the grazing season.

PARASITE MANAGEMENT

Trends regarding management of external parasites is relatively high across Canada and continues to increase for internal parasites across regions. Most commonly used pour on products in the west impact

both internal and external parasite. It is unclear if producers are targeting external parasites and potentially encouraging resistance to internal parasites.

Table 28. Parasite control over time and by region

Technology/Practice	*Benchmark*	*Western Canada*	*Ontario*	*N. Ontario/ N.Quebec*	*Atlantic Canada*	*Trend*
External Parasite Treatment	99% lice (1998-99, Alberta) 80% lice Ontario (1983, Rogers et al.) 62% <40 hd 70% >40 hd Quebec (1995 Dutil et al.) lice/grubs	73-91% (2017, WCCCS II) 93% lice (2014, WCCCS)	87% lice (2017, OCC)	86% N. Ontario; 93% N. Quebec (2016, Lamothe) Note: study referred lice control as "dewormer"	84% lice (2017, ACC)	Western Canada Eastern regions
Internal Parasite Treatment	65% internal worms (1998-99, Alberta) 20% intestinal worms Ontario (1983, Rogers et al.) 43% <40 hd 57% >40 hd Quebec (1995 Dutil et al.)	63-74% (2017, WCCCS II) 82% internal worms (2014, WCCCS)	64% internal worms (2017, OCC)		70% internal worms (2017, ACC)	All regions

Parasite management products are typically economical and very easy to apply which may continue to increase adoption of this practice. While adoption is high, extension communication should focus on avoiding resistance to products.

VETERINARY COMMUNICATION

Benchmark information was largely unavailable for most regions, although Rogers et al. (1985) reported that Ontario veterinarians only spent 1.9% of practice time on delivering health information to beef cow-calf operations. Small and McCaughey (1999) reported that 45% of Manitoba producers were using a veterinary guided herd health program. Using pregnancy checking as a proxy for veterinary activity on a farm-level, producers are using veterinary services at a higher rate today than in the past. Recent policy changes regarding antibiotic accessibility have the potential to increase in veterinary-client-patient interactions.

Jelinski et al. (2015) reported that cow-calf producers in Saskatchewan averaged 2.0 veterinary farm visits per year, took animals to a veterinary clinic 1.5 times per year, and consulted with a veterinarian in-person, by phone, or by email 4.8 times per year. A small-scale livestock survey found that veterinary usage was highest among young producers with higher levels of education and farms with higher gross

receipts (Jelinski et al. 2015). USDA found that large producers were more likely than small producers to consult veterinarians on disease, nutrition, and livestock management practices (Jelinski et al. 2015).

In the WCCCS II, few producers reported that they made specific appointments to discuss recommended management practices and herd health programs. Many reported that these topics were discussed during office or farm visits. Producers reportedly interacted with their veterinarians up to 8 times per year - four times a year to purchase vaccines or other supplies, once for an emergency (e.g. calving, emergency health problem), once for pregnancy checking, once for a breeding soundness exam, and once to consult on herd health management (WCCCS II, 2018). While producers may not report specifically consulting veterinarians for information, they may obtain what they are looking for during other visits. Sheppard et al. (2015) reported veterinarians ranked fairly high as a preferred source of information for producers in the Prairie provinces.

Waldner et al. (2013) reported that 62.7% of producers in western Canada consulted with a veterinarian to treat sick calves, with 23.5% having a veterinarian examine or treat $\geq$1 calf that season, and 9.8% reporting having a post-mortem completed by a veterinarian. Waldner et al. (2013) found that producers with large herds (>136 calving females) were 2.2 times more likely to consult a veterinarian about sick calves and 7.3 times more likely to have a veterinarian perform a post-mortem.

In Atlantic Canada, producers ranked veterinarians as their top source of information for both animal health and animal nutrition in 2017. Sheppard et al. (2015) also reported veterinarians ranking fairly high as a preferred source of information in Atlantic Canada which indicates veterinarians are a main point of contact for producers in eastern regions.

Understanding the relationship that producers have with veterinarians is valuable when analyzing extension opportunities. Engaging producers through their veterinarian could be an effective strategy.

FORAGE AND GRAZING MANAGEMENT

Grazing management varies greatly by region, herd size and farm type (Alemu et al. 2016). Recommended grazing practices are diverse and specific to ecoregions, resource type (native or tame seeded), and land base (large or small). There is a wide range in how producer surveys and studies define rotational grazing, therefore interpreting results requires caution.

ROTATIONAL GRAZING

In general, rotational grazing is the practice of moving grazing livestock between pastures to prevent overgrazing and allow time for plants to regenerate. This varies from intensive multi-day moves to longer periods of 2-3 weeks, or longer which are considered extensive. In addition, stocking density varies significantly. This is usually contrasted with continuous grazing, when cattle remain in the same pasture throughout the entire grazing season.

The 2006 Farm Environmental Management Survey reported that most farms in every ecoregion practice rotational grazing with adoption rates ranging between 55-80% (FEMS 2006 Grazing Livestock Management). “Rotational grazing is considered a beneficial management practice (BMP) in all parts of the country, as it improves and maintains pasture productivity, soil health, and biodiversity through more intensive management than season-long grazing. The survey question accepts a broad range of grazing intensities as part of rotational grazing, even though for a specific region the recommended intensity for rotational grazing may be more strictly defined.” (FEMS 2006)

Table 29. Adoption of rotational grazing by province

Canada	**49.7%**
Atlantic Provinces	50.7%
Quebec	58.6%
Ontario	44.1%
Manitoba	48.0%
Saskatchewan	43.8%
Alberta	54.1%
British Columbia	57.4%

Source: 2016 Census of Agriculture

According to the 2016 Census of Agriculture, rotational grazing is the highest in Quebec (58.6%) followed by BC (57.4%) and Alberta (54%). The lowest adoption of rotational grazing is in Saskatchewan (43.4%) and Ontario (44.1%). Producer demographics have little impact on adoption, ranging between 46.7% for producers older than 55 years and 56.6% for three multi-generational operators. Jelinski et al. (2018) determined that there was no difference in adoption of rotational grazing between eastern and western regions, but rather that herd size had the greatest impact with herds greater than 500 head having the highest adoption rate. Use of rotational grazing can be influenced by grass type (tame or native), time of year, and land tenure.

Table 30. Adoption of rotational grazing by producer age

Producer Ages (multiple generation operations)	49.7%
<35 years of age	47.7%
35-54 years of age	53.1%
>55 years of age	46.7%
<35 years & 35-54 years	56.0%
<35 years & >55 years	55.8%
35-54 years & >55 years	53.8%
<35 years, 35-54 years & >55 years	56.5%

Source: 2016 Census of Agriculture

Table 31. Grazing practices by region over time

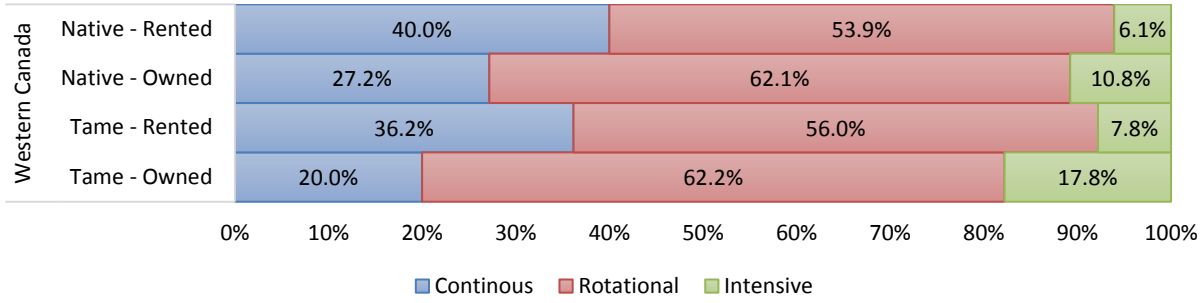
Technology/ Practice	***Benchmark***	***Canada***	***Western Canada***	***Ontario & Quebec***	***Atlantic Canada***	***Trend***
Rotational Grazing	41.7%* Canada (2001, FEMS Statistics Canada) 59% Alberta (1986-89)	49.7% Canada (2016, Canfax Research Services)	92% Alberta (2018, Alberta Agriculture and Forestry) 54-62% native/tame plus 6-18% intensive (2017, WCCCS II) 67-70% native/tame (2014, WCCCS)	44% prior to weaning (2017, OCC) 44.1% Ontario, 58.6% Quebec (2016, COA)	50.7% (2016, Canfax Research Services)	 All Regions

**includes all farms with cattle and pasture land*

Tame or Native

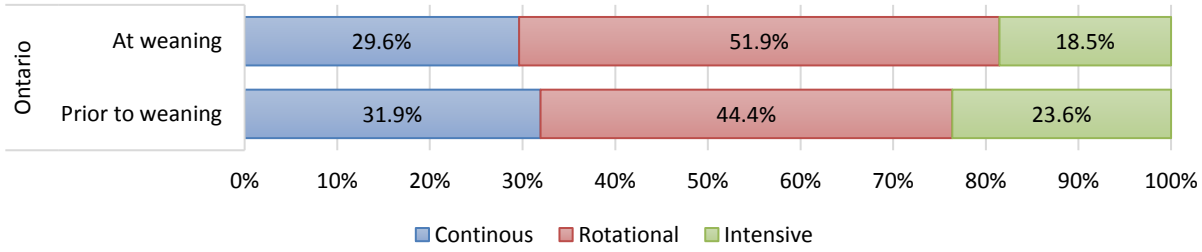
Small and McCaughey (1999) reported that 28% of Manitoba producers indicated they practiced continuous grazing, while 41% practiced *both* continuous and rotational grazing. Producers seem more likely to practice continuous grazing on native pastures. For example, Sheppard et al. (2015) found 35% and 26% of producers practiced continuous grazing on native and tame pastures, respectively, while WCCCS (2014) reported that 30% and 19% of producers continuously grazed native and tame pastures, respectively. Lamothe (2018) reported 56% and 30% of northern Ontario and northern Quebec producers, respectively, continuously grazed native pastures.

