ALBERTA BEEF, FORAGE & GRAZING CENTRE

# 2018 Annual Report

## Executive Summary

The Alberta Beef Forage and Grazing Centre (ABFGC or the Centre), while still a fairly new initiative, has garnered a large amount of industry support, as well as engagement from key stakeholders including federal and provincial governments, academic institutions and applied research associations. While challenges remain on how best to integrate activities taking place outside of the main hub at the Lacombe Research and Development Centre under the umbrella of the ABFGC, many of these activities are captured through current collaborations by research scientists or funding awarded by the three signatory organizations.

The momentum of the Centre is growing, with word of mouth awareness, key research and knowledge translation and transfer (KTT) activities, an engaged industry advisory board and management committee, and strong commitment from all stakeholders. The development of new KTT resources under the Centre's branding, in partnership with the Beef Cattle Research Council, has also helped to expand general awareness of the Centre. In addition, the Centre is now on social media at https://twitter.com/ABForageBeef

The number of projects led by, or with participation from, the Centre's core personnel group is growing. In 2018, 94 research and extension projects supported the Strategic Goals of the Centre, an increase from 72 in 2017. The dedicated extension initiatives, the Rancher Researcher Pilot and KTT Project, funded by Alberta Agriculture and Forestry, are particularly exciting. Most of these projects are in initial stages, as 2018 was a pivotal year for project completions due to the transition from Growing Forward 2 funding programs to CAP funded programs and projects. Pertinent results have been reported previously.

Several of the projects outlined in this report confer significant linkages to each other. For example, barley breeding efforts result in new varieties that are utilized in backgrounding or swath grazing trials. Grazing management and agronomy trials will impact the environmental component of feed efficiency as well as the environmental footprint of the cowherd, and feeding costs. Improved forage quality reduces cost of gain, while concurrently reducing greenhouse gas emissions. Improved knowledge regarding how management practices and environmental conditions impact genetic potential directly leads to better selection decisions and forage management strategies to ensure cattle are suited to their environment and production system.

It is important that the activities of the Centre reflect the strategic plan and goal development, recognizing the long-term nature of those goals. Granted, it can be difficult to assess progress against goals with a substantial time horizon (in this case 15-20 years), however; the research and KTT activities both in progress and completed demonstrate the commitment of personnel and organizations involved with the Centre towards achieving those long-term goals.

The Centre has six strategic, long-term goals as follows:

1. Reduce winter feeding costs by 50%

- Supported by sixteen research and extension projects, investigations into variety development, variety evaluation, higher energy forages, and grain processing will assist in decreasing winter-feeding costs for producers. Success stories include the development of sainfoin and alfalfa germplasm with higher oil (energy) content in vegetative tissues, the evaluation of new varieties in a "cow" context at an earlier point in the breeding process – determining the ability of a certain feed to provide profitable gain. In addition, several new high-performing varieties of two and six row barley, and triticale were commercialized.

2. Reduce the environmental footprint of the cowherd by 15%
   - Supported by twenty research and extension projects, determining the factors related to decreased methane production and improving nutrient management practices will help beef producers decrease their environmental footprint. In addition, a better understanding of carbon sequestration, water use efficiency, and biodiversity will also contribute to a reduced environmental footprint. An example of success is the generation of the hypothesis that there is an association among different species of bacteria and copy number within each RFI group, which represents a significantly deeper understanding of host-bacteria genome interactions.
3. Improve cow efficiency by 15%
   - Supported by thirteen research and extension projects, elucidating the factors contributing to differences between animals in feed efficiency, the interactions between feed efficiency and feed stuffs, as well as ways to improve the feed efficiency of the mature cow herd will not only improve producers' bottom lines, but also contribute to reducing the environmental footprint of beef production. Success stories include: A commercially available test for determining heterosis, along with an investigation of what constitutes "optimal" heterozygosity and completion of the first selection cycle of hybrid bromegrass with improved NDF, which created divergent populations for this trait.
4. Reduce backgrounding costs by 50%
   - Supported by twenty-six research and extension projects, incorporation of new or better adapted forage varieties, higher energy feedstuffs, interaction between feed quality and feeding management, and better grazing management will improve the performance of backgrounded cattle while decreasing costs. A success story looking at efficiency interactions with forage quality and diet formulations discovered a 33% to 44% reduction in feed conversion depending on the type of silage fed and the ration formulation used. 3% of the improvement in feed conversion with the triticale silage-based diet was due to type of silage, while 97% was due to diet formulation. For the barley silage-based diet, 60% of the improvement in feed conversion was due to the type of silage and 40% was due to feed formulation. Improvement in feed conversion was estimated to result in a 29% (triticale silage) to 40% (barley silage) reduction in methane emissions intensity and a 19% (triticale silage) to 28% (barley silage) reduction in the total cost of gain during the backgrounding period.
5. Improve late summer/fall pasture productivity by 30%

- Supported by nineteen research and extension projects, developing forage varieties and management practices to mitigate the decline in forage yield and quality in late summer and fall will reduce overall cost of production and help to ensure the nutritional requirements of cows are met year-round. Success stories include the development of alfalfa populations with reduced fall dormancy that are still winter hardy, and best management practices for pasture rejuvenation.

6. Build and maintain research and extension capacity
   - Supported by all of the activities and projects of the Centre, this key goal underpins all of the other goals. Without adequate research and extension capacity, this entire initiative, the strategic goals, and the progress made to date is lost, and unlikely to be recovered.
   - The activities of the Rancher Researcher Pilot are progressing very well, with additional economic data collection, the application of SOIL GROWS GOLD benchmarking, baseline forage and soil analysis and further conversations with the participants about adoption attitudes. The larger KTT project has already developed two decision making tools to assist producers in critical analysis of feed test results and to price feed based on quality that are available on beefresearch.ca. The KTT project has also been instrumental in preserving the knowledge that was available on foragebeef.ca. These two projects are critical components supporting all of the Strategic goals of the Centre. They have also contributed greatly to the coordination of extension initiatives within the province among multiple organizations, reducing duplication and maximizing resources while increasing impact and improving audience reach.
   - Key capacity is in place with adequate resourcing to fulfill current activities. However, it is important to note that specific capacity gaps in western Canada have been identified (primarily grazing management/utilization/agronomy, as well as forage beef “systems” expertise - combining plant and animal interactions in a cohesive manner). In addition, the need for adequate succession planning to re-fill potential upcoming retirements at various institutions has been recognized. As the Centre continues to grow and excel, it is likely that administrative capacity will be needed, at least on a part time basis, to adequately oversee all Centre activities.

## Background

The concept for the Alberta Beef, Forage and Grazing Centre arose from concerns expressed to the Alberta Minister of Agriculture and Rural Development by individual beef producers and forage/beef interest groups about a lack of essential applied forage research and extension available to beef producers in Alberta. A research-extension group called the Western Forage Beef Group had operated as a federal-provincial organization out of the Lacombe Research Station, from 1995 to 2005, and had a focused approach to these issues. The concerns and inquiries expressed the necessity for a similar group to address current industry issues. Subsequently, focus groups were organized and carried out by a third party, which confirmed the interest and the need for a renewed research and extension effort in the forage-beef area.

This led to the formation of a steering committee in the summer of 2011, with representatives from ARD, AAFC, University of Alberta (U of A), Alberta Beef Producers (ABP), Beef Cattle Research Council (BCRC), Agricultural Research and Extension Council of Alberta (ARECA), Alberta Forage Industry Network (AFIN) and the Canadian Forage and Grasslands Association (CFGA). Support for the concept was recognized throughout all levels of industry and government.

In April of 2015, The Alberta Beef, Forage and Grazing Centre became a reality, with a tripartite agreement between Alberta Beef Producers (ABP), Agriculture and Agri-Food Canada (AAFC), and Alberta Agriculture and Forestry (AF). It has the mission of developing and transferring knowledge, innovative processes and tools to improve the forage/beef industry.

The Centre utilizes existing AAFC and AF facilities and staff, with a small cash infusion from ABP to assist with core funding and KTT initiatives.

## General Centre Activities

- Industry Advisory Committee membership currently consists of:
  - Arno Doerksen, Gem, AB (cow/calf; finishing)
  - Sean McGrath, Vermilion, AB (cow/calf)
  - Ron Buchanan, Fort St. John, BC (cow/calf)
  - Matthew Gould, Consort, AB (cow/calf, backgrounding, finishing)
  - Stacey Meunier, Barrhead, AB (cow/calf, custom grazing)
  - Jill Burkhardt, Gwynne, AB (Alberta Beef Producers representative)
  - Christine Fulkerth, Olds, AB (Alberta Forage Industry Network representative)
  - Ken Ziegler, Rocky Mountain House, AB (Agricultural Research and Extension Council of Alberta representative)
- The third annual meeting of the Centre was held on February 6, 2019 in Lacombe, with attendance from multiple organizations with an interest in beef and forage systems work in Alberta, such as Olds and Lakeland Colleges, the University of Alberta, Agriculture and Agri-Food Canada Lacombe, Lethbridge, and Beaverlodge Research Stations, Alberta Agriculture and Forestry, Alberta Environment and Parks, Agricultural Research and Extension Council of Alberta, and the Beef Cattle Research Council. Each organization was invited to make a short presentation about how their activities support the Centre goals. Dedicated presentations on the Rancher/Researcher Pilot and KTT projects were also made. There was an open discussion session in the afternoon that focused on strengthening collaboration amongst groups and a demonstration of AF's Soil Information Viewer for producer attendees.

## Extension (KTT) Activities

- **"Advancing knowledge translation and transfer to support sustainable livestock and forage production systems." (PI: Alberta Beef Producers, supported by Susan Markus,**

**Andrea Hanson, Linda Hunt (AF), Darren Bruhjell (AAFC), Dianne Westerlund (CARA), Field Crop Development Centre, and others yet to be identified); in progress**

- Activities to date are broken out by project theme.
- **Managing grazing under average and extreme conditions:** Work is well underway in collecting, categorizing, and organizing existing information for the main activity under this theme, dubbed "Pasture School 2.0." Pasture School 2.0 will be a primarily online resource designed to be an abbreviated version of comprehensive hard copy pasture school binders. It will use a multimedia and modular approach to learning by presenting existing material in engaging ways, in addition to making the relevant information available at one location. It is envisioned that the course will eventually be incorporated as part of the BCRC site, www.beefresearch.ca
- A webinar was held for the applied research and forage association on the utilization of the Alberta Tame Pasture Scorecard, and copies of the scorecard were sent to each association for their use during events.
- In addition, a drought forecasting tool is in the initial planning stages of development. This tool, originally put together by a team from Montana State, uses past and current precipitation data to forecast percent of normal forage production. To be relevant to our producers, it needs to be populated with our weather station data. It is envisioned that the weather station data can be incorporated in real time.
- A BCRC hosted webinar on February 12, served to introduce the project prior to exploring the principles of adaptive grazing management, with producer and ABFGC Industry Advisory Committee member Sean McGrath presenting, with over 140 people registered. A copy of the webinar is available here: http://www.beefresearch.ca/resources/webinars.cfm
- **Species Selection for regional adaptation:** We applied for and were successful in obtaining additional funding for this theme from the Beef Cattle Research Council. We will be utilizing the tool developed by the Saskatchewan Forage Council about 12 years ago, and updating it to reflect all of the soil zones/eco-regions in western Canada. Another similar tool has been developed by the Peace River Forage Association of BC and we are currently in discussions around the best way to incorporate or link to that tool as well. Information on common weeds and control measures will also be included either directly into the new mobile site or via links to appropriate pre-existing weed ID/control apps. This project is slated to begin April 1, 2019 and end March 31, 2020. The new mobile site will be hosted either on the Saskatchewan Forage Council site, or beefresearch.ca.
- **Critical elements of animal nutrition and feed quality:** Two tools have been developed and are available at http://www.beefresearch.ca/research/feed-value-estimator.cfm.
- One tool looks at buying feed on a cost per nutrient basis, by using crude protein and total digestible nutrient values and comparing them to reference feeds. This comparison allows you to determine whether purchasing feed is a good deal or not in terms of feed quality, rather than simply buying feed by the ton, bale, or bushel and

pricing by weight instead of how well that particular feed will meet animal nutrient requirements.