Figure 21. Western Canadian grazing practices



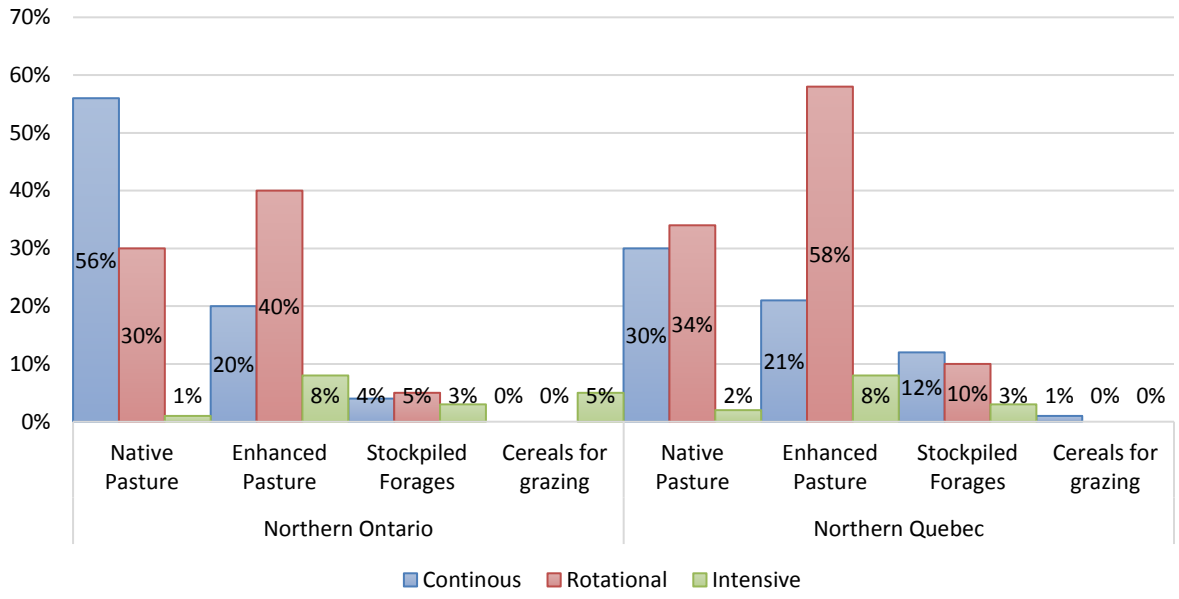
Intensive grazing, the practice of directly controlling the distribution of livestock usually with high stocking density and frequent moves, is included in recent surveys. In Western Canada, producers used intensive grazing on rented (6%) or owned (11%) native pastures, and on rented (8%) or owned (18%) tame pastures. In Ontario, producers used intensive grazing at weaning (18.5%) or before weaning (24%). Lamothe (2018) reported producers in northern regions of Ontario and Quebec use intensive grazing on native pasture (1%), enhanced pastures (8%) and stockpiled forages (3%). While intensive grazing is expected to be more prevalent in eastern regions than in western Canada, given higher rainfall allows for greater responsiveness by plants – recent surveys would suggest that is not the case. Exploring barriers to adopting intensive and rotational grazing in eastern Canada, such as small herds requiring fencing or labour limitations with off-farm work, may inform extension efforts.

Figure 22. Grazing by time period in Ontario



Source: Ontario Cow-Calf Survey 2015/16

Figure 23. Grazing by forage type in Northern Ontario and Quebec



Source: Lamothe (2018) Northern Beef Study 2015/16

The necessity of rotational grazing varies with time of year. Advantages of rotational grazing are greatest during the spring when fast growth requires frequent moves to avoid overgrazing (i.e. re-grazing before recovery has occurred). As grass growth slows throughout the summer longer periods between moves can transpire without risk of overgrazing occurring.

Land tenure (e.g. owned or rented) impacts the adoption of several grazing practices, as producers may be unmotivated to develop infrastructure (e.g. fence, water, corrals) on rented property.[13] Respondents to the WCCCS II survey indicated they are more likely to practice continuous grazing on rented or leased pastures (36% on rented tame, 40% on rented native), than on land they own themselves (20% owned tame, 27% owned native). Table 32 depicts land tenure for beef producers across Canada and Figure 24 shows that the practice of renting land has increased over time in western Canada.

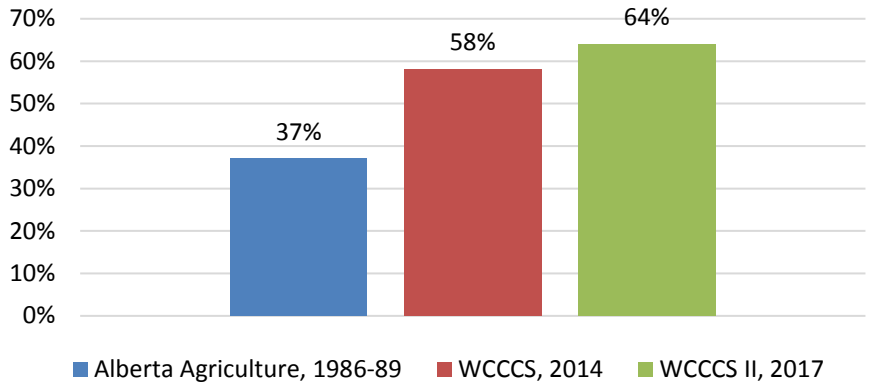
Table 32. Land tenure for Canadian beef producers

Region	***Area Owned***	***Area rented/leased from government***	***Area rented/leased from others***
Canada	57.5%	20.2%	22.9%
Atlantic Provinces	78.8%	3.7%	13.4%
Quebec	77.6%	0.3%	22.0%
Ontario	67.3%	0.6%	30.6%
Manitoba	63.6%	14.8%	24.5%
Saskatchewan	57.9%	20.5%	22.8%
Alberta	54.2%	22.3%	23.4%
British Columbia	47.7%	38.3%	13.1%

Source: 2016 Census of Agriculture

[13] Or not permitted if it's crown lease land (depending on the terms of the lease) or on community pastures where the management is not up to the individual. There may also be limitations on community/co-op grazing lands.

Figure 24. Proportion of beef producers renting land (any amount) in western Canada



Sources: Alberta Agriculture and Rural Development, 1997-98; WCCCS, 2015; WCCCS II, 2018

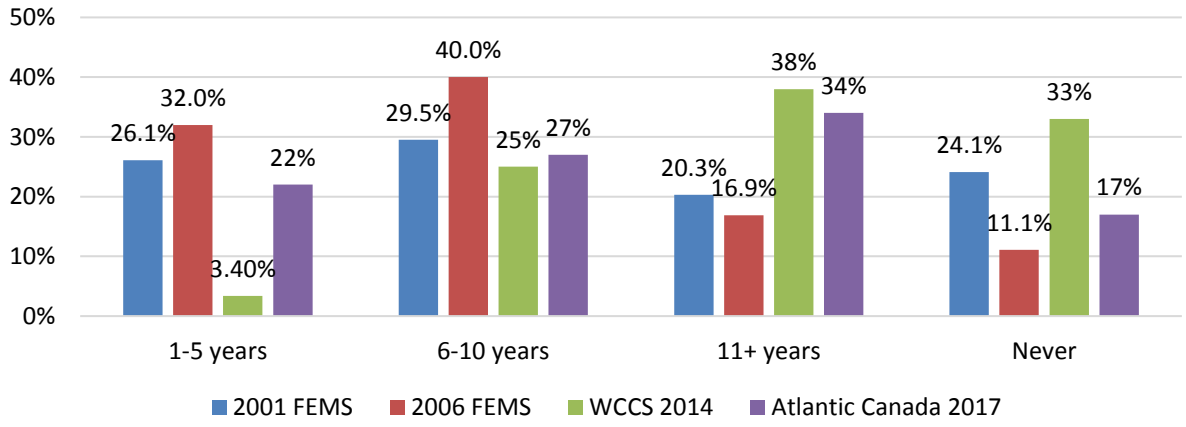
Grazing season reporting methods vary by survey and region. Small and McCaughey (1999) reported Manitoba producers had an average grazing season of 145 days which typically began in late May. Alemu et al. (2016) reported a grazing season of May to October grazing. The Ontario Cow-Calf Survey (2018) reported 90% of producers graze their herds for greater than 3 months, the remainder reported grazing less than 3 months. The WCCCS II (2018) reported average grazing season of 180 days with an average pasture turnout date of May 21.

Sheppard et al. (2015) reports 731 cow-calf operations (73% of respondents) across Canada in 2011 indicated they used on-farm summer pastures grazed June to September (91-96%), with lower proportions grazing in May (36%) and October (66%). However, this excludes community pastures, which are used by 15% of respondents Canada-wide, and 20% of respondents in the Prairie region (Sheppard et al. 2015).

FORAGE REJUVENATION

Tame forage yields, as well as desirable plant species composition, decrease naturally over time without proactive rejuvenation efforts. The 2001 and 2006 Farm Environmental Management Survey provides a historic benchmark on reseeding intervals. There are regional variations as rainfall impacts forage stand productivity over time.

Figure 25. Proportion of producers rejuvenating tame pastures



Sources: Farm Environmental Management Survey 2001, 2006 (beef and dairy producers); ACC, 2018; WCCCS, 2014 (beef producers only)

More frequent rejuvenation appears to occur in Eastern Canada. By 2011, Sheppard et al. (2015) reported that 84% of beef producers grazed old or native grass in the Prairie region and 57% of eastern producers grazed old or native stands, which means rejuvenation of older tame forage stands is an issue affecting beef producers across Canada. The proportion of producers rejuvenating tame pastures every 1-5 years has decreased since 2001 and 2006, particularly in western Canada, and the proportion rejuvenating after 11 or more years has increased. In western Canada, the proportion who do not rejuvenate at all has also increased to 33%.

Table 33. Number of years established forage stands were in production before being broken up: forage farmers who also have beef operations, 2017

	No forage stands	Some forage stands broken up in the last 5 years				
Province	broken up in the last 5 years	One to two years	Three to five years	Six to ten years	More than ten years	Don't know
Canada	**49.99**	**1.39**	**16.22**	**17.99**	**12.63**	**1.52**
Quebec	71.87	3.39	15.61	7.70	1.42	0.00
Ontario	30.01	2.57	41.85	18.36	6.59	0.62
Manitoba	42.16	0.15	10.01	24.03	17.78	5.87
Saskatchewan	56.09	1.09	6.63	14.71	19.19	1.83
Alberta	51.57	0.92	14.14	19.95	12.27	0.77
British Columbia	50.57	0.94	7.02	24.89	14.67	1.36

Figures may not add up to 100% as a result of rounding or due to the exclusion of respondents that did not answer the question.
Source: Statistics Canada, Farm Management Survey, 2017

The 2017 Farm Management Survey (Table 33) reported that 50% of Canadian forage/beef producers had not broken up any forage stands in the last five years. This was highest in Quebec (72%) and Saskatchewan (56%). Those who had broken up forage stands in the last five years reported the stands to have been three to five years old (16%), six to ten years old (18%), or more than ten years old (12.6%). Those who rejuvenated stands more than ten years old where higher in Saskatchewan (19%) and Manitoba (17%) which makes sense given the higher risk of failed stand establishment due to climate.