- The other tool uses well established nutritional rules of thumb to "flag" any major nutritional deficiencies in a single feed. Users can choose their class of cattle (backgrounders (with an approximate rate of gain associated with it), heifers or mature cows at early, mid, late gestation or lactating, or mature bulls), enter their own feed test results and the tool uses colour coding to tell approximately how well that feed meets the nutritional requirements of that class of cattle at certain stages of production.
- When feed test results are received by a producer, some are confused with the large amount of information presented, and generally, little context is provided on feed test results report with regards to what is "normal" or "acceptable" for a particular feed. This can lead to confusion and difficulty in determining what is important when evaluating a feed. If a feed test result is simply filed, and the information not utilized, it provides no value for producers, which may be one reason why feed testing has still not reached critical mass. The Western Canadian Cow/Calf Survey II indicated that the main reason why producers do not feed test is that "my cattle seem healthy, so I have no reason to test." This analyzer helps producers to recognize and input the essential nutritional information to make a preliminary evaluation of the feedstuff in question. It provides basic information only, and is not a replacement for existing ration balancing software, or nutritionists, but rather is designed to alert users to potential serious deficiencies a feed may have and direct them to resources that already exist such as CowBytes or a local nutritionist.
- These tools were piloted at "Feed What You Need" workshops across the province in the fall/winter of 2018/19, co-hosted by ABFGC and the applied research/forage associations. Feedback from these sessions was extremely positive, with some suggestions from those meetings incorporated into the final versions of the tools. Overwhelmingly, producers felt these tools would be useful, and were excited for their eventual online debut. We have only received invoices for five of the workshops thus far, but approximately 212 people attended.
- The two tools were also demonstrated at the Chinook Applied Research Association's (CARA) Cattlemen Clinic in November 2018, receiving a similarly positive response from the 65 attendees. They were used for individual consultations with cattlemen by CARA staff for specific analysis of feed test results. Feedback indicated the tools provided a valuable way to review feed test results for major errors, and prompted more discussion of other tools such as CowBytes to facilitate appropriate ration development.
- **Rancher Researcher Pilot Expansion:** This work will be kicking off in late spring/early summer with the development of a template for this extension model, and recruiting of new participants into the existing program.
- **Review of Foragebeef.ca:** The content review of foragebeef.ca and integration of relevant material into beefresearch.ca is well underway. The first section on grazing management is live here: http://www.beefresearch.ca/research-topic.cfm/grazing-management-48, and was announced on the BCRC blog on February 4, 2019. Since the

grazing management page went live (Feb. 4 to April 3, 2019) it received 1259 page views, 1112 of which were unique, with users spending approximately 5 minutes on the page. The previous grazing management page hits from the same time period in 2018 (a year prior) were 110, with 99 of those being unique, and users spending less than three and a half minutes on the page.

- The stored forages topic page is live at http://www.beefresearch.ca/research-topic.cfm/stored-forages-87, and a BCRC blog post highlighted it on April 4, 2019.
- Drought Management Strategies and Rangeland and Riparian health are also live here: http://www.beefresearch.ca/research-topic.cfm/drought-management-strategies-96 and here: http://www.beefresearch.ca/research-topic.cfm/rangeland-and-riparian-health-82.
- Next up are pasture rejuvenation, forage species and extended grazing. New graphics have also been designed as necessary to illustrate the concepts presented on each topic page.
- This project was presented at the annual meeting of the Alberta Beef, Forage and Grazing Centre on February 6, 2019 in Lacombe, AB to approximately 45 attendees, and a written update on the project was included in the attendee package of the Alberta Forage Industry Network Annual General Meeting in March 2019. This project was also presented to the ABP Annual General Meeting in December 2018 to about 75 attendees, introduced to the Range Stewardship Course attendees (~50) in Stettler in September 2018, and described in detail to the National Technology Transfer Network annual meeting attendees (85) in March 2019.

- **"The Rancher Researcher Pilot." (PI: Alberta Beef Producers, supported by Susan Markus and Andrea Hanson (AF), Darren Bruhjell (AAFC), Dianne Westerlund (CARA); Kathy Larson (U of S), Kristine Dahl (Consultant)); in progress**
  - Most innovations have been implemented on farm. Three operations have utilized drone technology to increase efficiency of checking cattle, fencelines and water sources. Three operations utilized parentage testing and/or Envigour HX (hybrid vigour analysis) on their 2018 calf crop. Two operations rejuvenated pastures via reseeding, and while the effectiveness of this particular innovation may have been impacted by dry conditions in 2018, the full effects will be assessed in this upcoming growing season. Three operations implemented software to improve recordkeeping and management. One of these focused on pasture management (Pasture Map), while the other programs (HerdTrax and ITS global) are enterprise based systems. One operation implemented a new Bluetooth enabled scale and chute system to enhance animal processing and recordkeeping efficiency. Water developments have been completed on one operation, vastly improving access and water quality on this operation, with great interest from neighbouring producers. Two-stage weaning with nose flaps was utilized during weaning on one operation as well. Operations have also begun evaluating and monitoring soil health indicators at sites within their grazing systems.
  - Feedback on these implemented innovations overall has been very positive thus far. The feedback has depended on the type of innovations selected. For example, those

who selected pasture rejuvenation have expressed some concerns that the time and money required to implement the rejuvenation hasn't appeared to have impacted the pastures noticeably at this point. However, as noted above, and as was explained to them at the time of implementation, rejuvenation processes are usually slower to observe, especially in an establishment year. We do hope to see some improvement in the next growing season. Other comments were received in some cases indicating that the amount of time needed to implement some of the innovations was greater than expected. For example, soil sampling or inserting/removing the weaning nose flaps. Other innovations have received nothing but positive feedback, including the water developments, software programs and the drones. Each of these have been spoken very highly of by their adopters and all expressed the sentiment that the additional time or cost required to implement was well worth the investment.

- All participants have or will be completing further soil analysis on their grazing lands, and with one exception, all participants are currently undergoing an economic analysis of their operation through AgriProfit$ as an addition to the project in order to provide an economic assessment of the innovations on farm.
- In addition, a series of soil, forage and animal-based benchmarks have been developed in order to compare productivity on the farm. SOIL GROWS GOLD is the acronym describing these productivity measures and comprises: Structure (soil compaction and aggregation), Organic carbon and organic matter, Infiltration (water holding capacity), Life (soil biology), Grazing intensity, Rest and recovery, Organic matter (litter), Weeds, Stocking rate, Growth, Open rate, Length of calving season, and Death loss. These data have been captured for 2017 and are in the process of being collected for 2018.
- The SOIL GROWS GOLD benchmarks, along with the AgriProfit$ data will be analyzed to determine the effect of technology adoption for each individual operation. These pilot participants will be champions for the promotion of innovation adoption, utilizing the very effective peer-to-peer model of adoption. One operation has already expressed interest in holding a field day for neighbouring producers to share the success of his water development projects. Moving forward, it is our intention to create a template program for this type of extension model for use by other industry and government organizations to promote the adoption of best management practices and new technologies. The template development is projected to begin in late spring/early summer, after the data metrics have been analyzed. Through IMD Project #2017L054D, these templates will be tested in an expansion of this pilot program.
- While the project to date has been well received and implemented to date, the project team has noted some opportunities to improve the program. For example, when the producers were first invited to participate, they were provided with a list of potential innovations and were told to choose what interested them. In hindsight, this may have been a biased approach, with some producers potentially choosing what interested them versus what may have been of the most benefit to their operation. In refining the program, a suggestion would be to initiate a farm visit at the outset with a qualified

person in order to assess with a third party what innovations could have the greatest positive impact on an individual operation.

- To date, we have not experienced the direct interactions between the project participants and innovation experts that we had hoped for. This was a largely self-directed exercise, with the expectation that participants would contact subject matter experts for input on implementation of their chosen innovations. Feedback has indicated that this lack of direct two-way communication was largely a factor of time, but also that the chosen innovations were something that the producers already had gathered at least some information on and didn't feel the need to seek out more unless problems arose. This reinforces the idea of an initial on-site visit to identify areas of improvement with a specialist. In addition, many producers trust the advice and expertise of their peers more fully than academia, which lends itself to further promoting these initial pilot participants as champions for others thinking about adopting similar innovations.
- Student training opportunities that were completed (Jan.-Apr., 2018) with Olds College students for a business class resulted in additional outreach activities. The report that was based on a focus group interview, on-line survey, and literature search on rancher psychology and its effect on innovation adoption was attached with the last report. This report was presented at the poster competition at the Canadian Beef Industry Conference in London, ON in August 2018 and placed first. Over 600 people were in attendance at CBIC in 2018 and had the opportunity to view the poster. These same students then attended the Canadian College Applied Research Symposium in Ottawa in November 2018 to discuss student projects based on industry issues.
- A second student project at Olds College is underway (Jan.-Apr. 2019) and will be completed mid-April, 2019. A team of three Olds College students in the Business Management stream are participating in a course that involves real-life projects of which the Rancher Researcher Pilot project is one of the subject areas. The question being examined is "Why did the chosen eight producers chose soil health, precision ranching, and DNA sire parentage as their top projects of interest, what have they learned so far, did it make a difference, and would they choose those technologies again?" The consultant hired for the Rancher Researcher pilot project is providing information to the students from the feedback she has gleaned from the 8 producer participants.
- CapStone project topics based on the Rancher Researcher pilot project were again made available to the University of Alberta in 2019, but unfortunately, no student group selected them.
- One of the pilot ranches was featured as part of the ABFGC summer tour in August 2018, with approximately 50 attendees. Industry, researchers, extension personnel and other stakeholders toured the ranchers' feedlot and corn crop to gain perspective on the drivers and barriers to innovation adoption on farm.
- This project was presented at the annual meeting of the Alberta Beef, Forage and Grazing Centre on February 6, 2019 in Lacombe, AB to approximately 45 attendees, and

a written update on the project was included in the attendee package of the Alberta Forage Industry Network Annual General Meeting. This projected was also presented to the ABP Annual General Meeting in December to about 75 attendees, and mentioned briefly to the National Technology Transfer Network annual meeting attendees (85) in March. In addition, short radio-friendly articles have been developed for use on "Call of the Land," but have not aired yet.

- **"Fall or spring management options for pastures: renovate or rejuvenate?" (PI: Akim Omokanye); completed Nov 2018**
  - This project supports Goals 5 and 6 by demonstrating which methods of pasture rejuvenation are most effective and economical. This project is funded by ABP.
  - Forages make up a large part of the feed requirements of beef cattle, and grazing remains the most economical form of feed delivery. However, several years after pasture establishment, forage productivity and longevity usually decline. Maintaining productive forage stands over time then becomes a major challenge that beef producers face. A 3-yr on-farm study was conducted at 2 sites in Alberta (Wanham and Oyen), with different soil characteristics (grey wooded and brown soil zones) to determine the effect of several pasture rejuvenation methods, such as breaking & reseeding, spraying to control weeds and brush, forage seeding methods, fertilizer application, pasture rest and aeration/spiking on forage dry matter (DM) yield and forage quality.
  - At site 1 (Wanham), 3 years after treatments were implemented, pasture rejuvenation methods investigated significantly affected ($P<0.05$) forage DM yield, forage botanical composition, forage Ca, P, Ca:P, K, Mg and Cu but did not have any influence ($P>0.05$) on forage CP, S, Na, Fe, Zn, Mn and TDN. Spring herbicide application + direct seeding (RSS), fertilizer application (FERT) and fall herbicide application + broadcast seed in spring (RFBSS) improved forage production and some forage quality parameters more than other methods over control. The amount of legumes in the total forage production was as much as 29% for RSS compared to about 2-17% for other methods including control. RSS incurred higher total input costs (up to CAD $216) than other methods (except for RFBSS). For a 2-year (2017 & 2018) combined forage DM yield after treatments were implemented, revenue generated for forage production and profit over control seemed to be greater for both RSS and FERT than other pasture rejuvenation methods.
  - At site 2 (Oyen), 3 years after treatments were implemented, pasture rejuvenation methods did significantly affect ($P<0.05$) grass botanical composition but did not significantly influence ($P>0.05$) total DM yield and legume botanical composition. The only method that involved land cultivation and reseeding (B&R) showed higher total input costs than other methods. The returns were generally positive for all methods, with the control recording the highest (CAD $1232/ha). B&R had the lowest returns (CAD $593/ha). Weather was thought to have negatively affected forage production at site 2.
  - Read the results summary report here: https://irp-cdn.multiscreensite.com/f1ef9cf3/files/uploaded/FRG1315%20Final%20Report.pdf

- **"Perennial forage variety evaluation and demonstration at multiple sites in Alberta" (PI: Dianne Westerlund); completed Nov 2018**
  - This project supports Goals 4,5, and 6 by demonstrating the regional adaptability of various forage species and varieties alone and in mixed stands. This project is funded by ABP.
  - A selection of perennial forages species and varieties were seeded in 2016 at 8 sites in Alberta to evaluate establishment, yield and nutritional quality. Trial treatments were divided into 3 blocks: Grasses (12 entries), Legumes (15 entries) and Grass/Legume Mixes (9 entries). Data was collected from the sites in 2017 and 2018. Growth was challenged at some sites by adverse conditions both at seeding time and in the 2 years following seeding. Information collected from the sites was grouped by agro-eco regions for reporting.
  - Highest yielding varieties for the Mixed Grassland region over the two years in southern Alberta included Greenleaf pubescent wheatgrass and AC Success hybrid brome; Yellowhead and Rugged alfalfas and mixes AC Success hybrid and Fleet meadow bromes with Yellowhead alfalfa.
  - In the Boreal Transition region of central Alberta, AC Success hybrid brome, Rangelander and Yellowhead alfalfas and the AC Knowles/AC Mountainview sainfoin and the AC Success hybrid brome/Yellowhead alfalfa combinations were the top yielding entries.
  - AC Saltlander green wheatgrass, Greenleaf pubescent wheatgrass and AC Admiral meadow brome were top yielding grasses in the Peace Lowland region. There was no significant difference amongst the legume entries in the Peace trials. Fleet meadow brome/Yellowhead alfalfa was the highest yielding grass/legume mix.
  - Average yields at most sites were much less in 2018 versus 2017, most likely due to a cold, dry spring. Yields of the Fojtan Festulolium, Killarney orchard grass and Courtney tall fescue grasses dropped considerably at most sites between 2017 and 2018, indicating a lack of tolerance to winter and other weather stressors.
  - The AC Mountainview sainfoin and the cicer milk vetch varieties do not appear to persist as well as the majority of the alfalfas.
  - Read the results summary report here: https://irp-cdn.multiscreensite.com/f1ef9cf3/files/uploaded/FRG1915%20Final%20Report.pdf
- **"Regional Silage Trials" (PI: ARA groups across the province); in progress**
  - The trials support goals 4,5 and 6 by demonstrating the regional adaptability of various species, varieties and mixes of annual crops for forage at points across the province.
  - Nine applied research and extension associations participate in the project, and results are summarized and included in Alberta's Seed Guide
  - Currently funded internally
- **"Best management practices for the re-introduction of sainfoin into existing alfalfa and grass pastures for western Canada" (PI: Alan Iwassa); completed Nov 2018**
  - This project supports Goals 4, 5, and 6 by determining cost-effective best management practices to rejuvenate existing alfalfa/sainfoin and crested wheatgrass stands. This project is funded by ABP.

- Both AAFC-SCRDC and LRDC were successfully able to establish sainfoin. This occurred even though growing conditions, especially at AAFC-SCRDC were very challenging with two years of drought after establishment. AAFC-SCRDC sainfoin seedlings emerged between 18 to 43 plants per m2 among different sainfoin/alfalfa treatments and 24 to 52 plants per m2 among different Sainfoin/MBG treatments. At AAFC-LRDC sainfoin seedlings emerged between 16 to 42 plants per m2 among different sainfoin/alfalfa treatments and 7 to 49 plants per m2 among different Sainfoin/MBG treatments. In 2018, no differences in plant counts were observed among any of the different rejuvenation techniques at Swift Current, although numerically the highest plant counts occurred for break and reseed compared to the other treatments for the alfalfa and CWG mixes.
- It seemed that sainfoin established better into the CWG stand versus the alfalfa. At Lethbridge under irrigation, the breaking and reseeding also resulted in significantly higher sainfoin plant counts, but in Swift Current seeding into an alfalfa stand seemed better, since the MBG may be more aggressive.
- Generally, the break and reseed method proved to be the most effective way of reintroducing sainfoin into the stand. At AAFC-SCRDC, at the flowering stage in the CWG plots, the break and reseed had the highest yield. In the alfalfa plots the yields were mixed, but only the break and reseed method was over the recommended 20% sainfoin in the stand at the flowering stage and for the break and reseed and spring spray methods at the seed pod stage. For the seed pod stage, similar observation occurred among the sainfoin/alfalfa and sainfoin/CWG treatments. The better carry over of moisture from the previous year and the good spring moisture conditions occurring in 2017 compared to 2018 allowed the break and reseed method to statistically and numerically be better than the other rejuvenation treatments. At AAFC-LRDC, the break and reseed method had the best yields for the first cut in both the alfalfa and MBG plots. For the second cut, there were no differences in the alfalfa plots, but the break and reseed method produced the highest yield in the MBG plots. At the seed pod stage, the break and reseed method had the highest yield for both plots. In the alfalfa plots, all of the methods had over the recommended 20% sainfoin, but for the MBG plots only the break and reseed method did. This was true for both cuts and at the seed pod stage.
- Forage yield production and quality analyses values measured over the two sites can be explained by different environmental growing conditions, irrigation provided, stage of maturity, plant material being combined or separated and rejuvenation treatment. Swift Current suffered very dry conditions in 2017 and 2018, and this resulted in poor forage yields. Only in 2017 for the sainfoin/alfalfa site at the flowering stage was the quality and forage biomass yield sufficient to maintain a growing animal. In 2017 the sainfoin/alfalfa and sainfoin/CWG sites at seed pod stage were just under or close to the forage biomass yields needed, with adequate quality to maintain a dry cow on maintenance. Better sainfoin established for the sainfoin/CWG site would have greatly improved the forage quality of the stand. Lethbridge yield and quality for both years for the sainfoin/alfalfa at the flowering and seed pod stages were more than sufficient to

meet the nutritional needs of a growing animal. The same was true for yield and quality for the sainfoin/MBG at the flowering and seed pod stages which was just adequate. Good sainfoin establishment at Lethbridge aided in the good forage yields and qualities observed in the mixes.

- For AAFC-SCRDC, overall N and P levels were higher at all three soil depths for the sainfoin/alfalfa and sainfoin/CWG sites compared to the starting soil analyses measurements. Therefore, the rejuvenation and presence of legumes were a benefit to the available N soil profile. For AAFC-LRDC, the N levels were similar or a bit lower for the sainfoin/alfalfa site when comparing the initial soil measurement to after the first production year sampling. The N levels for the sainfoin/MBG was also lower when comparing the start to the later soil measurement. For the sainfoin/MBG this was not surprising with the good forage biomass production and predominate grass stand. The total C for the sainfoin/alfalfa and sainfoin/MBG sites were much lower numerically when comparing the start soil measurement to after the first production year. In the short measurement period, it was not surprising that these perennial forages did not sequester organic carbon in the soil, especially with the dry conditions.
- A sainfoin/alfalfa mix can be an economical choice under the right soil conditions and treatments. At AAFC - Swift Current, none of the four treatments - break and reseed, simulated grazing, fall spray and seed, spring spray and seed - showed a positive investment choice because the yield values did not offset the cost of production. Of the four treatments, fall spraying and seeding showed the highest potential return. At AAFC - Lethbridge, all four treatments showed positive investment choices because of higher yields with irrigation. Spring spraying and seeding appeared to have the highest return of the four treatments. Comparative mixes did not fare as well as the sainfoin/alfalfa mix. The sainfoin/CWG mix at AAFC - Swift Current did not show positive investment returns under all four treatments. At the AAFC - Lethbridge site, spring spraying and seeding showed the highest positive investment choice.

- **“Nutrient patterns in swath grazed fields” (PI: Darren Bruhjell); in progress**
  - The project supports Goal 2 and 6. This work will lead to improved nutrient loading/loss estimates for the Nutrient Loading Calculator because the data can be used to validate and modify the estimates in the AAFC calculator, which currently are based only on theoretical nutrient balances. The work will also lead to improved swath grazing management guidelines that will benefit producers because it will lead to better recommendations on the amount and formula of additional synthetic fertilizer required for the next year's forage crop growth
- **“AC Saltlander.” (PI: Bill Houston); completed 2018**
  - The project supports Goal 5 and 6. This development/technology transfer project will demonstrate the usefulness of AC Saltlander on saline areas. Darren Bruhjell is the collaborator.
  - An **“**AC Saltlander for Western Canada Technical Bulletin” is currently being developed.
- **“Data Interpretation for Sustainable Cow-calf Production” (PI: Susan Markus); in progress**
  - Supports Goal 6

- Animal agriculture is prone to market and environmental variation which ultimately affects individual farm profitability and competitiveness. Science-based best management practices exist to show acceptable measures of success, but they are not always connected to the four aspects: profitability, productivity, environmental sustainability, and public trust. Too much data and information with too little, meaningful, long term interpretation relevant to the efficiencies and profitability of beef operations is a concern as new technologies promote their benefits in isolation. This project will bundle meaningful indicators from innovations with impact on cow/calf operations' decision-making into a summarized custom report.
- Expanding on the work already done in the Rancher Researcher Pilot, 3 Ranches (Vermilion, Olds and East Central) will be followed to collect data from existing and some new programs (Income tax/Accountant; AgriProfit$; Verified Beef Production Plus; EnVigourHX and SOIL GROWS GOLD).

- **"Evaluation of AAC Trueman alfalfa on five sites in central and northern Alberta" (PI: Darren Bruhjell); in progress**
  - This project supports Goals 4 and 5.
  - Beef producers in the Northern and Western Prairies require alfalfa varieties with greater winter hardiness and late season yield to extend the grazing season and increase the hay supply.
- **"Carbon Pasture Management Pilot Project" (10 locations across the province); in progress**
  - Supports goal 2 and 6
  - Will involve collection of soils and soil analysis to monitor soil carbon levels under grazing

## Research Activities

- **"Identification of forage potential using a forage evaluation spreadsheet of current and recently registered cereal varieties selected for other purposes." (PI Vern Baron and Co-PI Pat Juskiw, 2016-2019); in progress**
  - The project supports Goals 1 and 4 by evaluating and ranking potential and new barley, oat and triticale varieties compared to older checks. Initial indications are that some varieties sold as forage types, for example CDC Cowboy, are inferior for forage quality attributes compared to cultivars such as Champion. Results from the agronomic trial and spreadsheet are verified in swath-grazing trials at Lacombe where cows swath grazing a genetically similar cultivar Maverick have consistently lost more weight than the food-type Canmore.
  - Previously we had developed a forage evaluation spreadsheet which yield and quality data from plots and were projected onto animal response and economic data. For swath grazing, parameters included weight gain or loss, body condition score and daily cost. Backgrounding parameters included, rate of gain and cost of gain. Two projects were carried out which ranked small grain forages for backgrounding and swath grazing

potential using the Forage Evaluation Spreadsheet. Milk potential was determined using the Milk 2006 spreadsheet.

- It was suspected that cereal cultivars marketed as forage types were no better than varieties developed for other purposes such as malting, food or feed grain. The spreadsheets could be used to identify production benefits and risks as a result of variety choice, thus providing a competent variety choice-decision. All of the spreadsheets provided an evaluation that combined attributes of yield and quality, instead of single variables. Seven 2-row, three 6-row barley, three oat and three triticale varieties were grown over the three-year period at two Lacombe locations and Trochu, AB. In each of 2016, 2017 and 2018 various prospective breeding lines of barley that were entered in the Western Canadian forage barley coop were also included.
- **Forage yield and quality.** Canmore, Champion and Gadsby 2-row barley were identified as having superior attributes for animal utilization based on yield and quality compared to Cowboy, a variety marketed as a forage type. The former varieties were superior for starch content and fiber digestibility and lower fiber (ADF and NDF) contents than Cowboy, including lignin, which is indigestible. For triticale, AC Ultima had the best combination of yield and quality over Bunker; Sunray had superior quality but was lower yielding. For oat, Baler had superior forage quality, but not greater yield than Mustang and Haymaker.
- **Swath grazing.** Canmore and Gadsby barley had the best combination of weight gain and daily feeding cost. The lower yield of Champion reduced carrying capacity and increased daily cost, but weight gain was acceptable. A major drawback for Cowboy barley was low weight gain, which would indicate a risk for cows under cold temperatures. Ultima triticale was identified as a good choice for reduced cost, although weight gain was not at the top level. Oat carrying capacity and low daily cost were favorable, but low weight gain due to low forage quality indicated a risk compared to the best 2-row barley cultivars.
- **Backgrounding.** The evaluation spreadsheet calculated rate of gain (ROG) and cost of gain, which was used to indicate varieties with potential. Cost of gain was reduced by high digestible dry matter yield. Generally, backgrounding potential ranked 6-row barley > 2-row barley > triticale > oat. On the basis of individual varieties, Canmore, Champion, Gadsby and AC Ranger barley, and AC Ultima triticale were identified as those with the most potential. The lowest among barley cultivars was Cowboy. ROG of oats was too low. Even though forage yields were high enough to reduce costs, a low ROG was considered risky in volatile price/cost scenarios.
- **Milk production.** For milk potential barley > triticale > oat. Canmore, Champion, AC Ranger and Vivar barley were superior for milk/tonne, while Cowboy was lowest. For milk/ unit area Gadsby could also be included in the group. Canmore and Champion tended to rank highly for backgrounding and milk production. This was primarily due to consistently high starch contents and fiber digestibility and greater than average forage yields.

- **New varieties.** Canmore and Champion emerged as being superior for many aspects of ruminant utilization as forages. With respect to yield and forage quality parameters FB455, FB022, FB472, FB473 and FB476 were comparable to Canmore. FB473, FB472 and FB476 were within range of Canmore for swath grazing potential. For backgrounding FB455, FB 472, FB473 and FB476 are projected as having potential. FB472, FB473 and FB476 were similar to Canmore and Champion for milk potential. From these lines FB455 (AB Cattlelac) was chosen by Alliance seeds and FB473 (AB Advantage) was chosen by SECAN for marketing as forage varieties.
- **Outcome.** Seed companies may use the evaluation system outputs to provide marketing information to customers. Alberta Barley has included information about the variety-choice system with copies of the Alberta Seed Guide to all barley and wheat producers in the province of Alberta. Breeders now use the evaluation system in pre-licencing programs such as the Western Co-operative Forage Barley Registration Test.

- **"Integration of Forage Quality for Ruminant Nutrition into Western Canadian Cereal Forage Breeding Programs." (PI: Pat Juskiw); in progress**
  - This project supports Goals 1 and 4 by evaluating and ranking promising varieties for quality at an early stage of selection during the breeding process for quality. The project got underway in 2018. The goal is to integrate the forage nutritional spreadsheet (see above project) developed by Dr. Baron et al. into selection practices for forage oat, barley, wheat and triticale. The spreadsheet allows evaluation to meet the nutritional needs of different classes of beef and dairy cattle.
  - Funding was attained from AAF to conduct forage quality analyses and conduct simulations of swath grazing, backgrounding and milk production.
  - The Western Co-operative Forage Barley Registration Test was grown at Lacombe AAFC and AAF in Alberta, at Kernen and Saskatoon by U of S and Melfort AAFC in SK and at Brandon and Hamiota, AAFC in Manitoba. These were evaluated in the system described above and reports completed and presented.
  - A total of 900 lines of breeding material were also assessed using the above system. These were:
    Oats: J. Mitchell-Fetch, Brandon AAFC; Jim Dyck, Oat Advantage, Saskatoon.
    Barley: Joseph Nyachiro, Pat Juskiw and Flavio Capettini, Lacombe, AAF
    Spring triticale: Mazan Aljarrah, Lacombe, AAF
    Winter Triticale: Mazen Aljarrah, Lacombe, AAF; Rob Graf, Lethbridge, AAFC.
  - This work will continue in 2019-20 and 2020-21
  - **Publications, presentations, articles and public outreach:**
    **Baron, Vern. 2019.** Research gets choosy with forage barley. P 10-11 in Spotlight on Alberta Barley Funded Research. Alberta Barley article written by Geoff Geddes. www.thewordwarrior.ca. January, Article included in the Seed Grower Guide for Alberta, 2019

**Juskiw, P. and Baron, V. 2019.** 2018-2019 Forage Barley Coordinators Report. Field Crops Development Centre and Lacombe Research and Development Centre, Lacombe AB.