Tame forage improvements can be made through reseeding, fertilizing with commercial fertilizer, manure, incorporating legumes, and other methods as outlined at http://www.beefresearch.ca/research-topic.cfm/improving-forage-yields-84. Surveys from Alberta Agriculture indicates that in 1986-89, one third of producers fertilized their pastures. Sheppard et al. (2015) found that in 2011, 13% of pastures were fertilized commercially and 13% were manured, compared with 19% of tame hay that received commercial fertilizer and 19% fertilized with manure. There were regional differences, however, with 27% of eastern region pastures receiving manure compared to 9% of pastures in western Canada. Generally, eastern regions used manure fertilizer on forages, pastures, and cropland more than western regions.[14]

Sheppard et al. (2015) also indicated tame hay had a higher percentage of legumes in the sward (42%) than tame pasture stands (22%). Again, regional variations appeared, with Atlantic Canada having only 22% of perennial forage swards containing legumes; while the rest of Canada had >38% of legumes in the stand. In eastern regions, 59% of operations get at least two cuts of perennial forage, while in western regions, this number is reduced to 23% (Sheppard et al., 2015).

[14] This is manure applied to forages and pastures; excluding manure from field feeding.

According to the 2016 Census of Agriculture (Table 34), only 2-3% of beef farms used herbicide and commercial fertilizer, but this represented 25% of the acres (including cropland). Solid manure (incorporated or not) was used by 4-6% of producers, representing 1.4-1.7% of the acreage. While not specific to forage rejuvenation this indicates significant opportunity for extension efforts.

Table 34. Land Management, percentage of total beef cattle farms

Province	Herbicide	Commercial Fertilizer	Solid Manure *incorporated*	Solid Manure *not incorporated*
Canada	2%	3%	4%	6%
Atlantic Provinces	4%	5%	8%	13%
Quebec	20%	23%	30%	30%
Ontario	11%	12%	11%	8%
Manitoba	27%	23%	16%	17%
Saskatchewan	34%	31%	26%	20%
Alberta	2%	5%	5%	6%
British Columbia	2%	3%	4%	6%
Canada (% of acres)	25%	25%	1.7%	1.4%

Source: 2016 Census of Agriculture

Opportunities and Barriers for Adoption

Improving the way beef cattle producers graze livestock, as well as improving forage production, quality, and storage, presents an economic opportunity to producers across Canada. There remains a lack of comparable data that examines pasture management. Undertaking an independent survey that identifies what type of rotational grazing is taking place on what types of pasture, and identifies pasture improvements through commercial fertilization, manure application, reseeding, and plant species used would be beneficial. Surveys must be carefully designed in order to avoid reliance on proxies that are not equal for all regions, such as plant carry over or stubble height.

Producers are increasingly renting pasture and hay land; this may be a barrier to rejuvenating forages or other recommended grazing and pasture management practices. Producers seem less willing to adopt land management practices on land they don't own, so any effective extension efforts will need to promote economic benefits regardless of land tenure.

Data shows that producers are more likely to improve tame hay rather than tame pastures, and there remains an opportunity to highlight the value of improving pastures. In western Canada, a third of producers reported that they do not rejuvenate forages. Potential barriers may include a perception of high rejuvenation costs, a lack of specialized equipment such as press drills or seeding equipment, and generally high annual crop commodity prices. There is a great potential to promote innovative and non-intrusive rejuvenation strategies, including bale grazing, feeding legume seed in mineral, overseeding existing stands, or using cover crops, particularly in conjunction with regional forage extension organizations.

In Atlantic Canada, where forage stands have a lower percentage of legumes, there is extension potential to support the inclusion of more persistent legumes (e.g. alfalfa rather than clovers). Producers in eastern regions are more likely to reseed, apply fertilizer, and apply manure than their western counterparts. Promoting the inclusion of regionally-adapted forage species may be an effective extension strategy for producers in these areas.

STOCK WATER

Controlling livestock access to surface water improves water quality, increases animal gains and can improve animal health. Testing and monitoring water quality is also a recommended practice. Stock water sources vary greatly among regions, with 18% of Ontario beef producers relying on surface water compared to 30% of western Canadian herds accessing surface water and another 12% accessing creeks, lakes or rivers. Controlling livestock access to stock water is a relatively new practice in some regions of Canada and there is limited long-term benchmark data. Water testing is not a new technology and is relatively affordable,[15] however most beef farmers do not regularly test. Data presented includes stock water testing and domestic farm use testing, as noted. Other regions install tile drainage to remove excess water from forage or crop fields, which is also included.

Table 35. Water quality and riparian management

Technology/ Practice	***Benchmark***	***Current***	***Trend***
Controlling livestock access to stock water sources	58.6% do not allow cattle direct access to water in Canada (2001, Statistics Canada)	63% control access (2018, Alberta Agriculture and Forestry)[16] 54% pump water to cattle (2017, OCC) 42% limit access (2014, WCCCS) 79% pump water to cattle in winter in N. Ontario; 98% pump water to cattle in winter in N. Quebec (2016, Lamothe) 63% pump water to cattle in summer in N. Ontario; 95% pump water to cattle in summer in N. Quebec (2016, Lamothe)	 All Regions
Test water quality	5.2% tested domestic water twice/year; 11.6% tested once/year; 9.1% tested once in two years (2001, FEMS Statistics Canada)	5% tested once/year; 7% tested twice in three years; 29% tested once in three years; 59% never test (2017, WCCCS II) 30% tested in last 5 years (2017, OCC) 41% N.Ontario; 17% N.Quebec tested water once/last five years (2016, Lamothe)	 All Regions
Implement stock water systems	25.9% used off-site water systems Canada (2001, FEMS Statistics Canada)[17]	43% off-site water system - Alberta (2018, Alberta Agriculture and Forestry) 31% solar/wind/battery powered water system - Western Canada (2017, WCCCS II)	 Western Canada

[15]Feed and water testing laboratories by province
https://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/dis13074

[16] Alberta Agriculture and Forestry conducts a biennial Environmentally Sustainable Agriculture Tracking Survey. Ipsos completes a 24 minutes telephone survey with a random representative sample of 500 Alberta agricultural producers in January with quotas established for five regions to ensure reliable sample size for each region. The target population is primary agricultural operators who had gross farm sales of at least $10,000 in the prior year.

[17] https://www150.statcan.gc.ca/n1/pub/21-021-m/2007001/t/4054688-eng.htm

Riparian area management	45.5% farms with wetlands use fencing (2001, FEMS Statistics Canada)	70% protect riparian areas from overgrazing; 72% time grazing activities to avoid riparian vulnerability; 79% maintain a buffer area along water's edge (2018, Alberta Agriculture and Forestry)	 Western Canada
Tile draining fields used in livestock production	Unavailable	51% N. Ontario and 51% N. Quebec producers use tiling in forage crop fields (2018, Lamothe). 15% N. Ontario and 24% N. Quebec use tiling on enhanced pastures (2018, Lamothe).	 Across Regions

Opportunities and Barriers for Adoption

In the WCCCS II survey reasons for not testing water included cattle seemed healthy, cattle drank from the same water as the producers; rationalizing that if it was safe for them it was safe for their cattle. Illness and death due to surface stock water quality in western Canada can fluctuate with drought. Regardless of whether the water source is surface or well water, there is a clear opportunity to present benefits of water quality testing to producers across Canada. Encouraging producers to develop their own on-farm water quality benchmarks will allow them to monitor changes over time, understand conditions under which quality parameters may change, and make strategic decisions based on that information. Creating awareness in producers regarding cumulative effects of nitrate, sulfate, or other toxins in water and feed is also critical to prevent mineral toxicities or deficiencies (e.g. copper).

Higher rates of using off-site watering systems are positive as that practice also protects riparian areas. The health and weight gain benefits have been outlined in the BCRC's Economics of Water Systems Calculator [18] and the Fact Sheet [19] by Canfax Research Services. Encouraging producers to explore provincial programs that offer funding for water infrastructure may address some of the longer time frame to pay off the initial investment for smaller herds.

WINTERING MANAGEMENT

According to the 2016 Census of Agriculture, 51.1% of Canadian beef cattle farms have windbreaks or shelterbelts (natural or planted), and 35.4% use in-field winter grazing or feeding. A smaller proportion (7.9%) use winter cover crops and 7.5% plow down green crops into the soil, which helps to improve soil tilth and fertility. As expected, adoption rates vary by region as appropriate to the local climate. Windbreaks and shelterbelts are largely seen in the Prairie provinces (56-62%), as in-field winter grazing or feeding is popular in BC (49.4%), Alberta (45.8%) and Saskatchewan (40%) and is lower in Manitoba at 30.7% and central Canada around 20%.

In general, farms with multiple operators have the highest adoption rates of production practices. Farms in Alberta tend to have higher adoption rates of the listed management practices (see Table 36), followed by farms in British Columbia. Farms in Quebec tend to have lower adoption rates due to regulations banning infield winter grazing.

[18] http://www.beefresearch.ca/research/water-systems-calculator.cfm
[19] http://www.canfax.ca/samples/economics%20of%20water%20systems.pdf

Table 36. Adoption of in-field winter grazing, rotational grazing, windbreaks

	Percentage of total farms	In-field winter grazing or feeding	Plowing down green crops	Winter cover crops	Windbreaks or shelterbelts
Canada		35.4%	7.5%	7.9%	51.1%
Atlantic Provinces	3.1%	15.9%	12.5%	8.9%	36.4%
Quebec	6.8%	20.6%	12.9%	4.5%	24.0%
Ontario	20.0%	19.9%	18.4%	20.9%	38.8%
Manitoba	10.0%	30.7%	2.9%	5.6%	58.5%
Saskatchewan	21.8%	40.0%	2.9%	4.0%	56.5%
Alberta	31.2%	45.8%	3.6%	4.1%	61.9%
British Columbia	7.1%	49.4%	6.8%	6.3%	43.2%

Source: 2016, Census of Agriculture

Between 2006 and 2011, Western Canadian producers shifted away from feeding animals in confinement during the winter months to a system of wintering cattle in fields or pastures, and providing feed through bales, stockpiled forages, or swath grazing. There have been numerous studies demonstrating the economic and environmental (manure management) benefits of extensive wintering. The Farm Management Survey showed adoption increased from 28% in 2006 to 39% in 2011. Eastern regions had lower extensive wintering adoption rates, which may be due in part to excessive precipitation causing a loss of plant biomass and reducing forage quality (Sheppard et al., 2015). However, the 2016 Census of Agriculture indicates that in-field feeding increased in Ontario, Quebec and British Columbia between 2011 and 2016, but declined in the Prairie provinces where most beef cattle are located (Table 37).

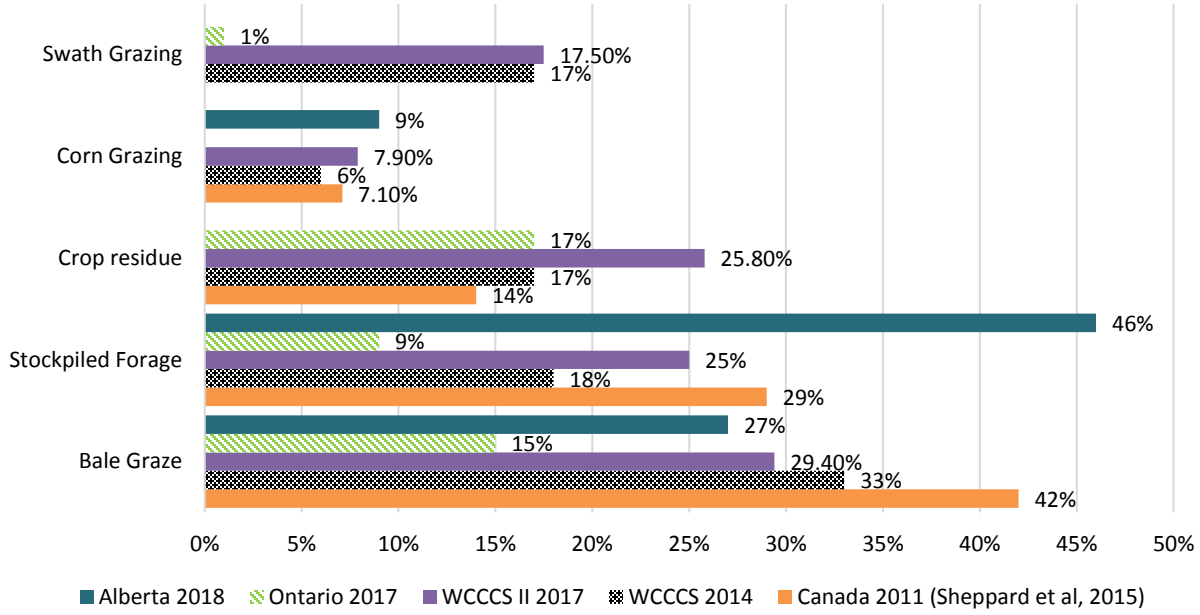
Table 37. Benchmarks of extended winter grazing practices

Extended Grazing	**Small and McCaughey, 1997**	**FEMS, 2006.** Statistics Canada	**FEMS, 2011.** Statistics Canada	**Sheppard et al., 2011**	**COA, 2016.** Statistics Canada*	**WCCCS II, 2017**	**Trend** FEMS 2011 to COA 2016
Canada		**27.8%**	**39%**	**58%**	**35.4%**		↓
Atlantic			17%	35%	15.9%		↓
Quebec			6%		20.6%		↑
Ontario			17%		19.9%		↑
Manitoba	34.8%		54%	68%	30.7%	88.9%	↓
Saskatchewan			65%		40.0%		↓
Alberta			62%		45.8%		↓
BC			45%		49.4%		↑

**In-field winter grazing or feeding.*
NOTE: 2017, FMS data was unavailable at time of publication.

Producers provide winter feed for their cattle through a variety of means. The 2006 Farm Management Survey reported that 18% of farms use early spring forage, 16.8% use late fall forage, 47% feed hay, 15.3% use swaths, and 17.7% dormant season graze. Figure 26 demonstrates the most recent adoption rates of specific extensive winter-feeding practices across Canada and by region. It's important to note that surveys and studies reported a widespread use (62%-82%) of feeding bales in fields by rolling, placing them in feeders, and/or using bale processors, but the methodology was inconsistent, so this is not included in the figure. However, bale grazing and use of stockpiled forage has dropped since the Sheppard et al. (2015) study, except in Alberta which reported higher stockpiled forage in 2018.

Figure 26. Adoption of extended wintering methods by region



According to the 2016 Census of Agriculture, baled crop residue is used by 2% of beef farms and represents only 4.7% of acres managed. There have been anecdotal reports that new technology in combines means that the nutritional value of crop residues is minimal, which requires this practice to be re-evaluated. However, straw for bedding is the primary reason crop residue is baled. Alternative bedding, such as wood chips, are getting more expensive in some regions (e.g. British Columbia) and may result in a shift in practices.

Table 38. Land management, percentage of total beef cattle farms (2016 COA)

Province	Baled Crop Residue
Canada	2%
Atlantic Provinces	7%
Quebec	22%
Ontario	12%
Manitoba	25%
Saskatchewan	31%
Alberta	2%
British Columbia	2%
Canada (% of acres)	4.7%

The WCCCS II (2018) reported average winter feeding of 185 days with an average winter feeding start date of November 15.

Opportunities and Barriers for Adoption

Producers who do not winter graze offered reasons including too much snow, lack of winter water source, too cold, concerns with wasting feed, animal welfare, and animal performance as their top reasons (Sheppard et al., 2015). Similar concerns were cited among non-adopters in the WCCCS II in 2017.[20]

[20] The Sheppard study and WCCCS II used the same list, providing a consistent comparison between 2011 and 2017.

Conversely, Sheppard et al. (2015) reported that producers who did use extensive wintering suggested it reduced their cost of production (80%), improved cattle condition and health (58%), benefited the environment through a reduced footprint (42%), and provided agronomic benefits due to improved soil fertility and yields (16%). Contrasting views on extensive wintering suggest science-based regionally-appropriate extension strategies that demonstrate benefits may be effective.

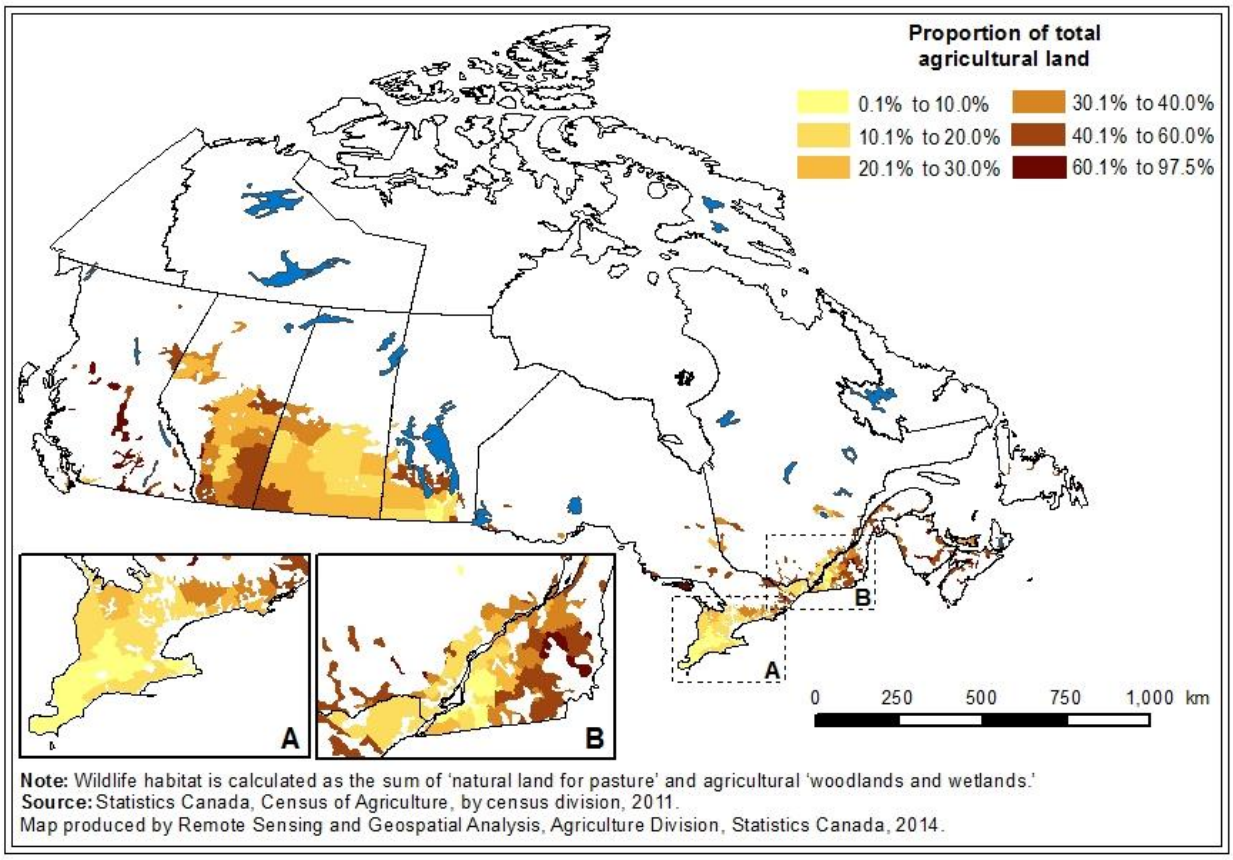
Recent surveys show that 61% of Ontario and 70% of Atlantic producers house cattle using a combination of indoor and outdoor facilities during the winter. Extensive wintering may be a more dramatic paradigm shift and a barrier for producers in central and eastern regions, compared with the Prairie provinces. To effectively promote extensive wintering benefits, producers may prefer hearing benefits from peers.

A reduction in the use of infield winter feeding is not necessarily bad. However, understanding why producers have made that move would inform extension. Particularly if reasons include cows not getting the nutrition needed to rebreed, concerns about wasted feed, wildlife in the swaths or common mistakes in implementing an extensive winter feeding program that result in higher costs rather than saving dollars as intended.

WILDLIFE & SPECIES AT RISK

The National Beef Sustainability Assessment (Canadian Roundtable for Sustainable Beef, 2016) reports that beef production utilizes approximately 33% of agricultural land in Canada, but provides 68% of the wildlife habitat capacity within the agricultural landscape. In 2015, Statistics Canada reported 30.2% of agricultural lands were wildlife habitat, with pastures, woodlands, and wetlands (i.e. grazing lands) comprising the majority of this habitat. Beef producers had the largest proportion of wildlife habitat out of all agricultural sectors. A map of wildlife habitat in Canada can be seen in Figure 27.

Figure 27. Map of agricultural land as suited for wildlife



Source: Statistics Canada, 2015.