**Juskiw, P and Lajeunesse, S. 2019.** 2018 Western Co-operative Forage Barley Registration Test report. Presented Breeding and Agronomy Evaluation Team of the Prairie Recommending Committee for Oat and Barley (PRCOB), Saskatoon, SK. PRCOB password protected. Feb 25, 2019

**Baron, V.S. 2018.** Barley/cereal annual forage for backgrounding and cow-calf production. Workshop on opportunities for feed grain improvement. Beef Cattle Research Council. June 26, 2018, Calgary, AB. Invited presentation (BCRC) 25 people.

**Baron, V.S. 2018.** Presentation at Research and Extension from the Farm and Ranch Perspective. Alberta Beef Forage and Grazing Centre Summer Tour. Halkirk, AB, August 8, 2018. (40 attending)

- **"Forage Potential of Hybrid Rye." (PI: Vern Baron); in progress**
  - Support Goals 1, 4, and 5.
  - Hybrid rye (HR) is a new winter cereal crop that was introduced in 2015 to western Canada for grain production. In pre-registration trials across Canada the new hybrid types out-yielded the traditional open pollinated rye (OP-R) for grain (approx. 30%) and had equal to or better winter-hardiness. Registration did not require "forage testing." The fact that HR are the F1 generation conferred advantages over OP-R types such as vigour and uniformity, but they are also genetically different, shorter, have less lodging, and are more stress (heat and drought) tolerant.
  - While the research-evaluation for forage potential is non-existent, "on-farm" yield and quality of silage in southern Alberta in 2015 was impressive as evidenced by Kolk Farms feed analyses (KWS commun.). Hybrid fall rye (HR) bred by KWS has been grown in Germany since the 1970s. Inbred rye lines are developed by selfing and selection and F1 seed is produced using a cytoplasmic male sterility-restorer gene system. At least two heterotic families exist ensuring heterosis is maximized in the F1. Heterosis has allowed HR to achieve greater yield and stress tolerance than OP-R counterparts.
  - Agronomic investigation in public cereal evaluation trials among HR lines relative to grain yield has been much more prevalent than on forage and pasture production. Because of the hybrid seed production, HR seed costs are higher than for OP-R varieties.
  - Collaborative research proposals have been written or are in progress to investigate the potential of HR as a forage and grain (Penner). Funding has been attained from Saskatchewan Cattlemen's Association, KWS and FP Genetics to carry out field trials at Lacombe to compare HR varieties with other winter and spring cereal species.
  - Preliminary work has been conducted at Lacombe on HR and other winter cereals for use as fall and spring pastures.
- **"Two-row barley variety development." (PI: Pat Juskiw); in progress**
  - The project supports Goals 1 and 4 by development of new forage varieties of two-row barley. The goals are high yields and good agronomic adaptation; good feed and malting quality characteristics desired by the market place and to enhance overall economic

returns; good disease resistance to the diseases as set out in the overall FCDC breeding objectives; good tolerance to abiotic stresses such as low nitrogen, water stress, cold stress, and other environmental stresses. Core breeding project at FCDC.

- **2018-19 Success:** The two-row breeding program made significant progress of having two two-row lines supported by the Prairie Recommending Committee for Oat and Barley (PRCOB) for registration in February 2019. The supported lines are TR16629, a high-yielding malting line, and TR17639 (FB484), a high yielding feed and forage line with moderate resistance to Fusarium Head Blight. Both lines have been put forward to seed marketing companies for commercialization.
- **TR16629** is a two-rowed malting barley. It has an excellent grain yield, agronomic, and disease resistance package. It has yields 1 to 2% higher than AAC Synergy, and 8% higher than CDC Copeland, with wide adaptation across all soil zones of western Canada. It has good lodging resistance, similar to AAC Synergy and CDC Austenson. It has moderate resistance to FHB with DON levels 25% lower than AC Metcalfe, the best check. Its malting quality package is similar to CDC Copeland with lower diastatic power and high extracts.
- **Strengths of TR16629:**
  - Grain yield is 102 to 121% of the malt check CDC Copeland across all soil zones of western Canada, and overall yields are 1% higher than the malt check AAC Synergy. Yields were higher than AAC Synergy in the western black/grey soil zone and higher in the brown soil zone in 2016.
  - Lodging scores are lower than the malting checks and similar to the feed check CDC Austenson.
  - Moderately resistant to the surface-borne smuts, stem rust and FHB with DON 25% less than AC Metcalfe (in 6 location years).
  - Intermediate resistance to the spot-form of net blotch and scald.
  - Good malting traits with low protein and high fine extract. Wort beta-glucan is lower than AC Metcalfe and CDC Copeland in Coop trials and lower than AC Metcalfe in Collabs.
- **TR17639 (FB484)** is a dual purpose feed and forage two-row barley. It has a great disease resistance package with low DON, similar to CDC Cowboy. Its grain yields are higher than CDC Austenson and Champion under drought, and continue to be higher than CDC Austenson under high yielding conditions and similar to Champion. Its forage yields are similar to CDC Cowboy, with similar carrying capacity, and better average daily gain and milk yields. This line did well under drought with biomass yields 1% higher than CDC Cowboy.
- **Strengths of TR17639 (FB484):**
  - Grain yield is 109% of the malt check CDC Copeland with an overall yield greater than feed check CDC Austenson. Did especially well in 2018 (a drought year across most of the prairies) with yields 2% higher than Champion and 5% higher than CDC Austenson. Well adapted across all soil zones.

- High forage yields equal to CDC Cowboy and Gadsby, and yielded 1% higher than CDC Cowboy and 2% higher than Gadsby under the drought conditions of 2018. Predicted Carrying Capacity for Cows for swathgrazing was equal to CDC Cowboy.
- Maturity 1 day earlier than the feed check CDC Austenson, similar to Champion. Two days earlier maturity than CDC Cowboy.
- Moderately resistance to surface-borne smuts, stem rust, spot blotch and Fusarium Head Blight with DON ratings 33 and 41% of the feed checks in 2017, and 54 and 75% in 2018
- Early heading in forage Coop with lodging resistance to soft dough stage similar to the most resistant check CDC Austenson.
- Forage quality better than CDC Cowboy with lower NDF and ADF, and higher In Vitro Fiber Digestibility, NDF30/NDF ratio, and starch such that predicted average daily gains for a calf in backgrounding, and milk tonnage were much higher than for CDC Cowboy.

- **"Six-row barley variety development." (PI: Joseph Nyachiro); in progress**
  - The project aligns with Goals 1 and 4 of developing six-row hulled feed and forage barley varieties. The objectives of the program are to develop high grain and forage yielding barley varieties with strong straw and lodging resistance, incorporate early maturity without compromising yield and desirable end-use grain and forage quality traits, improve on genetic disease resistance including stripe rust, scald and net blotch, immunity to loose smut(*Run8* gene), resistance to the surface-borne smuts. Core breeding project at FCDC.
  - **2018-19 Success:** The six-row breeding program made significant progress of having two six-row lines supported by the PRCOB for registration in February 2019. The supported lines are SR17515 (FB481) and SR17519 (a nitrogen-use efficiency line). At the time of writing this summary, a seed marketing company had acquired SR17515 for commercialization. We anticipate that SR17519 will also find a marketing company.
  - **SR17515 (FB481)** had the highest grain yield for two consecutive years in the coops. It is a smooth-awned, hulled barley with consistently good agronomic performance, including lodging resistance better than AC Ranger and Vivar. SR17515 was tested as FB481 in the Forage Barley Co-op where it showed higher forage yield than AC Ranger and equal to CDC Austenson and CDC Cowboy. SR17515 has cow carrying capacity similar to CDC Austenson but higher than AC Ranger.
  - SR17515 has an acceptable disease package with moderate resistance to the surface-borne smuts, intermediate resistance to stem rust, and net- and spot-forms of net blotch and spot blotch. The high grain and forage yields with good lodging resistance traits make SR17515 (FB481) suitable for feed grain and forage production.
  - **Strengths of SR17515 (FB481)**
    - Grain yield is 108% of AC Ranger and Vivar in the Six-row Co-op, and 107% of CDC Austenson in the Forage Coop.
    - Forage yield is 106% of AC Ranger and 103% of CDC Austenson.

    - Percent plump seed is higher than AC Ranger.
    - Test weight is higher than all the six-row feed checks AC Ranger, Vivar and Amisk.
    - Carrying capacity is higher than AC Ranger, CDC Austenson and Vivar in the Forage Barley Coop.
    - Lodging resistance is better than all checks in the Six-row Coop and better than Gadsby in the Forage Coop.
    - Intermediate disease resistance to the surface-borne smuts, loose smut, stem rust, scald, spot blotch, and spotted net-blotch.
  - **SR17519** has superior nitrogen use efficiency that could enhance yields when nitrogen inputs are limited. It has high grain yield combined with good disease resistance, improved lodging resistance, and plumper seed. **SR17519** is a smooth-awned, medium height, six-row barley well adapted to all soil zones of western Canada. This line had a high grain yield across all the soil zones in the Western Cooperative Six-Row Barley Trials. As well, SR17519 has shown better lodging resistance and seed plumpness than AC Ranger and Vivar. With high grain yield combined with its smooth awn, excellent lodging resistance, plumper seed, and good disease resistance package, SR17519 is a good candidate for annual grain production. Through ongoing research at FCDC, SR17519 was selected for its better nitrogen use efficiency (NUE). In FCDC test carried out under high and moderately low nitrogen regimes, this line showed 106% higher NUE than the check cultivar Vivar. It also performed well in the drier year 2018. SR17519 shows significant improvement over its parent Vivar. The advancement includes 50% less DON accumulation, 6% higher seed plumpness, superior nitrogen use efficiency, 2% higher grain yield particularly in the drier year of 2018, better lodging resistance, and the smooth awn characteristic.
  - **Strengths of SR17519**
    - Superior nitrogen use efficiency, 106% of Vivar.
    - Higher grain yield than AC Ranger, Vivar and Amisk.
    - Resistant to lodging, better than all the checks.
    - Percent plump seed is 109% of AC Ranger and 106% of Vivar and similar to Amisk.
    - Thousand kernel weight, test weight better than or comparable to the best check.
    - Feed quality traits (digestible energy content, starch) similar to the checks.
    - Days to maturity similar to the feed checks.
    - Resistant to stem rust and covered smut, moderately resistant to net form of net blotch, and intermediate resistance to spot form of net blotch and spot blotch.
    - Less Deoxynivalenol (DON) levels than the checks, 50% less than its parents Vivar.
- **"The Development of Improved Spring Triticale Cultivars." (PI: Mazen Aljarrah); in progress**
  - The project supports Goals 1 and 4 by developing new varieties of forage spring triticale. The objectives of the program are to develop spring triticale with improved sprouting resistance, lodging resistance, disease resistance, early maturity and seed development via a conventional modified bulk breeding system; with high silage yields; and with high grain yields. Core breeding project at FCDC.

- **2018-19 Success:** The spring triticale breeding program made significant progress of having two lines supported by the Prairie Recommending Committee for Wheat, Rye and Triticale (PRCWRT) for registration in February 2019. The supported lines are T267 and T270. At the time of writing this summary, a seed marketing company had acquired one of the lines for commercialization.
- **T267** is a large seeded spring triticale suitable for feed. T267 has intermediate resistance to FHB, with lower DON content than AC Ultima. It is medium to short in height with very strong straw, suitable for high moisture areas.
- **Strengths of T267**
  - Intermediate to moderate resistance to FHB.
  - Resistant to common bunt and leaf, stem and stripe rusts.
  - Strong straw and better lodging resistance than Pronghorn, AC Ultima and Brevis.
  - Grain yield is 112% of AC Ultima.
  - Lower ADF and NDF than all triticale checks, complimented with high digestibility.
  - Lower ergot infection than all checks
- **T270** is a spring triticale with the lowest ergot infection compared to the triticale checks. This line has high dry matter yield, with lower ADF and NDF than Bunker and Taza. It is well suited to drier areas.
- **Strengths of T270**
  - Lower ergot infection than all checks.
  - Grain yield is 111% of AC Ultima.
  - Dry matter yield is 102% of Taza, 101% of Pronghorn and Bunker.
  - Lower ADF and NDF than Bunker and Taza, complimented with high digestibility.
  - Strong straw with better lodging resistance than Pronghorn and AC Ultima.
  - Resistant to common bunt and leaf, stem and stripe rusts.