In many cases, wildlife and beef cattle farms are co-dependent. Natural and planted shelterbelts, perennial forage cover (hay or pasture), wetlands, and woodlands all provide beneficial habitat for wildlife while also providing forage, shelter, biodiversity, and resilient ecosystems for beef cattle.

Land tenure and pressure from crop commodity prices have placed pressure on wildlife habitat and forage land in Canada. Between 2011 and 2016, Statistics Canada reported a reduction of 1.0 million acres of natural pasture land, 1.1 million acres of tame or seeded pasture, and 695,000 acres of Christmas trees, woodlands, and wetlands (COA, 2016). Historical reports show that loss of perennial forage cover in the Prairies has been ongoing, including an estimated loss of 3.3 million acres from 1990 to 2015 in Saskatchewan alone, an issue that affects beef producers and wildlife alike (Sawatzky, 2018). Changes to

the community pasture structure in western Canada, a program that 20% of Prairie producers utilize (Sheppard et al. 2015), as well as a decline in cost-sharing environmental benefit programs (e.g. provincial Farm Stewardship Programs) may continue to put negative pressure on perennial landscapes and the adoption of practices supporting both wildlife and ranching.

There is little long-term benchmark information available on practices that support wildlife habitat (outside of using a flushing bar on swathers[21]); in addition, these practices vary greatly by region. Data measuring wildlife supportive practices in Alberta demonstrate fairly stable adoption. In 2018, 84% of producers retained woodlands, bush and native grassland, compared with 83% in 2012; 71% adopted grazing practices to encourage natural growth of woodland understory in 2018, the same percentage as in 2012; and 64% managed grazing to provide wildlife habitat in 2018, compared with 61% in 2012 (Alberta Agriculture and Forestry, 2018).

Henderson (2014) undertook a study to identify producers' attitudes toward Prairie species at risk (SAR), wildlife, and conservation in which 86% of producers interviewed believed Prairie wildlife would not be in the study area were it not for producer stewardship efforts over the past century. Sixty percent of producers cited money as the main barrier for adopting new practices. Henderson's work also identified that producers who understood less about SAR legislation were less willing to adopt new management practices or share information about SAR on their land. Producers that demonstrated greater detailed knowledge about SAR were overall more willing to implement new practices and share information. The number of years producers spent ranching in the region and the size of their landbase impacted willingness to share SAR information or adopt new practices. In general, producers who spent more than 50 years in the region and managed more than 6000 acres of land were less willing, whereas producers that lived in the region for less than 50 years and operated on fewer than 6000 acres were more willing.

If conservation of SAR is the goal, Henderson suggests targeting outreach on younger ranchers who tended to be more willing to engage in voluntary stewardship and creating a specific strategy to target older ranchers who tend to be less willing. Improving trust between producers and agencies delivering programs would improve uptake of voluntary stewardship, and programs that pay for ecoservices may help alleviate concerns about financial repercussions of managing for SAR (Henderson, 2014).

MANURE MANAGEMENT

Production practices that impact manure/nutrient management that can contaminate water quality are critical for producers and consumers. According to the 2016 Census of Agriculture, manure (solid or liquid, incorporated or not incorporated) was applied to 3.5% of beef cattle farm acres with a range of 1.6% in British Columbia and a high of 21.9% in Quebec (see Table 34). This is similar to Sheppard et al. (2015), who indicated more manure was spread in pastures in the east (27%) than in western Canada (9%). In general, Statistics Canada (2016) reports that beef producers in western Canada applied manure to a limited number of acres (1.6-3.5%). This may partly reflect the greater use of in-field winter feeding in western provinces (30.7-49.4%).

Lamothe (2018) reported that 41% and 50% of northern Ontario and northern Quebec producers, respectively, applied manure to pastures. Producers in the same regions also reported applying manure to young stands of grass/hayland (42% Ontario, 60% Quebec) and old stands of grass/hayland (38% Ontario, 58% Quebec) (Lamothe, 2018).

[21] https://extension.sdstate.edu/haying-wildlife-mind

In 2001, Statistics Canada reported that 86% of Canadian beef producers had no formal plan for manure management. Most manure (38.4%) was applied in the fall, followed by spring (31.4%), then summer (25.1%), and the least amount (5.1%) was applied in winter. In 2018, Alberta Agriculture and Forestry reported that 75% of Alberta producers keep manure records, and 91% avoid applying manure on frozen or snow-covered ground.

In 2001, 55.1% of beef farms reported leaving manure on the surface or incorporating after seven days of application, 31.5% incorporated 1-7 days post application, and 13.4% incorporated the same day as application (Statistics Canada, 2001). Sheppard et al. (2015) reported that 58% of Prairie operations spread manure between September and November, whereas 76% of eastern operations spread manure from December to May. This suggests that in western regions, manure is spread directly on land whereas in eastern Canada, manure may be stored or composted prior to spreading.[22]

Table 39. Land Management, percentage of total acres on beef cattle farms

	Commercial Fertilizer	**Lime**	**Trace Minerals**	**Solid Manure** *incorporated*	**Solid Manure** *not incorporated*	**Liquid Manure** *incorporated*	**Liquid Manure** *not incorporated*
Canada	25.0%	0.3%	1.8%	1.7%	1.4%	0.2%	0.2%
AP	16.5%	4.7%	1.8%	4.6%	6.4%	0.3%	0.3%
QC	12.9%	2.8%	1.2%	5.2%	9.3%	1.8%	5.5%
ON	31.5%	1.0%	5.1%	6.9%	5.5%	1.2%	0.6%
MB	29.7%	0.1%	2.1%	1.8%	1.0%	0.5%	0.2%
SK	28.4%	0.2%	1.5%	1.1%	0.9%	0.1%	0.0%
AB	23.9%	0.1%	1.9%	1.6%	0.9%	0.1%	0.1%
BC	5.1%	0.1%	0.3%	0.6%	0.8%	0.1%	0.1%

Source: 2016, Census of Agriculture

The 2016 Census of Agriculture, reports that the land (includes pasture, forage and annual cropland) manure (liquid or solid) is applied to on beef operations, is only 3.5% of the total acres managed. The highest proportion is in Quebec (21.9%) followed by Ontario (14.2%) and the Atlantic Provinces (11.5%) with all other provinces below 3.5%. This is likely influenced by provincial regulations. Commercial fertilizer while only applied on 3% of beef operations (see Table 34) is applied to 25% of the land managed (Table 39).

RECYCLING

Recycling agricultural waste is a relatively new practice and Canada-wide information is currently unavailable. Alberta Agriculture and Forestry recorded that in 2018, 52% of producers were recycling plastics, such as twine, feed bags, silage wrap, and bale wrap, which is an increase from 44% reported in 2012.

[22] ESA 2018. 56% incorporate after applying; 30% sample manure. 2017 FMS data will be available in Spring 2019.

FEED AND NUTRITION

A wide range of survey methods and producer practices preclude detailed reporting on the types of feedstuffs used by cow-calf producers. In general, producers in Western Canada traditionally rely on dry hay or straw, supplemented with grain or pellets to feed livestock. Silage is reportedly used in approximately 13-15% of cow-calf herds in Western Canada, which has remained relatively static since the late 1980's (Alberta Agriculture, 1999; Small and McCaughey, 1999).

Generally, corn and hay silage is more commonly fed in eastern regions, historically comprising 23-28% of a beef cow's diet (Rogers et al., 1985), which has increased to an estimated 45% of producers currently feeding silage (OCC, 2018). This means that most producers still use hay (Alfalfa-Grass Hay - $100/ton dry matter; $87 per ton as fed; $243/acre to grow/harvest[23]) because it is less costly than silage (Barley Silage - $122/ton dry matter; $45 per ton as fed; $300/acre to seed/harvest[24]). Barriers to adoption may be the cost of getting custom silage done, particularly for small operations or differences in winter feeding (extensive rather than confined). A solution may be having neighbours work together, to share the cost of a custom silage operator. Challenges and frustrations around sharing silage equipment are numerous. It may be helpful to have guidelines on logistics for successful partnerships between neighbours who silage together.

FEED TESTING AND RATION BALANCING

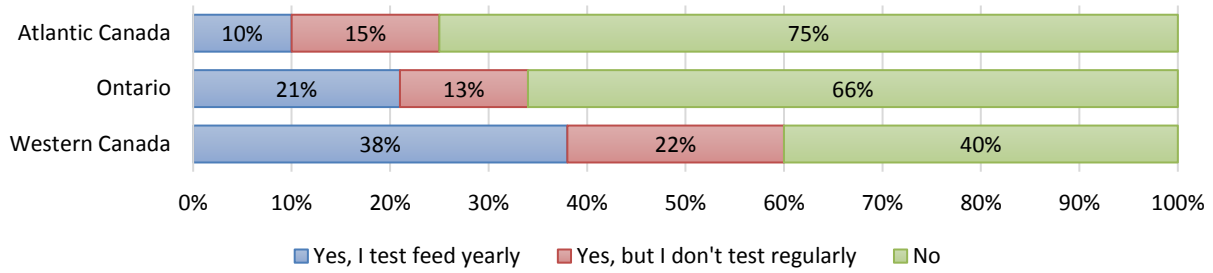
Testing forages to obtain an accurate analysis of nutrient content, identify potential toxins, and establish forage value is a recommended practice for beef producers. Forage analysis allows producers to prevent obvious nutritional deficiencies from occurring. It may also help producers develop on-farm benchmarks and identify insidious reproductive or health issues in their cattle. Ideally, producers test feed in order to balance proper rations for the appropriate class of cattle they are feeding.

Table 40. Adoption of feed testing over time and by region

Technology/ Practice	***Benchmark***	***Western Canada***	***Ontario***	***N.Ontario/ N.Quebec***	***Atlantic Canada***	***Trend***
Feed Testing	27% regularly test & 24% test occasionally Manitoba (1997, Small and McCaughey) 30% (Alberta, 1997-98) 17.7% Alberta (1986-89)	38% regularly test, 22% test occasionally (2017, WCCCS II) 47% test (2014, WCCCS	21% regularly test, 13% test occasionally (2017, OCC)	16% Ontario; 43% Quebec (2016, Lamothe)	26% (2017, ACC)	 Western Canada  Across Canada

[23] https://www.gov.mb.ca/agriculture/farm-management/production-economics/cost-of-production.html#forage
[24] https://www.gov.mb.ca/agriculture/farm-management/production-economics/cost-of-production.html#forage

Figure 28. Proportion of producers that test feed



Sources: ACC, 2018; OCC, 2018; WCCCS II, 2018

Table 41. Producers that use lab analysis to balance feed rations

Technology/ Practice	***Benchmark***	***Western Canada***	***Ontario***	***N.Ontario/ N.Quebec***	***Atlantic Canada***	***Trend***
Balance Feed Rations	25.7% of total cow-calf herds balance rations (1997-98, Alberta)	Of the 60% that test at least occasionally, 44.4% balance their own rations, 38.1% use a nutritionist, 12.5% use an extension specialist, 5% do not balance rations (2017, WCCCS II) Of 47% that test, 80% balance rations (2014, WCCCS)	Of the 34% that test at least occasionally, 48% balance rations with nutritionist, 31% balance own rations, 21% do not balance rations (2017, OCC)	Of the 16% that test, 15% balance rations in N. Ontario Of 43% that test, 26% balance rations in N. Quebec (2016, Lamothe)	Of the 26% that test, 72% balance rations (2017, ACC)	↑ *Western Canada* ? *Across Canada*

Opportunities and Barriers for Adoption

Adoption of feed testing has increased slightly over time (25.7% in 1997/98 to 47% in 2014 and 60% in 2017 – see Table 41) and most who do test use it to balance rations in some fashion.

In WCCCS II (2018), producers indicated the main reason they choose not to feed test is because their cattle seem healthy so there is no need. Very few suggested cost as a barrier. Other producers purchase feed and rely on the seller to test. The concern with producer complacency toward feed testing is that problems related to feed can be treacherous with low levels of toxins or deficiencies occurring without producers being aware. Waiting for animals to show clinical symptoms before a feed analysis is very risky as animals may be too far gone to reverse the problem, or it may prove difficult to source alternate feedstuffs to resolve the issue. Extension efforts geared toward encouraging producers to feed test for the first time could be more effective than encouraging continued annual use of feed testing, as producers may be more likely to continue the practice and to use the results to balance rations after they have tried it for the first time. This needs to start with how to take a representative feed sample so that producers

are confident in the test results. Followed by interpreting and implementing the feed test results in ration development.

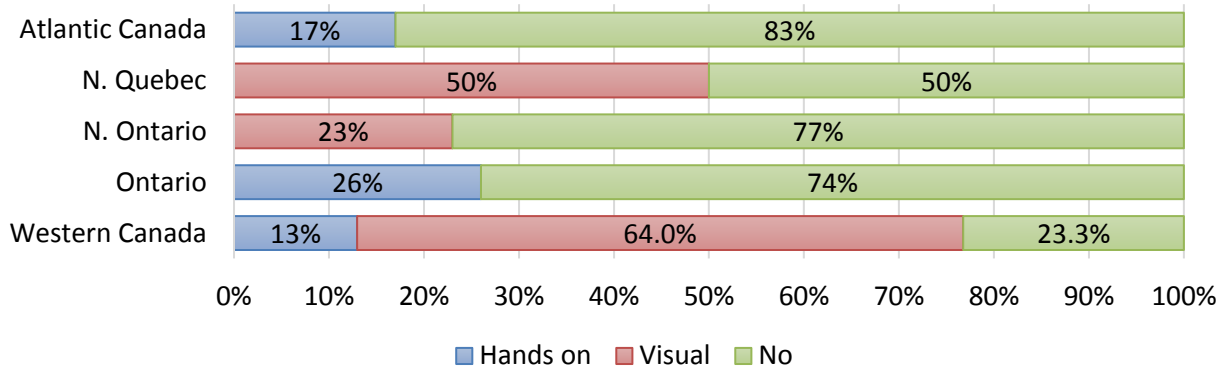
BODY CONDITION SCORING

Cows with an ideal body condition score (3.0 in a 5 point system) rebreed up to 30 days sooner than thin cows, which allows more cows to calve in the first 21 day cycle. This can add up to 42 lbs in calf weaning weight since the calves born earlier in the calving season will be heavier at weaning time. Cows in ideal body condition also have pregnancy rates double those of cows in poor condition, have improved milk production, fewer cases of abortion and stillbirth, healthier calves, and have fewer instances of calving problems.[25]

Body Condition Scoring (BCS) is a technique to help producers determine the condition of their animals and assess whether cattle need to be fed a different ration or managed differently. While the accuracy of BCS is higher when done hands-on[26] (64% R^2 with ultrasound results), most western Canadian producers use a visual assessment that is deemed good enough (41% R^2 with ultrasound results at weaning time). Broring et al (2003) found differences in scores when visual assessments were performed by people with varying levels of experience, but these differences were removed with hands-on assessments. Producers reported that they believe visual assessment allows them to sort cows based on condition into different winter-feeding groups.

In Western Canada, the majority (73%) of producers manage females based on body condition; in Atlantic Canada only 33% manage based on body condition, preferring to manage based on age.

Figure 29. Regularly Body Condition Score



[25] http://www.beefresearch.ca/research/body-condition-scoring.cfm
[26] Hand-on method includes using six specific sites on the animal's body

Table 42. Adoption of body condition scoring (BSC) by region over time

Technology/ Practice	*Benchmark*	*Western Canada*	*Ontario*	*N.Ontario/ N. Quebec*	*Atlantic Canada*	*Trend*
Body Condition Scoring	23.4% BCS - does not specify hands-on or visual (1999, Alberta)	13% perform hands-on 64% visual (2017, WCCCS II) 19% regularly BCS (2014, WCCCS)	26% regularly perform and record BCS (2017, OCC)	23% N.Ontario; 50% N.Quebec – does not specify hands-on or visiual (2016, Lamothe)	17% BCS (2017, ACC)	 Western Canada  Across Canada
Manage cattle according to condition	39.6% feed thin cows separately, (1997-98, Alberta)	73% manage breeding females differently (2017, WCCCS II) 56% sort females by condition/age (2014, WCCCS)	Data unavailable	Data Unavailable	46% manage cows by age, 33% manage cows by body condition (2017, ACC)	 Western Canada  Across Canada

Opportunities and Barriers for Adoption

Body condition scoring (BCS) is variable over time and across regions, and there is disparity in reporting methodology. Adoption of the hands-on method seems to be decreasing in Western Canada and the trend is uncertain in other regions. Correct BCS involves a hands-on appraisal of fat cover, and some survey methods included visual appraisal as an option. Of producers that did not BCS, 50.8% cited that a visual appraisal was good enough, 24.6% suggested their cattle seem healthy so they don't view BCS as a priority, 11.5% indicated they didn't understand how to BCS, and 8.2% said they did not have time.

The purpose of BCS is that producers' sort and manage cattle differently to better manage nutritional requirements (i.e. lower BCS cows receive a higher plane of nutrition). In western Canada, there seems to be an increasing trend in producers managing females according to condition, however they are likely doing this without using hands-on BCS. Producers that do not manage females separately or see that as a possibility are unlikely to perform BCS. It may be useful to illustrate the accuracy of hands-on BCS compared with visual appraisal, and also promote the ability to combine it with other routine practices. Suggesting producers target a handful of cows to BCS instead of the entire herd may help improve uptake; trialability is a key element of persuasion.

MINERAL SUPPLEMENTATION

Trace minerals are important for preventing nutritional deficiencies that can negatively impact growth and reproductive rates. Once again there was a wide range in survey methodologies, with some data reporting mineral supplementation in general (i.e. macro-minerals *and* trace minerals), and other data reporting by season of use (i.e. summer or winter supplementation).

Table 43. Adoption of mineral supplementation by region and over time

Benchmark	***Western Canada***	***Ontario***	***Atlantic Canada***	***Trend***
92.7% provide trace minerals (TM) in winter, 84.2% TM in summer (1997-98, Alberta) 57.8% provide minerals (1986-89, Alberta) 79-80% fed mineral during breeding & last month of pregnancy in Ontario (1983, Rogers et al.) 16% TM, 64% fed salt/mineral mix in winter in Manitoba (1997, Small and McCaughey)	69% provide TM in winter; 76% provide TM in summer; 82% provide mineral in winter; 60% provide mineral in summer (2014, WCCCS) 55.8% supplemented trace minerals to breeding females on pasture; 82.6% pre-calving; 72.7% post-calving in SK (2012, Jelinski)	72% provide minerals at turn-out to breeding, 65% provide minerals during breeding, 59% provide minerals after breeding, 60% have minerals in winter (2017, OCC)	97% provide minerals (2017, ACC)	 Eastern Regions  Western Canada

Opportunities and Barriers for Adoption

Mineral deficiencies can impact reproductive performance and support general animal health. There are regions within Canada with known mineral deficiencies in forages that should be supplementing year-round. Other regions lack this specific data, so information on mineral supplementation needs to be based on seasonal forage and water quality. Continued general communication should be useful to help reverse the declining trend in western Canada.

MARKETING METHODS

Understanding how calves are marketed is useful to identify production practices that optimize animal health and profitability as the animal moves through the value chain. Marketing methods vary by region and over time. While the advent of electronic and online auctions has presented a new opportunity for cattle marketing, it is important to note that most calves are still marketed via live auction in Canada.

Table 44. Marketing methods across Canada

Marketing Method	***Benchmark***	***Western Canada***	***Ontario***	***N.Ontario/ N.Quebec***	***Atlantic Canada***
Auction Market	89% Manitoba (1997, Small and McCaughey) 70% (1987-91, Alberta)	79.4%* (2017, WCCCS II) 80% (2014, WCCCS)	54.2% live off-site auction (2017, OCC) 11.4% live on-farm auction (2017, OCC)	76% N.Ontario; 37% N.Quebec (2016, Lamothe)	55% cattle sold live auction (2017, ACC raw data)
Electronic Auction *(includes satellite, video, online)*	12% Manitoba (1997, Small and McCaughey)	11% (2017, WCCCS II) 9% (2014, WCCCS)	0.2% (2017, OCC)	Data unavailable	Data unavailable
Direct Sales	4.4% to feedlot, 12.3% to farmer (1986-89, Alberta) 35% Manitoba (1997, Small and McCaughey)	20.1% (2017, WCCCS II) 12% (2014, WCCCS)	15.4% (2017, OCC)	9% N. Ontario, 12% N. Quebec, direct to feedlot (2016, Lamothe)	28% cattle sold direct to feedlot (2017, ACC)
Order Buyer	9.3% (1986-89, Alberta)	5.3% (2017, WCCCS II) 7% (2014, WCCCS)	3.9% (2017, OCC)	*Other (includes order buyers) 14% N.Ontario; 17% N.Quebec (2016, Lamothe)	11% sold through order buyer (2017, ACC raw data)
Custom Fed		48% (2017, WCCCS II)[27] 2% (2014, WCCCS)	1.9% (2017, OCC)		<1% (2017, ACC raw data)

Percentages won't add up as producers are able to choose multiple methods
*59% of calf crop through live auction plus 11% through electronic auctions (satellite/video)

[27] This may be an indication of sample bias in the survey with larger operations with a higher probability of retaining ownership being represented than what is seen in the sector overall.