- **"The Development of Improved Cultivars of Winter Triticale (PI: Mazen Aljarrah); in progress."**
  - The project supports Goals 1, 4 and 5 by development of new varieties of forage winter triticale for fall pasture and silage. The objectives of the program are to develop cultivars with winter hardiness similar to Norstar; disease resistance genes (snow mold, powdery mildew and leaf diseases); short stature; enhanced sprouting resistance; reduced-awn trait; early maturity; and high forage yield. Core breeding project at FCDC.
  - **2018-19 Success:** The winter triticale breeding program made significant progress of having two winter lines supported by the PRCWRT for registration in February 2019 (WT0009 and WT0011). As well, the recommendation of interim registration for WT0010 was moved to full registration. As of the time writing this summary, SeedNet has acquired WT0010 for commercialization as AB WinterNet. We anticipate that both of the other winter triticales will acquire marketers.
  - **WT0009** is a reduced awned winter triticale suitable for feed and forage. It has superior dry matter yield, being 127% of Bobcat. Its winter survival exceeds all the winter triticale and winter wheat checks.
  - **Strengths of WT0009**

    - Superior dry matter yield is 127% of Bobcat and 105% of Luoma and Metzger.
    - Grain yield is 123% of Bobcat, 112% of Metzger, and 102% of Luoma.
    - Winter survival (95%) is better than all winter triticale and winter wheat checks.
    - Forage protein content is 12.5% higher than Metzger and Luoma, similar to Bobcat.
    - Higher forage protein and digestibility than all winter triticale checks.
    - Maturity is two days earlier than Luoma and similar to Metzger and Bobcat.
    - Lodging resistant, shorter than Metzger and Luoma, taller than Bobcat.
  - **WT0010 (WinterNet)** is a high yielding winter triticale suitable for feed and forage. It has superior grain yield, being 161% of Bobcat and 150% of Metzger. Its forage digestibility is better than the checks. It has a large seed with high kernel weights.
  - **Strengths of WT0010**
    - Superior high grain yield is 161% of Bobcat, 150% of Metzger, 138% of Luoma, also outyielding Pintail winter wheat and Hazlet fall rye checks.
    - Forage digestibility is significantly higher than in Metzger, Bobcat, and Luoma, with a lower lignin content.
    - Dry matter yield is 123% of Bobcat and 105% of Luoma.
    - Large seed with significantly higher kernel weight than all checks, including Metzger, Bobcat and Luoma.
    - Test weight is significantly higher than Bobcat, and is within the range of Metzger and Luoma.
    - Lodging resistance is significantly better than all checks, including Hazlet fall rye and Pintail winter wheat checks.
    - Good disease resistance to leaf spot, powdery mildew and tan spot.
  - **WT0011** is a high yielding winter triticale suitable for feed and forage. It has superior grain yield, 154% of Bobcat, 139% of Metzger, and 127% of Luoma. Its forage digestibility is higher than checks with lower lignin content. It has higher grain protein than Luoma and Metzger
  - **Strengths of WT011**
    - Super high grain yield, 154% of Bobcat, 139% of Metzger, and 127% of Luoma.
    - Forage digestibility is significantly higher than Metzger, Bobcat and Luoma, with a lower lignin content as well.
    - Dry matter yield is 120% of Bobcat and within the range of Metzger and Luoma.
    - Maturity is earlier than all triticale checks.
    - Resistant to lodging, better than all winter triticale, Hazlet (fall rye) and Pintail (winter wheat) checks.
- **"Germplasm and variety development of barley and triticale for animal feed with a focus on feed quality, yield and disease resistance of both grain and annual forage production." (PI: Flavio Capettini); Completed March 2018**
  - The project supports Goals 1, 4 and 5. Over the course of the funding the two-row barley Canmore and the six-row barleys, Amisk and AB Cattlelac, were released plus just supported for registration were several six-row and two-row barleys, winter triticales, and spring triticales. Canmore was the sixth most popular feed variety grown in Alberta

in 2018 (Alberta Ag Financial Services Corp), due to in part to its excellent forage qualities and lodging resistance. The project also allowed us to have continued appraisal of FHB resistance at AAFC nurseries, and with the release of Lowe, malting barley, we have shown we are able to select for moderate resistance to the disease with low DON in the grain. The new lines supported for registration in 2019 continue to exemplify the high yields, good quality, and disease resistance that were part of this project.

- A final report was prepared and submitted to Alberta Beef Producers.
- **Publications, presentations, articles and public outreach:**
  - JUSKIW, P.E., L. OATWAY, M. ORO, J. M. NYACHIRO, KEQUAN XI, T. K. TURKINGTON, S. LOHR, J. BOWNESS and F. CAPETTINI. 2019. Registration of 'Lowe' a Two-rowed Malting Barley with Enhanced Resistance to Fusarium Head Blight. J. Plant Registration. 13: (accepted Jan 28, 2019).
  - JUSKIW, P.E., J. SAHO, L. OATWAY, J. H. HELM, M. ORO, J. M. NYACHIRO, KEQUAN XI, and T. K. TURKINGTON. 2018. Registration of 'Canmore' Barley. J. Plant Registration. 12:168–175.
  - JUSKIW, P. 2019. Forage Breeding: Annual Cereal Crops. Guest Lecture University of Alberta, Plant Science 354 Forage Crops. Edmonton, Alberta. Jan. 17, 2019
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- **"Development of a rapid screening method to assess grain processing responses of barley as a trait for the selection of feed varieties for cattle." (PI: Joseph Nyachiro/Tim McAllister, 2017-2020); in progress**
  - The project supports Goals 1,2, and 4. By incorporating grain processing responses of barley into the selection of feed varieties, there is an opportunity to reduce costs and environmental impacts through improved efficiency. This project complements the recently completed Beef Cluster project led by Flavio Capettini that was focusing on germplasm and variety development of barley and triticale with improved feed quality, yield and disease resistance for both forage and grain production.
- **"Determining the critical traits associated with lodging in a set of elite breeding lines and Canadian barley varieties." (PI: Joeseph Nyachiro/Ludovic Capo-chichi, 2018-2021); in progress**
  - The project supports Goals 1 and 4. Higher yielding varieties with good lodging resistance can maintain high grain and forage quality while remaining easy to harvest. Lodging results in crop losses, decreasing yield and is a primary concern for barley producers.

- **"gGreenBeefCow: Identifying and evaluating genomic and fecal microbiome markers for low methane emissions in beef cattle." (2016R033R; PI=Carolyn Fitzsimmons and John Basarab; April 2016 to March 2019); in progress**
  - The research supports Goals 2 and 3. The overall objective is to evaluate genomic and microbiome markers for animals which produce lower methane emission (g/d) and/or methane yield (g methane/ kg DMI). As of April 2018, a total of 26987 animal/day observations for methane have been collected from 893 unique animals.
  - **Evaluating the accuracy of molecular breeding values (MBV) predicted for methane emission (g/day) in beef cattle.** Yearling beef heifers (n=527) were individually monitored for methane production on-farm from 2015-2017 using the GreenFeed Emissions Monitoring system (C-Lock Inc., Rapid City, SD, USA). Animals were genotyped using Illumina BovineSNP50 Bead Chip (50K). Analyses was completed using the gBLUP software, which generates genomic heritability of the trait, MBVs and their accuracy. Results showed that genomic heritability for methane emission was moderate (0.29±0.07). Average accuracy of MBVs for validation population was 0.33±0.03, and it did not change for animals born in different years. The results support the use of genomic technology to generate MBVs to select beef cattle for reduced methane emission. This would be a slow process and thus, genomic selection should be combined with other practices such as improved diet quality, feeding 3-nitroxypropanol or biochar, breeding management to optimize retained heterozygosity and reducing days to slaughter to reduce methane emission in beef cattle.
  - **Quantifying methanogens from fecal samples:** DNA was extracted from 240 fecal samples collected from Lacombe and Kinsella heifers which were a part of the summer grazing trials in 2015. Each group had 20 animals: 10 high RFI (inefficient) and 10 low RFI animals (efficient). All animals grazed meadow brome grass and were supplemented once daily with C32 pellets. Heifers were dosed with the C32 pellets for 8 days (day 0-7) to get the marker to a steady state in the rumen, then dosed with C32 pellets from Day 8-12 and fecal sampled twice daily from Day 8-12. The fecal samples that were used to analyze methanogen abundance and diversity were collected on Day 8, 10 and 12. After DNA extraction, qPCR of total methanogens from those samples was completed to obtain copy number counts for different methanogen species. PCR of amplicon sequencing was performed and sequencing results from Genome Quebec have been obtained.
  - **Comparison of methanogen population in the fecal samples:** In total, there were 6,448,996 sequences generated for methanogen communities in 239 samples with a count of 26,983±123 (mean ± SEM) per sample. When α-diversity indices were compared between high and low RFI groups, chao1 (richness), observed species (diversity), Shannon (evenness) and Simpson index were not different. β-diversity which is estimated by using Principal Coordinates Analysis (PCoA) based on Bray-Curtis dissimilarity metrics showed no clustering based upon the high and low RFI. After classifying 231 OTUs into archaeal species taxonomic level, 20 species-level taxa were detected. The most abundant archaeal taxa were *Methanobrevibacter gottschalkii*

(80.04%) and *Methanobrevibacter ruminantium* (9.64%), followed by members of *Methanosphaera sp.* ISO3-F5 (4.91%). In low RFI cattle, *Methanobacterium subterraneum*, *Methanobrevibacter boviskoreani*, and *Methanosphaera sp.* Group5 represent a higher proportion while *Methanosphaera sp.* ISO3-F5 were significantly lower compared to the high RFI group. And for two predominant groups, *Methanobrevibacter gottschalkii* tended to be lower and *Methanobrevibacter ruminantium* tended to be higher in the low RFI group.

- Total methanogen population in high RFI cattle was not different from that in low RFI cattle (P=0.19). There were time, day and location effects on the methanogen populations, and the methanogen population detected was higher in cattle from Lacombe compared to Kinsella. On Day 8 the methanogen population was highest and decreased as the trial continued, and afternoon fecal samples had higher methanogen population than morning samples.
- **Correlation analyses between fecal methanome and methane traits**. The PROC CORR in SAS software was used to explore the association among different bacteria species and copy number within each RFI group. The transformed bacteria species data and copy number were subjected to the GLM procedure in SAS to test effect of RFI groups (Low vs. High), herd (Kinsella vs. Lacombe), days of sampling (8, 10, and 12), and time of day (AM and PM) on different bacteria species and copy number.
- Microbiome analysis included counts (%) of 10 bacteria species called M1 to M10. The bacteria species were M1: Sulfolobus and relatives; M2: Methanobacterium; M3: Methanobrevibacter gottschalkii and relatives; M4: Methanobrevibacter ruminantium and relatives; M5: Methanobrevibacter smithii; M6: Methanobrevibacter wolinii and relatives; M7: Methanosphaera; M8: Methanocorpusculum and relatives; M9: Methanopyrusk and leri; M10: RCC and relatives. The copy number (g) was output of qPCR analysis for each sample.
- **<u>Hypothesis:</u> There is an association among different species of bacteria and copy number within each RFI group.** The results show that different RFI groups had various correlations among species and with copy number. Out of 10 species M3 had moderate to high correlation with M4, M7, M8, and M10 in Low RFI group; whereas, M3 had moderate to high correlation with M2, M4, M5, M7, and M8 in high RFI group. Most of the species had moderate correlation with copy number in Low RFI group; while, all species (except M10) had low correlation with copy number in high RFI group.
- These rumen microbiome markers are being evaluated for their ability to improve the accuracy of MBVs for methane emission (g/d) and methane yield (g methane/ kg DMI).
- **Publications, articles, posters and presentations & public outreach:**
  **Ekine-Dzivenu C, Akanno EC, Chen L, McKeown L, Irving B, Baker L, Vinsky M, Miller S, Wang Z, Crowley J, Colazo M, Ambrose D, Juarez M, Bruce H, MacNeil MD, Plastow G, Basarab J, Li C, & Fitzsimmons C. 2018.** Improvement of cow feed efficiency using molecular breeding values for residual feed intake - The "Kinsella Breeding Project". Conference paper at the World Congress on Genetics Applied to Livestock Production, Aukland, New Zealand. February 2018.

**Akanno, E.C., Abo-Ismail, M.K., Chen, L., Crowley, J.J., Wang, Z., Li, C., Basarab, J.A., MacNeil, M.D., Plastow, G.S. (2018)** Modelling heterotic effects in beef cattle using genome-wide SNP-marker genotypes. J. Anim. Sci. https://doi.org/10.1093/jas/skx002

**Fitzsimmons C, Ekine-Dzivenu C, Akanno EC, Chen L, McKeown L, Irving B, Baker L, Vinsky M, Crowley J, Colazo M, MacNeil MD, Plastow G, Basarab J, & Li C. (2018)** Improvement of cow feed efficiency and the production of consistent quality beef using RFI and carcass trait MBVs. Presentation to the Alberta Beef Producers Research Committee Meeting, Calgary, AB. February 9.

**Fitzsimmons C.** Reduction of GHG Emissions by Beef Production: Diverse Sources and Solutions. Inter-American Institute for Cooperation on Agriculture information session for 'Methane emission in the livestock sector: Minimizing the environmental footprint to achieve GHG emission targets', building collaborations with agriculture in Uruguay. Edmonton, Canada with video link to various locations in Uruguay. May 25.