ON-FARM RECORDS

Record keeping is an important tool that can enable producers to identify production gaps at a herd level or on an individual animal basis. Pruitt et al. (2012) determined that using computer records is highly correlated to adopting other recommended practices, including feed testing and the use of veterinary services. There are a wide range of record-keeping systems and details, including financial records, animal production records, paper-based systems, and electronic/online software. The purpose of keeping records is to improve profitability and efficiency (Manglei, 2016), but little is understood about how producers utilize records to better manage their operations (Micheels et al. 2018). On-farm benchmarking, whether informal or formal, depends on the type of records kept.

Table 45. Adoption of production records across Canada over time

Recommended Practice	***Benchmark***	***Western Canada***	***Ontario***	***N.Ontario/ N.Quebec***	***Atlantic Canada***	***Trend***
Production Records	27% Manitoba (1999, Small and McCaughey) 30% Ontario (1983, Rogers et al.) 70% <40 hd 85% >40 hd Quebec (1995 Dutil et al.) weight of calves, age of cows, health events, treatments	39.5% use computer-based production records (2017, WCCCS II) 40.6% have detailed record-keeping (2015, Manglai)	97.6% keep records - 86.6% paper - 19.5% electronic - 14.6% other (2017, OCC)	N. Ontario - 88% use hand-written records; 18% use smartphone/tablet; 23% use Excel; 9% use breed associations; 9% use BIO (2016, Lamothe) N. Quebec – 80% use hand-written records; 18% use smartphone/tablet; 24% use Excel; 4% use breed association; 1% use BIO (2016, Lamothe)	98.5% keep records- 89.2% paper - 1.5% electronic - 7.7% other (2017, ACC)	 Across All Regions

Murray et al. (2016) found that only 6.8% of the 256 Alberta cow-calf producers did not record anything at calving. The majority (66%) used paper, 24% recorded on paper then entered into a computer, and 2.8% directly on a smartphone or electronic device. These numbers would suggest the sample of participating producers was biased towards those willing to collect and submit the necessary data for the study.

Micheels et al. (2018) assessed results from a 2018 record keeping survey of 62 producers in western Canada. The primary reasons commercial cow-calf operators kept records was to improve production (41.9%) followed by improving genetics (38.7%). They found that of producers who maintain records, 52% maintain paper *and* electronic records, 22% maintain electronic records only, and 26% keep paper records only. Fifty percent of producers who reported using electronic records relied on Excel spreadsheets, followed by other programs at lower rates, such as Cattlemax, breed associations, HerdTrax, BioTrack, and others.

Manglai (2016) surveyed 110 producers in 2015 (with a 61% response rate) to determine what types of production records they were keeping. Manglai (2016) found that 40.6% of producers surveyed practiced detailed record keeping (defined as collecting: calf ID linked to Dam ID, birth date and weaning weight).

Herd size was a negative and significant association with record keeping. It is perhaps unsurprising, because with increased herd size more time is required to track/keep detailed production records, and as time becomes limited, ability to commit to detailed record and analysis diminishes. Producers in Saskatchewan and Manitoba were 3.85% and 4.45% less likely to use **detailed record-keeping** than their Alberta counterparts.

Table 46. Record-keeping parameters measured by producers in western Canada

Production Parameter	***Percentage of Respondents Measuring***
Birth date	98.6%
Individual animal ID (e.g. management tags)	92.8%
Calf ID linked to dam ID	91.3%
Culling/death loss records	91.3%
Health records	85.5%
Birth weight	47.8%
Weaning weight	42%
Detailed record keeping	40.6%
205 day adjusted weight	27.5%

Source: Manglai (2016)

Micheels et al. (2018) learned that 70% of producers track conception rates, a common metric; however, fewer producers track production standards commonly promoted through extension efforts, such as calving distribution, pounds weaned per exposed female, pounds produced per acre, or calf weaning weight as a percentage of dam's weight. Micheels et al. (2018) data shows that producers may be maintaining valuable records, but they may not be using that data to establish and analyze benchmarks in order to compare production and financial performance. Manglai (2016) reported similar results, showing that while benchmarking can result in a return of around 60 lbs per exposed female on cow-calf operations, only 36.7% of producers are establishing operational benchmarks.

Manglai (2016) determined Manitoba producers were 33% more likely and Saskatchewan producers were 48% less likely to use **benchmarking** compared to Alberta producers. Manglai found that learning oriented producers were more likely to use both record-keeping and benchmarking. Producers with total family income from beef production ranging from 25% to 49.99% were less likely to keep detailed records and use benchmarking than producers with more than 50% of their income coming from beef production.

Opportunities and Barriers for Adoption

Manglai (2016) determined that Manitoba and Saskatchewan producers are less likely to use **production records and benchmarking** than Alberta producers, perhaps due to variations in regional extension efforts. Manglai highlighted a few initiatives, such as the Saskatchewan Ministry of Agriculture's 21 Day Calving Challenge, as an example of a specific record that immediately provides informational benefits for producers by comparing their results to the recommended benchmark. He also indicates that larger herds had a lower tendency to keep records. Record-keeping is time-consuming and the amount of effort required increases as herd size increases. Technology (e.g. Bluetooth on weigh scales) is making this easier, but it must be able to operate at the speed of current operations. If producers maintain records, yet fail to translate the information into useful benchmarks, they may discontinue the practice.

Record-keeping and benchmarks are intrinsically tied, so if producers are making the effort to keep records, they should be able to extract value from them in a simple, effective manner. There are numerous different ways to calculate benchmarks and financial, production, and social goals vary according to operation and region. Metrics such as calculating pounds of calf weaned per acre, while often promoted

through extension, may seem irrelevant to producers who rent pastures, graze crop residue, use community pastures, or have other unique collaborative grazing strategies. For producers who don't have a scale to record weights, establishing a benchmark of a calf's weaning weight as a percentage of cow weight will not be useful. Therefore, it may be most effective for extension organizations to strategically promote simple, standard metrics such as the GOLD indicators to producers already using record-keeping. Promoting self-comparison on an annual basis using fewer, key parameters may be perceived to be more attainable by producers so that they are introduced to the benefits or benchmarking without being overwhelmed. Once producers become familiar with the habit of establishing benchmarks, they can tailor their goals and measures as needed.

EXTENSION OPPORTUNITIES

Specific examples of extension opportunities are highlighted in each section of this report. This discussion highlights general themes that emerged from survey results that point to potential strategies.

Some surveys, particularly the WCCCS II (2018), asked producers to identify reasons for non-adoption of a recommended practice. A recurring reason for not adopting practices such as feed testing, water testing, vaccination, or body condition scoring, is "cattle seem healthy, so why bother?" This is a risky mindset because if producers wait to manage an issue until clinical symptoms are present or it becomes very obvious from an animal health and welfare or economic standpoint, it may be too late to rectify. Explaining how risks are reduced and opportunities or realized by adopting practices that "**prevent wrecks**" can be helpful. As noted earlier, Sheppard et al. (2015) found most producers are willing to take risks to be successful; but are cautious about new ideas. There is a greater focus on preventing large losses than missing substantial gains which may result in a reluctance to adopt new things until they have been seen working for others. Sharing case studies or flowcharts[28] may be an effective approach. These tactics may be effective at reaching producers who may not consider the losses caused by subtle, subclinical, or insidious issues.

Producers tend to not handle animals more than necessary, and concerns regarding time, labour, and facilities were perceived as barriers throughout most surveys for many practices. For this reason, it may be beneficial to promote recommended practices as "extensions of" an already existing routine. Compatibility is a key element of persuasion. Considering cow-calf operations from a whole system and promoting a suite of valuable practices that may be performed concurrently may be effective in some circumstances.

In Atlantic Canada, producers ranked veterinarians as their top source of information for both animal health and animal nutrition in 2017. Sheppard et al. (2015) also reported veterinarians ranking fairly high as a preferred source of information in the Prairie Provinces. Producers reportedly interacted with their veterinarians up to 8 times per year (WCCCS II, 2018). Using pregnancy checking as a proxy for veterinary activity on a farm-level, producers are using veterinary services at a higher rate today than in the past. Recent policy changes regarding antibiotic accessibility have the potential to increase in veterinary-client-patient interactions. It would be useful to target the veterinary community with animal health and nutrition practices (e.g. vaccine use, pain control, early life interventions, dystocia, mineral supplementation, feed and water testing) in order to utilize their relationship with producers to encourage adoption. Some regions, particularly Atlantic Canada, primarily rely on veterinarians for information. Engaging with beef veterinarians to learn what about potential emerging issues they face (e.g. emerging diseases, health issues, nutrition questions with alternative feedstuffs), while partnering with them on key initiatives to support mutual extension efforts regarding a particular practice or practice set, will ensure producers are receiving the right messages from a variety of trusted, influential source.

Land tenure will continue to impact adoption of land management practices such as forage rejuvenation and management of grazing and manure. Producers may be more motivated to adopt practices on their own property than on rented land, and extension strategies need to recognize this in order to remain effective. Extension efforts that recognize this limitation and lowers barriers by persuading a land owner,

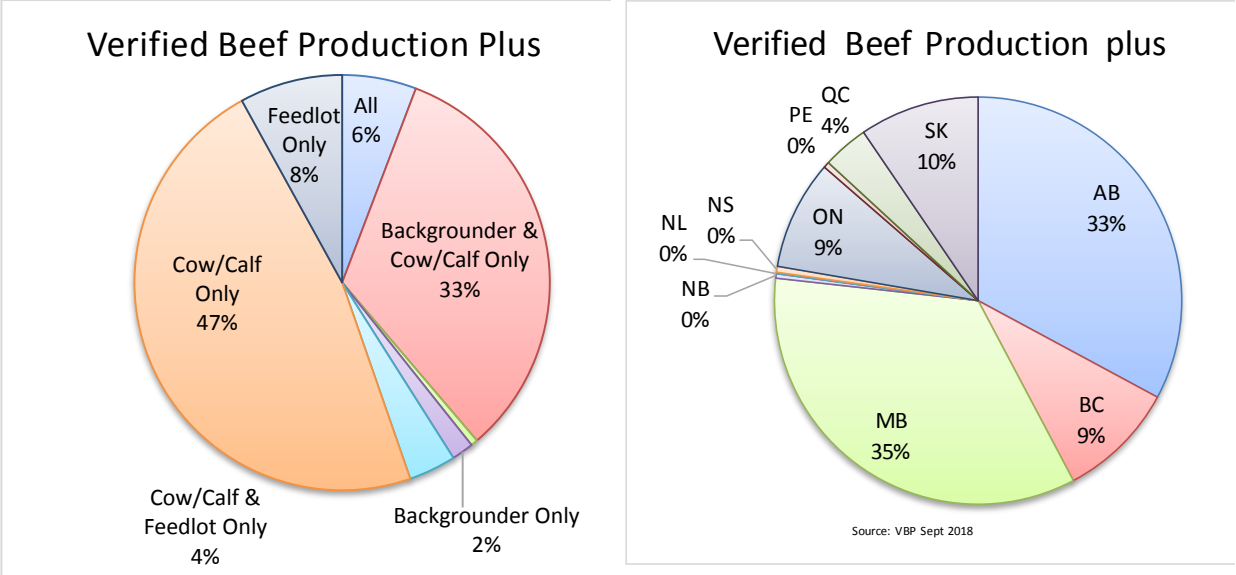
[28] For example, the Vaccination flowchart for decision making http://www.beefresearch.ca/files/pdf/Bovine%20Viral%20Disease%20BVD%20Flowchart%20-%20Saskatchewan%20Cattlemens%20Association%202017.pdf

that is renting to a producer, to encourage adoption of practices through longer rental agreements and other innovative solutions.

Verified Beef Production (VBP) Plus

Verified Beef Production plus (VBP+) began as an on-farm food safety program that has expanded to include environment, biosecurity, and animal welfare (as of June 2016[29]). Through the Cargill Beef Sustainability Acceleration Pilot project there are now financial incentives for producers to be on VBP+. The training materials and communications provided by VBP+ is a way to connect directly with producers about adoption of beneficial management practices. As of September 2018, 852 active operations were enrolled in the VBP+ program operations across Canada, representing approximately 992,000 head of cattle. Every type of operation is represented, with the majority being combined cow-calf/backgrounders (33%) or cow-calf only (45%).

Figure 30. Verified Beef Production Plus



DATA GAPS

Of the 18 data sources reviewed for this report, no single survey included all the key indicators for all productivity or management practices. For example, none of the most recent surveys had data for cow weights which would allow one to calculate the **weaning weight as a percentage of mature cow weight**. In contrast, providing only the average weaning weight (which was not in all survey results) decision making can be skewed to focus solely on additional pounds. At a minimum, having a 205-day adjusted weaning weight is needed for comparison.

Filling some of the key data gaps, such as open rate and calving season length in Quebec, would guide extension efforts in certain regions. Asking producers to quantify use of pain control during difficult calvings in future surveys will provide insight into post-natal pain management. Having a consistent question across surveys to monitor any changes in veterinary-client-patient relationships with the new antimicrobial use policy would help guide collaborative extension efforts personnel with veterinary clinics.

[29] http://verifiedbeefproductionplus.ca/about-vbp/what-is-vbp.cfm

SURVEY COMPARISONS

If comparisons across regions are desired moving forward, it is critical to **ensure survey questions and reporting methods are similar**. For example, when survey data reports average weaning weights, some regions reported average weaning weight of calves born from cows versus heifers, average weaning weight per cow exposed, average weaning weight of specific classes of calves (steers, bulls, heifers), or estimated weights rather than scale weights. This is similar for other GOLD metrics such as calving distribution and calf death loss. **It is recommended that survey developers identify core target metrics that are to be included in all surveys to ensure the methodology and reporting measures are comparable**. Ideally, future surveys should be managed by one group with all questions developed by representatives from each of the participating regions.

Incidence of **dystocia** and **castration practices** are not currently comparable among regions. There is also a high degree of variability among regions regarding **vaccination**, which occurs partly because different areas have different herd health needs. However, there was clear producer confusion regarding which vaccines are used for which diseases (reproductive vs. respiratory); and they often overlap, so there's opportunity to encourage adoption of respiratory vaccines to improve reproductive performance. A more strategic effort to compare common issues across regions would better guide extension efforts while potentially improving animal health and welfare.

There is a high level of interest in **preconditioning,** yet very little survey information is available to compare across regions. It is recommended that future surveys further explore preconditioning, determine producer motivation (retained ownership; guaranteed premiums), determine which practice sets are common, and when preconditioning activities occur. There is also limited survey information on **creep-feeding**. While some regions have information on whether or not creep-feeding occurred, they do not have the underlying justification. It could be helpful to delineate between creep for bunk-breaking (i.e. as part of a preconditioning program) or creep for environmental reasons (i.e. drought).

Water testing was not comparable by region, so consistency in survey questions/reporting among regions is recommended. **Body condition scoring** is another important tool that is often promoted; however, disparity among regional surveys left questions regarding whether producers were using hands-on scoring or visual methods. Clarity among extension personal about the end goal (e.g. feeding separately based on condition) will determine if visual appraisal is 'good enough' even if it is not as accurate.

Existing producer surveys regarding **forage use, development, and management** are variable. Given the understanding that forages make up a large portion of a producer's cost of production, a better effort should be made in future surveys to establish a clear picture of management, barriers, and opportunities. Alternatively, regional or national forage surveys could be designed and carried out by partner agencies. Grassland acres continue to disappear, and cow-calf operators must be creative in order to produce forage and manage grazing on fewer acres. A clearer understanding of **rejuvenation practices, grazing strategies, plant species used in rotations** would be helpful in focusing future research and extension efforts. Some of these questions are answered in the 2018 Farm Management Survey and these results should be communicated to the extension community when available.

Marketing methods will likely continue to evolve as internet sales become more mainstream. It is important to ensure that producers differentiate between selling online (e.g. DLMS, TEAM) and selling at live auction via satellite, as this distinction caused some confusing survey results.

Potential surveys must be carefully designed in order to establish **a cohesive approach, improve sample sizes, and reduce inconsistencies in data**. Finally, **raw data should be analyzed similarly across regions**

(i.e. percentage of cattle preg-checked, vs. average number of cows reported as being preg-checked) with reporting in a similar way in order to be most effective at identifying trends. Response burden is a major concern with low response rates and selection bias being a real challenge. Having a set of core questions that are the same in every region which focus on 'need to know' with a special interest section that can change between regions addressing 'nice to know' issues.

FUTURE SURVEY OPPORTUNITIES

The Canadian beef industry has undergone some recent changes that may affect adoption of recommended practices. New products (such as pain medication), new recommendations in Canada's Code of Practice for the Care and Handling of Beef Cattle, impending new transport and traceability regulations, a new policy from Health Canada regarding access to livestock antimicrobials (effective December 1, 2018), and future shifts in management or the regulatory environment will affect general cow-calf practices and may also impact adoption of recommended practices.

As pain management continues to evolve, with more research results and products available, this will be an important area in future surveys. For example, if producers begin to consider the pain associated with dystocia or illness, it may be helpful to address pain management for those conditions in greater detail in future surveys.

Most surveys cover breeding of one year through to weaning of the following year, and it may be helpful to ask producers to self-identify if there were any external factors (i.e. hard winter, spring blizzard) that may have impacted their calf crop in an extraordinary way. While this anecdotal information may not be statistically sound, it may provide insight into differences in reported results. Statistics related to calf death loss, in particular, may be impacted by weather or other external factors. Also asking questions about how many years (i.e. two of the last three) they utilized certain practices rather than focus on a single calf crop would also remove some of the uncertainty around external factors influencing answers.

Understanding where producers get information is a critical link to developing effective technology transfer and extension strategies. While all three recent surveys addressed sources of information, only results from the WCCCS II and the Atlantic Cow-Calf Survey were readily available for analysis at the time of writing. Going forward, how and where producers access information should be included in surveys across Canada, particularly as social media, rural internet access, and digital practices evolve. Future surveys should assess which specific sources and/or platforms producers (1) use most often, (2) prefer and why, (3) are most influenced by and (4) trust to provide accurate information.

Recommend that future surveys ask questions about how producers view their veterinarian to better understand the barriers of why veterinarians aren't utilized more (e.g. is consultation just a perceived expense that won't pay for itself, disagree with advice provided, vet lacks interest/skill in teaching/communicating).

As new technologies, production and management practices become more mainstream, future surveys should include questions to track speed of adoption.

ADOPTION MOTIVATORS

The WCCCS II asked producers who indicated that they did not adopt a particular practice, to provide their justification (i.e. producers could choose from a list of answers or could provide their own reasons). This is useful for extension and research initiatives, and other regional surveys should consider incorporating

this self-reflection. Understanding why some practices are in decline with dis-adoption occurring (are producers moving towards a different practice or abandoning a practice that did not work on their operation) could also inform extension efforts.

Though challenging to address, there is a lack of long-term information on what social factors affect a producers' willingness to change. Henderson (2014) analyzed the social dimension of producers' willingness to adopt conservation practices. While **profitability is often rated as the top motivator**, several intangible social factors often motivate producers, which should be recorded and examined. Sheppard et al. (2015) surveyed producers on their comfort levels with risk and specific motivators for change, as did the WCCCS II, and this component should be surveyed in other regions, as well as monitored over time. Does short-term profitability impact a producer's willingness to take a risk and adopt a technology or practice? It may also be valuable to examine how risk management programs with perceived or actual benefits impact adoption. For example, if producers manage their risks through WLPIP, does this make them more likely to adopt other practices? However, when happiness is a larger motivator than profitability, the analysis is complicated. For example, family pressures or consideration of staff morale are sometimes reason enough to adopt.

A study of adoption of pain mitigation would be useful for understanding intangible factors that motivate producers to adopt. The regional differences could be confounded by herd size. A hypothesis could be that producers in the East may use both an anesthetic and an anti-inflammatory because they are processing fewer animals compared to the West.

The WCCCS II also asked producers to outline their operational goals, which provides information about social motivators. It is recommended that examination of operational goals should be replicated in other regions, and perhaps could be analyzed with respect to market disruption or weather events.

It may also be useful to determine how low profits or losses impact adoption. For example, whether or when negative or low profit margins are a barrier to adoption (i.e. a producer wanted to adopt a practice however drought diverted their funds) versus a catalyst for adoption (i.e. does a drought cause producers to increase adoption of a practice such as pregnancy-checking).

More in-depth analysis of existing survey results is warranted. For example, examining whether a producer's years of experience and/or stage of production (i.e. start-up vs. well established) affect adoption rates of specific practices. Producer demographics are poised to shift drastically in the next five to ten years. It will be important to strategize the best approaches for communicating content and promoting recommended practices to the upcoming coming generation of producers (who may have different mindsets or values) while also being mindful of the intricacies of succession planning.

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