- **"Measuring and assessing Canadian rangeland and other agricultural best management practices with the enhanced whole-farm model Holos (Whole-farm BMP evaluation using Holos)." (Roland Kroebel, PI); in progress**
  - This project supports Goal 2. Several modeling methods using Tier 2 IPCC methods are used to estimate greenhouse gas emission on a systems basis. Data from grazing systems is supplied from Swift Current and Lacombe. An LCA conducted by Dr. Baron showed swath grazing reduced the amount of energy used in the winter feeding process by 50% and reduced the greenhouse gas emission per kg of feed fed compared to a traditional feeding system. The carbon footprint for wintering beef cows was reduced by 18.3 kg C per cow grazed for 100 days.
- **"Development and deployment of MBVs/gEPDs for feed efficiency and carcass traits that perform in commercial beef cattle." (PI= John Basarab, co-PI= Donagh Berry and John Crowley; October 2015 to September 2019); in progress**
  - The project supports Goal 3. It aims to develop and deploy genomic tools to commercial cow-calf producers and has three major deliverables/Activities: 1) 30 million variants screened for functional impact on traits of interest; 2) gEPDs for 10 traits with > 35% accuracy in crossbred cattle; and 3) two multi-trait value indices for commercial producers.
  - This project has already developed the EnVigour HX genomic tool, a first in Canada service marketed by Delta Genomics and published two foundation papers supporting the science (Akanno et al. 2017) and validating its economic benefits (Basarab et al. 2018). In this fiscal year, a license was sold to Neogen Canada and a royalty of $2.50/EnVigour HX test returned to Delta Genomics. Molecular Breeding Values (gEPDs) for 18 growth, feed efficiency, and carcass traits with >35% accuracy have been developed for crossbred cattle. In addition, two multi-trait value ($) indices have been developed, one for feeder cattle and one for female fertility and lifetime productivity. These indices will undergo validation against commercial cattle data sets and further refinement.

- **Activity 1. 30 million functional genomic variants screened:** This activity has been completed and a manuscript on structural variants (SV) submitted to GigaScience. The revisions are complete, with the revised manuscript being submitted on February 26, 2019. The revision work was primarily completed by Drs. Arun Kommadath, Paul Stothard, and Jason Grant. As of the end of the reporting period the revised manuscript is still under review.
- Annotated SNP and indels from Run 6 of the 1000 Bull Genomes Project, which were generated in part through sequence data obtained through this project, have been shared with Activity 2 for use in imputation. The annotated SVs from this activity have also been shared. The impact of the SV information will take longer to realize, as there are challenges related to their imputation and genotyping in large numbers of animals.
- **Activity 2. On-farm phenotyping, GWAS using imputed sequence and phenotypes and Genomic Predictions and gEPDs.** Feed intake and efficiency testing were completed on 127 crossbred steers from November 16, 2018 and January 18, 2019. All steers have been genotyped and carcass data will be collected by August 2019. In addition, 200 crossbred heifers were transported from Echo Sand Ranch to the Olds College Feed Intake Test Facility on January 23, 2019. These animals have been genotyped (GGP-LD) and they will be tested for feed intake and efficiency between February and April 2019. This will complete phenotyping for this project.
- Mohammed Abo-Ismail, the post-doctoral fellow (PDF) on the project. is in the fourth round of the genotype analyses repeating genomic breed composition, imputation, genome-wide association studies (GWAS), and genomic predictions. Thus, in the last 3 years, we have collated ~27000 animals from different sources including our target population (i.e commercial cattle). In the current round, we performed genotype imputation using multi-stage approach (i.e. from low density SNP panels to high density panel and then to sequence genotypes). Animals with low density SNP genotypes (8K or 15K SNPs which overlapped with illumine 50K SNP panel) were imputed to 50K. Then, animals (n=20,868) with 50K genotypes were imputed to HD genotypes using 6,122 animals with HD genotypes. Next, animals with HD (24600 animals) were imputed to sequence using Run 6 genotypes (n=2333 animals) from 1000 Genomes Project. The PDF is currently doing quality control for phenotypes and genotypes as well as locating the missing genotypes for 1800 animals with phenotypes and to run the GWAS using 50K and HD and estimate the MBVs. The MBVs will be used in the selection index activity. We have published previous results in Plant and Animal Genome XXVII conference proceedings (San Diego 2018) and are presently working on draft manuscripts based on the results from the current round of analyses.
- **Activity 3. Growth and efficiency indices.** The main purpose of this activity has been to generate economic values for growth and feed efficiency traits of replacement heifers as well as for reproductive performance over five calving, aiming to develop a multi-trait lifetime productivity selection index. For this goal, phenotypic information of 411 replacement heifers born from 2005 to 2015 at the Agriculture and Agri-Food Canada Lacombe Research and Development Centre (LRDC, Lacombe, AB, Canada) were used. A

detailed description of the phenotyping procedure over 11 production cycles and five parities was previously presented by Basarab et al. (2018).

- Descriptive statistics for over 30 heifer traits have been generated. Among them, the traits found significant (P<0.05) to build the multi-trait replacement heifer index were heifer birth weight (**BW**, kg), heifer 200 days wean weight (**WW200d**, d), heifer retained heterozygosity (**RHETg**), heifer on-test dry matter intake (**DMI**, kg DM/d), heifer on-test residual feed intake (**RFI**, kg DM/d), age at first calving (**AFC**, d), and number of different times a female has had offspring over lifetime productivity (**Nparity**). These traits were selected based on the following criterion: *i*) available on farm and easy to measure (BW, WW200d and AFC); *ii*) new traits with additional costs (RHETg, DMI and RFI), and *iii*) late phenotypes and hard to measure (Lifetime productivity and Nparity).
- The weighting factors are usually economic-based, and the economic weight for each trait was based on total input costs and profit functions. The following inputs and costs were considered to estimate the economic values: *i*) income from weaned calves: weaned calf price of $3.97 kg/live wean weigh, *ii*) calf lost opportunity cost: calves that born alive and died before weaning were considered as the cost of $3.97 kg/birth weight, and *iii*) cow input cost: considered the replacement heifer cost, as suggested by Basarab et al. (2018) and was input costs minus salvage value of the heifer estimated at $1250. Thus, all replaced cow cost $1250 when culling for any reason. Calf lost opportunity cost was considered as a penalty for those cows that calved but did not wean the calf. Additionally, lifetime net return ($) was considered the total economic return over consecutive parities and was calculated as cumulative 200 d weight of calf weaned per initial replacement heifer over five parities (also known as lifetime productivity). Calf weaning weight was adjusted to 200 d of age, and for calf gender (steer equivalent) and calf sire breed.
- A multi-trait partial regression model was fitted to estimate the economic value of each trait considering cumulative lifetime net return (lifetime productivity) as a dependent variable and the actual phenotypic information of BW, WW200d, RHETg, DMI, RFI, AFC, and Nparity as independent variables (Multiple R-squared = 0.763).
- After the calculation of economic values based on net revenue and actual phenotypic information for each trait, the estimated economic value was calculated based on the multi-trait regression model aiming to identify the reliability of the fitted model. The coefficient correlation between actual and estimated economic return was high (r = 0.87, $p < 0.05$). Thus, the economic weighting factor of each trait included in the lifetime profitability index can be represented as follow:
- *Lifetime profitability economic index =* - BW * 8.02 + WW200d * 5.04 + RHETg * 268.41 - DMI * 92.14 – RFI * 21.64– AFC * 0.35 + Nparity *1292.22
- Based on the target traits and economic values, the next step will be the selection index development and validation against our commercial cattle data set obtained from producers (e.g., Cow-Calf Health Management Services and HerdTrax). In this way, molecular breeding values (MBVs), (co)variance components and genetic parameters will be used to calculate the selection index coefficient (*b*) and then develop the multi-

trait lifetime productivity selection index (LTPindex) using a dynamic linear programming. These genetic parameters will be estimated using the dataset included in the project entitled "*Development and deployment of MBVs/gEPDs for feed efficiency and carcass traits that perform in commercial beef cattle*" and the final index will be as follow:

- $LTPindex = b_{BW} * MBV_{BW} + bW_{W200d} * MBV_{WW200d} + b_{RHETg} * MBV_{RHETg} + b_{DMI} * MBV_{DMI} + b_{RFI} * MBV_{RFI} + b_{AFC} * MBV_{AFC} + b_{Nparity} * MBV_{Nparity}$
- **Publications, articles, posters and presentations & public outreach:**

**Basarab, J.A., J.J. Crowley, M.K. Abo-Ismail, G.M. Manafiazar, E. C. Akanno, V.S. Baron, and G. Plastow. 2018.** Genomic retained heterosis effects on fertility and lifetime productivity in beef heifers. Can. J. Anim. Sci., https://doi.org/10.1139/CJAS-2017-0192

**Akanno, E.C., L. Chen, M.K. Abo-Ismail, J.J. Crowley, Z. Wang, C. Li, J.A. Basarab, M.D. MacNeil, and G. Plastow. 2017.** Genomic prediction of breed composition and heterosis effects in Angus, Charolais, and Hereford crosses using 50k genotypes. Can. J. Anim. Sci., 97(3): 431-438, https://doi.org/10.1139/cjas-2016-0124

**Callum, C., Ominski, K.H., Crow, G., Zvomuya, F. and Basarab, J.A. 2018.** Relationship between residual feed intake classification as a heifer and lifetime productivity of beef cattle. Can. J. Anim. Sci., https://doi.org/10.1139/CJAS-2018-0002.

**Manafiazar, G., Baron, V.S., McKeown, L., Block, H., Ominski, K., Plastow, G., and Basarab, J.A.** 2019. Methane and carbon dioxide emissions from yearling beef heifers and mature cows classified for residual feed intake under drylot conditions. Can. J. Anim. Sci., submitted Feb 2019.

**Basarab, JA. 2018**. Genomic tools to increase calf crop, feed efficiency and sustainable beef, 6th Fall Forum, Delivering a sustainable future for resilient food production & for the environment, Belfast IR, 2018/11/12-15.

**Kommadath, A., D.P. Berry, C.F. Baes and P. Stothard. 2019.** A large interactive visual database of copy number variants discovered in taurine cattle. GegaScience. Accepted

**M. K. Abo-Ismail**, J. J. Crowley, G.M. Manafiazar, C. Li, M. Sargolzaei, P. Stothard, G. Plastow, J. A. Basarab. Genome-wide association studies for female fertility and lifetime productivity in beef cattle. International Plant & Animal Genome XXVII / January 12-16, 2019 - San Diego, CA, USA (**Poster**)

**M. K. Abo-Ismail**, J. J. Crowley, D. Berry, C. Li, P. Stothard, G. Plastow, and J. A. Basarab. Genome-wide association studies for feed efficiency traits in beef cattle. International Plant & Animal Genome XXVII / January 12-16, 2019 - San Diego, CA, USA (**Poster)**

**Valente, T.S., Abo-Ismail, M.K., Crowley, J., Basarab, J.A., Plastow, G.** Genetic correlation estimates between feeding behaviour and feed efficiency traits in beef cattle. BA/ISAE 2018 Conference Chile

**Basarab, JA.** Sustainable Beef, Livestock Crop and Livestock Research directors and ADM, Lacombe AB; 2018/10/04.
**Basarab, JA**. Beef Research Program. Livestock Crop and Livestock Research Updates; Lacombe AB; 2018/10/04.
**Basarab, JA.** Feed Efficiency and methane emissions, Animal Science 474/574, University of Alberta, Edmonton, 2019/03/29.
**Basarab, JA**. Genomic tools for commercial beef herds. Farm Forum, Mayerthorpe, 2018/11/29.
**Webcast, Provincial.** "Research Plays Weighting Game with Carcass Traits". Tiago Valente, Genome Alberta, 2018-12-01. http://genomealberta.ca/livestock/research-plays-weighting-game-with-carcass-traits.aspx.
**Webcast, National**. "Genomic tools for crossbred cattle in the works". Graham Plastow, Canadian Cattlemen: The Beef Magazine, 2018-12-14. https://www.canadiancattlemen.ca/2018/12/14/genomic-tools-for-crossbred-cattle-in-the-works/?module=carousel&pgtype=homepage&i=1
**Webcast, Provincial. "Research Plays Matchmaker with Genes and Traits". Mohammed Abo-Ismail, Genome Alberta, 2019-01-01. http://genomealberta.ca/livestock/research-plays-matchmaker-with-genes-and-traits.aspx.**
Webcast, Provincial. "Student Genome Research in a Class by Itself". Alastair Cribb, Genome Alberta, 2019-03-01. http://genomealberta.ca/livestock/student-genome-research-in-a-class-by-itself.aspx
**Basarab, JA**. Sustainable Beef, Alberta Beef Forage & Grazing Annual meeting, Lacombe Research and Development Centre, 2019/02/06.
**National. "Genomic tools for crossbred cattle in the works". Graham Plastow**, Canadian Cattlemen: The Beef Magazine, December 2018.

- **"Evaluating a new tool (GGP-F250) for improving accuracy of gEPDs for production efficiency in commercial beef cattle." (2017R034R; PI: Graham Plastow and John Basarab; April 2017 to March 2019); in progress**
  - The project supports Goal 3. The project will run approximately 1200 genotypes of genetically diverse cattle using the GGP-F250K and impute approximately 4000 crossbreds genotyped with GGP-LD (~30K SNPs). The results will provide important information on utility and cost of different genotyping strategies to help increase adoption of genomic tools in commercial cattle.
  - Our preliminary analysis of GGP F250 (Neogen; ~250,000 SNPs) genotypes from 1149 beef cattle identified over 5000 putative mutations of which 90 mutations were mapped within or nearby 25 genes which overlapped with reported haplotypes causing infertility. These results indicate potential carriers of lethal fertility mutations, at a frequency of 1-25% in crossbred beef cattle. Identification of such mutations can be easily and rapidly translated to improved fertility by avoiding carrier by carrier matings. While validated haplotypes can immediately be incorporated into genotype-based

management tools, there are advantages to identifying the underlying causative mutation. Our next step is to validate these haplotypes against our cow fertility data bases to determine the value of the GGP-F250K tool and whether we can identify marker SNPs and create a smaller, more cost effective panel to identify fertility haplotypes in beef cattle.

- **"Optimize heterozygosity in composite multi-breed and cross breed beef populations using genetic and genomic tools." (2017F103R; PI: Graham Plastow and John Basarab; March 2017 to February 2019); in progress**
  - The project supports Goal 3. This project proposes to 1) determine how many SNPs are required for determining the optimum panel (cost/information content) to accurately predict genome-wide retained heterozygosity (gRHET); 2) test the relationship between gRHET and cow reproductive (e.g., fertility, lifetime productivity) performance; 3) evaluate DNA pooling to determine breed composition and retained heterozygosity and; 4) develop a strategy to monitor, maintain, and optimize RH in herds for improved performance and increased profitability.
  - **Objective 1:** Effectiveness of different density panels on breed composition and genomic retained heterozygosity (gRH) calculation were assessed. Genomic breed composition was predicted for all individuals using the cross-validation procedure implemented in ADMIXTURE software using different approaches in terms of number of single nucleotide polymorphisms (SNPs; including International Society of Animal Genetics parentage assignment panel; ISAG), methods of SNP selection, and breed information. Results indicated a strong effect for number of SNPs and SNP selection methods on breed composition and gRHET estimates. The correlation between gRHET estimated using the maximum number of SNP and other approaches ranged from 61 to 95%.The ISAG SNPs had 13 percentile points lower accuracy than that obtained when using the maximum number of SNPs (~7,616 SNP overlapped between SNP panels). It is concluded that predicting genomic-based breed composition was achieved using cost-effective marker panels without affecting the accuracy of estimation of gRHET required to optimize crossbreeding programs in beef cattle. These results were presented in International Society of Animal Genetics 2017.
  - **Objective 2:** Effect of genomic retained heterozygosity and its economic potential on reproductive traits using the Lacombe Research and Development cow herd database have been presented and discussed in a peer-reviewed article published in Canadian Journal of Animal Science (2018, 98(4): 642-655, https://doi.org/10.1139/cjas-2017-0192). In short, we demonstrated that each 10% change in genomic retained heterozygosity resulted in 51±20 d longer survival (P=0.011) in the herd and 35.7±15.2 kg more (P=0.019) calf weaned per cow exposed to breeding when summed over five parities. These differences resulted in an extra $161/heifer/year. These effects are being validated in two other data sets: 1: Roy Berg Kinsella Research Station herd (n>4000) and 2) Beefbooster herds (n>27000)
  - **Objective 3:** The effectiveness of pooling DNA samples from combining genotypes *in silico* from 5, 10, 20, 50, 100, and 200 individuals to predict genomic breed composition

(gBC) and retained heterozygosity (gRHET) using single nucleotide polymorphism (SNP) marker for crossbred populations were assessed. We have developed an algorithm in R package to randomly select individuals from a herd and to make required pools (5, 10, 20, 50, 100, and 200 individuals per pool). Then, we predict breed composition of the pool and compare this with the average of individual breed composition for the animals within each pool. The results indicated strong correlations (r=0.82 for 200 samples per pool to 0.95 for 5 samples per pool) between genomic breed composition generated from pools of crossbreed animals' DNA and individual gBC. Analyses of other scenarios are underway. Based on the preliminary results, pooling genotypes can be used for reducing the cost of the breed composition test in crossbred herds with relatively high accuracy and so as to help prescribe sire breed(s) to optimize retained heterozygosity level in the commercial herds.

- **Objective 4:** We will use the datasets to create different groups based on individual heterozygosity level then will test effect of different mating scenarios on reproductive and fitness traits.
- **Publications, presentations, articles and public outreach:**

  **Manafiazar, G.** Entering in Genomic era, Applied Beef Science 474, University of Alberta, Edmonton, 2019/03/29.

  **Basarab, JA.** Genomic tools to increase calf crop, feed efficiency and sustainable beef, 6th Fall Forum, Delivering a sustainable future for resilient food production & for the environment, Belfast IR, 2018/11/12-15.

  **Basarab, JA.,** Genomic tools for commercial beef herds. Forage to Beef Demo Days, Walden Ranch 2018/07/10.

  **Plastow, G.,** Genomic tools for commercial beef herds. Forage to Beef Demo Days, Difficulty Ranch 2018/07/11.

  **Basarab, J. Plastow, G.** Getting Genomics Working for Commercial Cattle. CBBC Technical Forum, London, ON 14th August 2018 (part of the Canadian Beef Industry Conference).

  **M. K. Abo-Ismail, J. J. Crowley, G.M. Manafiazar, C. Li, M. Sargolzaei, P. Stothard, G. Plastow, J. A. Basarab. 2019.** Genome-wide association studies for female fertility and lifetime productivity in beef cattle. Plant and Animal Genomic Conference. San Diego, USA.

  **M. K. Abo-Ismail, J. Crowley, E. C. Akanno , G. Manafiazar , C. Li1, G. Plastow , M. D. MacNeil , D. Berry , P. Stothard , and J. Basarab. 2017.** Genomic profiles to assess accuracy of breed composition and hybrid vigor in crossbred beef cattle. International Society of Animal Genetics, July 2017. Dublin, Ireland.

  **Basarab, J., Crowley, J. Abo-Ismail, M. Manafiazar, G. Akanno, E. Baron, V. Plastow G., 2018.** Genomic retained heterosis effects on fertility and lifetime productivity in beef heifers. Canadian Journal of Animal Science. https://doi.org/10.1139/CJAS-2017-0192

- **"Genetic analyses of feed intake, feed efficiency, female fertility, and cow lifetime productivity in beef cattle raised under two environments." (PI: John Basarab and Changxi Li, April 2018 –March 2023); in progress**

- The project supports Goal 3. Objectives are to: i) Estimate genetic and phenotypic correlations of dry matter intake (DMI as a heifer) and feed efficiency with heifer fertility, longevity and lifetime productivity (LTP) of cows reared under two winter feeding systems (higher vs. lower inputs); ii) Determine relationships of mature cow DMI per weight of calf weaned over 3 and 6 calvings with heifer performance; iii) Predict heifer fertility and cow LTP using additive, non-additive and environmental effects; iv) Quantify the economic value differences among heifers using feed intake, fertility, LTP and longevity; v) Phenotype 2000 commercial heifers for feed intake and efficiency using Growsafe's marketing approach and create value indices for these heifers.
- Year 1 Interim Report completed and approved by BCRC, and report is available upon request. Year 1 was mostly about data collection and data base construction no results presented.

- **"Development of functional genomic prediction platform for industry application." (PI: John Basarab and Changxi Li, April 2019-March 2021); in progress**
  - Supports goals 2 and 3.
  - Constant genetic improvement on beef production efficiency and quality is a key strategy to enhance national and international competitiveness and thus the sustainability of beef production. However, genetic improvement rate via traditional phenotype and/or pedigree based genetic evaluation and selection has been slow for certain important beef performance traits that are difficult/expensive to record such as feed efficiency, methane emission, and fertility. Over the past years, researchers at Livestock Gentec (UA, AAFC, AAF) developed a number of genomic prediction tools including genomic prediction of genetic merit or EPD for feed efficiency and carcass traits (Chen et al. 2013; Chen et al. 2015, Lu et al. 2016), genomic prediction of breed composition and retained heterosis (Akanno et al. 2017; Basarab et al. 2018), multiple trait selection indexes based on genomic EPDs (Ekine-Dzivenu et al. 2018).These genomic tools provide an enabling solution to improving beef cattle performance for the above traits, in particular for many commercial producers who don't have access to information from a breed association and want to select replacements from their own herd. To promote a wider application of the genomic tools in the industry, the proposed project aim to develop a user-friendly platform to deploy the genomic technologies through service providers such as Delta Genomics, Cow-Calf Health Management Services, and GrowSafe Systems Ltd. with the outcome of improving sustainability, competitiveness, and profitability of the Canadian Livestock Industry.
  - The platform will be a window-based portal with modules that include intake of animal data submitted by the industry, database management of reference populations for various genomic prediction purposes, consolidated pipelines for analyzing data for target genomic prediction (i.e. EPD prediction, breed composition and heterosis prediction, multiple trait selection index calculation), standardized format for release of genomic prediction results to users, and summary tools of feedback from users. The proposed project will use 1000 industry beef cattle as examples to demonstrate and train staff from service providers so the participants can uptake and apply the genomic

service via the platform. The expected deliverables include: (1). Standard operation procedures (SOP) for uptake and management of genomic data; (2). Pipelines for genomic data quality control; (3). Optimized reference populations for various genomic predictions based on target candidates; (4). Improved functional genomic tools via leveraging existing "omics" data; (5). Consolidated pipelines or statistical methods for genomic prediction (i.e. EPDs for feed efficiency, carcass and other performance traits, breed composition, retain hybrid vigor; multiple trait selection index); (6). A user-friend window-based platform that integrates all components from data uptake, data analyses, to result reporting via a demonstration of using 1000 industry beef cattle.

- The proposed project capitalizes genomic tools developed by researchers and will significantly promote the application of genomic approaches to address challenges and opportunities of importance to the beef industry through partnership with service providers. The proposed project is aligned well with the Program Guidelines as the developed genomic platform would allow more beef producers to access the genomic tools to select genetic superior beef cattle to increase production efficiency and quality, and to reduce the environmental footprint (GHG) of livestock production systems.

- **"Increasing the productivity in winter hardy alfalfa by selecting for reduced fall dormancy." (PI: Vern Baron); in progress**
  - This project supports goals 4 and 5
  - Alfalfa with reduced fall dormancy can grow later into the season, so it has higher yields. Alfalfa with higher winter hardiness survives the winter better. Winter hardy alfalfa usually has higher fall dormancy but these traits are genetically independent, so one should be able to select for winter hardy alfalfa with low fall dormancy.
  - Recurrent selection: The team will select Peace and Yellowhead alfalfa varieties for reduced fall dormancy, and test for freezing tolerance, researchers will then look for genes that respond to these selections. They will grow individual plants at long daylengths and warm temperatures, cut them, shorten the daylength and reduce the temperature, grow them again, and find the tallest plants. After three rounds of this, the tallest plants are crossed, and the cycle starts again.
  - Impact of recurrent selection: The resulting seed will be planted to evaluate grazing or cutting tolerance. These populations will also be tested for freezing tolerance by slowly freezing them at 4oC per hour to -22 through -36oC, thawing in the dark at -2oC, regrowing them for 3 weeks, and determining which varieties survive.
  - Genomic validation: Plots established in Normandin, Quebec City, Swift Current and Lacombe will be evaluated for yields, fall dormancy and winter hardiness and their stability in the different locations. Gene markers for freezing tolerance and fall dormancy that have previously been identified in Quebec will be validated in these western populations.
  - The new, improved varieties and others will be exposed to intense continuous grazing in Lacombe to see how they tolerate grazing, and tolerance to cutting frequency will be evaluated in Swift Current.
  - Funded by the Beef Industry Science Cluster

- **"Evaluation of alfalfa lines and populations for reduced dormancy, higher yield and winter hardiness across Canada." (PI: Vern Baron); Completed Nov 2018**
  - This project supports Goals 4 and 5.
  - Beef producers in the Northern and Western Prairies require alfalfa varieties with greater winter hardiness and late season yield to extend the grazing season and increase the hay supply. Fall dormancy or lack of growth and freezing tolerance are closely correlated and deemed necessary in the development of alfalfa winter hardiness for short season and semi-arid environments. Generally, at higher latitudes, dormancy and onset of acclimation to winter conditions begins early, reducing fall regrowth or yield to the extent that only one cut or grazing may be possible. Thus it is hard to increase yield or attain second growths in an already short growing season.
  - **Agronomic Trial comparing dormancy as indicated by plant height in the fall with winter survival and second cut yield**. (Baron, Schellenberg, Lajeunesse, Bertrand and Claessens). The objective is to find current varieties or develop new ones with relatively low fall dormancy, improved winter hardiness and the capacity to produce a second cut or grazing. Research has been carried out at AAFC Quebec City and Normandin, QC, Swift Current, SK and Lacombe, AB.
  - Three strategies all of which involved manipulating dormancy, but maintaining or improving winter hardiness in alfalfa to improve late-season yield are evaluated across the four locations. 1. Recurrent selection for reduced dormancy (tall plants) under reduced day lengths in growth chambers within the dormant and winter hardy alfalfa populations, Yellowhead and Peace, with retention of original winter hardiness; 2. Recurrent selection for greater low temperature freezing tolerance within alfalfa cultivars adapted to a lower dormancy (southern) region, then moved to a short-season, northern region, while retaining high yield; 3. Identification of superior varieties currently grown at northern latitudes, which appeared to have regrowth capability. Approximately 25 varieties and populations were rated for dormancy and winter-hardiness.
  - Each of the strategies showed potential to improve late season alfalfa yield for northern locations. First, MV Brand, Rhizoma and Taproot Lundgard, currently grown in northern Alberta, had greater regrowth yield than the very dormant and winter hardy, Anik and Yellowhead, but with similar winter hardiness. Second, selecting for greater freezing tolerance within Caribou improved the winter hardiness of the new Caribou FT3, so it could be grown in colder regions than recommended for Caribou, but with retained yield. Third, regrowth yield was significantly improved over the dormant Yellowhead by selecting within Yellowhead for tall plants under reduced day length in growth cabinets, while winter hardiness was not sacrificed.
  - **Demonstration trial carried out at Skeels' farm near Caroline, AB** (Bruhjell and Baron) Alfalfa populations known to survive in Northern Alberta were collected and established as pure stands on a Gray Wooded soil at Caroline Alberta in 2013. Of the populations collected only Yellowhead is registered as a variety. MV Brand was sourced from Seaborn Seeds, Rocky Mountainhouse, AB, the others from seed producers in the Peace

River region of Alberta. These are: Rhizoma (Allen Batt, Fort Vermillion, AB), Anik (Dave Bartlett, Fairview), Taproot Lundgard and Falcata Lundgard (Lundgard Seeds, Grimshaw, AB). Beginning in 2014 the plots were split in half forming two blocks originally intended as management treatments. Both blocks were cut and harvested as hay in July of each year with one grazed hard intensively in September and the other not grazed. These populations were genotyped and included in agronomy dormancy trials at all locations. The agronomic trials indicated that while all of these populations had Fall Dormancy (FD) < 2 from 0.9 (very dormant) for Anik, Yellowhead and Falcata Lundgard to 1.7 for MV Brand and in general these correlated to fall yield potential. By 2016 encroachment of the pure alfalfa stands by quackgrass and Kentucky bluegrass was substantial. Taproot Lundgard and Rhizoma survived in competition with grass, occupying greater than 60% of the sward content after 4 years, whereas highly dormant Yellowhead and Anik were almost totally out-competed and winterkilled. Rhizoma and Yellowhead produced 2300 and 3400 kg $ha^{-1}$ of grass and alfalfa forage in a second cut or graze with 66 and 68% alfalfa, respectively after four years of growth, whereas yellowhead only had 17% of alfalfa in the stand during September. These populations offer local and regional solutions to poor alfalfa winter hardiness and fall production for the northern Prairies.

- See the project results summary at: https://irp-cdn.multiscreensite.com/f1ef9cf3/files/uploaded/FRG0215%20Final%20Report.pdf
- **Publications, presentations, articles and public outreach**

**Bertrand, A. Claessens, A., Rocher, S., V. Baron, V. 2018.** Breeding alfalfa for cold tolerance and low dormancy. 11th International Plant Cold Hardiness Conference (IPCHS). Madison, WI. Poster August 5, 2018.

**Bertrand, A., Claessens, A., Rocher, S., Lajeuenesse, J. et Schellenberg, M. 2019.** Luzerne : faut-il vraiment choisir entre survie a l'hiver et rendement? Journee d'information scientifique – Boivins laitiers et plantes fourrageres. 3 pp. Drummondville, Quebec. (Invited Presentation 265 people)

**Bertrand, A. Claessens, A., Rocher, S. 2018.** An Indoor screening method for reduced dormancy in alfalfa, In : Brazauskas, G., Statkeviciute, G. Janaviciene, K. (eds) Breeding grasses and protein crops in the era of genomics. Springer pp.209-214

**Baron, V.S. 2018.** Managing genetics in a shifting tide. Canadian Forage and Grasslands Assoc. Annual meeting Nov. 14 -15, 2018, Calgary AB. Invited Presentation. (200 people)

**Baron, V.S., Block, H and Bruhjell, D. 2019.** Report on forage-beef research and extenstion at AAFC, Lacombe. Alberta Beef, Forage and Grazing Centre Annual Meeting, Lacombe, AB, Feb. 6. 2019. 50 people attending

**Duckworth, Barbara 2018.** Declining hay yields challenge herd growth. P 42. Western Producer. WWW. PRODUCER.COM. The Western Producer. Dec. 13. 2018.

**Guenther, Lisa. 2018.** Declining hay yields emphasize importance of perennial forages. Interview with Vern Baron. Podcast: Between the Rows. Canadian Cattlemen. Nov. 22, 2018

- **"Selection of annual forage wheat lines for yield and quality." (PI: Pierre Hucl); completed Nov 2018**
  - This project supports Goals 1 and 4 by exploring the potential of forage wheat in feeding programs, and is funded by ABP. See project results summary here: https://irp-cdn.multiscreensite.com/f1ef9cf3/files/uploaded/FRG0715%20Final%20Report.pdf
- **"Evaluating the potential interaction between efficiency types for backgrounding weaned cattle and silage varieties differing in feed quality." (PI: Hushton Block); in progress**
  - This project focuses on supporting Goals 3 and 4, but builds off activities for Goals 1 and 3 and contributes to Goal 2.
  - In each of two years 128 steers were genotyped and ranked into quartiles by genomic predicted molecular breeding values for residual feed intake. Within each quartile, steers were randomized into 4 pens with 2 pens per quartile randomized to one of two silage based backgrounding diets. Silages used in backgrounding diets were selected using a forage evaluation spreadsheet. Supplements to address nutrient imbalances in silages were formulated on a least cost of gain basis and fed to steers for 112 d.
  - Performance data collected from the feeding trial was used to evaluate accuracy of genomic predictions, compare silages for use in backgrounding and test for potential interaction between cattle efficiency type and diet quality, including an economic evaluation of treatments.
  - Results indicate genomic prediction of RFI was imprecise with no relationship between genomic predicted molecular breeding value for RFI and observed pen average RFI. Use of observed pen average RFI found there was no interaction between observed cattle efficiency type and diet quality. There was a 33% (triticale silage) to 44% (barley silage) improvement in feed conversion (vs. the ABFGC benchmark of 11:1 for a forage based diet) through silage variety selection and least cost of gain optimized diet formulation.
  - Evaluation of trial results with nutritional requirement evaluation software (NASEM 2016) indicate that 3% of the improvement in feed conversion with the triticale silage based diet vs ABFGC baseline was due to silage, and 97% was due to diet formulation. For the barley silage based diet, 60% of the improvement in feed conversion was due to the silage and 40% was due to feed formulation. Improvement in feed conversion was estimated to result in a 29% (triticale silage) to 40% (barley silage) reduction in methane emissions intensity and a 19% (triticale silage) to 28% (barley silage) reduction in the total cost of gain during the backgrounding period. This is good progress against the ABFGC goal to reduce backgrounding costs by 50%.
  - Project funding (AAFC) ended in March 2019. Study results inspired two additional project concepts: "Evaluation of silage varieties and sorting methods for backgrounding steer calves", and "Individually targeted cow-calf nutrition and management on pasture in support of a net zero carbon beef target.
- **"Evaluation of silage varieties and sorting methods for backgrounding steer calves." (PI: Hushton Block); in progress**
  - This project focuses on Goal 4 and contributes to Goal 2.

- In response to favourable results from silage variety selection in "Evaluating the potential interaction between efficiency types for backgrounding weaned cattle and silage varieties differing in feed quality" an anticipatory backgrounding study was conducted to expand the silage variety consideration to include a corn silage variety selected on the basis of low CHU requirements, and to look and genetic (breed composition) vs phenomic (appearance and weight) based sorting of backgrounding cattle to reduce within pen variation in cattle performance.
- Consideration of additional silage varieties has the potential to improve upon previous study progress towards ABFGC goals through improved crop production and cattle performance. Sorting strategies that reduce within pen cattle variation should allow more targeted nutrition and management contributing to both improved cattle production efficiency and beef quality.
- A total of 118 steers were randomized two groups based on breed composition. In one group, steers were randomized to pens based on breed composition and weight. In the other group, steers were randomized to pens based on phenotype (colour, breed composition was ignored) and weight. There were 3 pairs of pens per sort treatment (12 pens total) and one of each pair was randomized to a barley silage or corn silage based diet. Steers were backgrounded for 56 d with data collection on diet composition, feed intake, steer weight, and steer ultrasound backfat.
- Very preliminary data analyses indicates an effect of sorting method on within pen variability. Effect of backgrounding diet has not yet been assessed.

- **"Individually targeted cow-calf nutrition and management on pasture in support of a net zero carbon beef target". (PI: Hushton Block); in progress**
  - This project focuses on Goals 2 and 3.
  - Recent cattle management survey results (Sheppard et al. 2015) indicate very low use of supplemental feed, other than minerals, for cow-calf pairs on pasture. The cow-calf segment is the major source of methane related to beef production greenhouse gas emissions intensity (Beauchemin et al. 2010). Substantial improvement in feed conversion and reduction in modeled methane emissions were observed from the "Evaluating the potential interaction between efficiency types for backgrounding weaned cattle and silage varieties differing in feed quality" trial in response to providing a supplement to balance cattle nutrition. This creates incentive to address the challenge of providing targeted supplementation and improving management of cattle on pasture.
  - In each of 2 years, cow-calf pairs managed on a common pasture will be subject to either an un-supplemented (mineral only) or a supplemented (mineral, nutrition to compliment pasture, ionophores, anti-methanogen products via SmartFeed Pro, and implants for steer calves) treatment. Cattle weights and ultrasound backfat data will be collected and cows will be measured for methane emissions (GreenFeed). Cattle supplement (measured) and pasture (estimated from cattle performance and pasture quality) intake will be determined and used to assess improvement in cattle production efficiency and reduction in methane emissions intensity.

  - Parallel to the grazing trial will be an effort to use automation and artificial intelligence to predict pasture quality, cattle requirements, and supplement formulation to allow application by producers without requiring intensive sampling or direct exposure to nutrition evaluation complexity.
  - This study is funded (AAFC) from April 2019 through March 2022.
- **"Use of BioChar to reduce methane emissions from cattle." (Team member: Barry Yaremcio); in progress**
  - The project supports Goals 1, 2, 3, and 5 by investigating the reduction in GHG emissions, improve feed use efficiency, animal performance and improved forage production. The project runs from 2017 to 2021 by the BioChar team based out of Lethbridge which involves AAFC, Universities of Lethbridge, Alberta, Manitoba, Alberta Innovates (Vegreville), and Alberta Agriculture. An article providing an overview of the project was published in the Canadian Cattlemen's Magazine June 2017.
- **"Development of hybrid bromegrass cultivars with enhanced NDF Digestibility." (PI: Penner); completed Nov 2018**
  - This breeding project supports goals 3,4 and 5 and is funded by ABP. The project will eventually result in a new variety of hybrid bromegrass that is more digestible, improving rates of gain and efficiency. See project results summary here: https://irp-cdn.multiscreensite.com/f1ef9cf3/files/uploaded/FRG1415%20Final%20Report.pdf
- **"Improving lipid content in vegetative tissue to increase the nutritive value of herbaceous legume forages." (PI: Surya Acharya); in progress**
  - This continuation of a previous project supports goals 1, 4 and 5 and intends to 1) determine the stability of increased lipid content and altered fatty acid composition in subsequent generations of mutagenized forage crops; and 2) examine the potential of applying CRISPR/Cas9 on lipid metabolism.
  - The expected project deliverables will be to: 1) identify stable alfalfa and sainfoin populations with increased lipid content (about 5% on dry weight basis) in shoot tissues to increase nutritive value and energy content of forages without losing biomass productivity or other agronomic and nutritive constitution for which these crops are favoured; and 2) improve our knowledge base regarding the regulation of lipid metabolism in herbaceous perennial legumes
  - Funded by ABP and SCA
- **"Long-Term Agricultural Experiments Directory Project at Onefour, Kinsella and Stavely" (PI: Darren Bruhjell); in progress**
  - Supports Goals 2 and 5
  - A component of the Soil Health Institute North American, "Long-Term Agricultural Experiments Directory" Project.
  - Once compiled, this database will be made publicly accessible for building teams and planning agricultural research requiring inter-institutional collaboration on large scales, including soil health
- **"Development of native and tame forage varieties and mixtures for improved forage and environmental productivity and resilience" (PI: Mike Schellenberg); in progress**

  - Supports Goals 2 and 5
  - The project will develop new tame forage varieties and native plant germplasm and evaluate additional tame grass species.
  - The main focus will be on improved grazing characteristics such as regrowth and persistence across 4-5 different sites. The proposed project will also evaluate forage traits such as forage yield and forage quality.
- **"Effects of annual and perennial forage systems on plant and soil parameters, grazing animal performance and system economics (PI: Bart Lardner); in progress**
  - Supports Goals 2, 4 and 5
  - Specific objectives include 1) evaluate animal performance, and kg beef per ha grazing either perennial or annual forage systems utilizing improved cultivars; 2) evaluate grazing forage production of new and non-traditional forages; 3) evaluate grazing DM intake (DMI) and forage persistence under grazing; 4) determine soil water balance under perennial or annual pasture systems under western Canadian growing conditions; 5) determine methane emissions and C sequestered grazing either annual or perennial forage pasture systems; 6) determine C and N cycling, and biophysical and biochemical characteristics of soils; 7) determine systems costs and net returns for annual and perennial forage systems. These experiments are collaborative initiatives between Livestock & Forage Centre of Excellence and UofS involving expertise including forage breeding, agronomy & system economic management, soil health & nutrient management, water cycling, and beef cattle nutrition and metabolism. Funded by ABP and SCA.

## Proposals Written

- Graham Plastow/Eileen Wall, Co-PI; John Basarab and Vern Baron on leads for Activity 5 "The "omics" of grazing: A path forward to cattle productivity, ecosystem goods and services and long term sustainability.
- John Basarab/Angela Canovas/Paul Stothard/Donagh Berry, Co-PI. Genomic tools to increase calf crop, feed efficiency and sustainable beef
- Hushton Block, PI. Silages for backgrounding steers and genomic tools for sorting feeder cattle
- Hushton Block, PI. Evaluating silages and genomic tools for backgrounding steers

## General Extension Activities

- A tour was hosted by the Centre in August. It involved a visit to Solick Seeds, Ltd. and one of the Rancher Researcher Pilot participants, James Madge. Approximately 40 people were in attendance. Post-tour a discussion session was held to investigate areas of concern and identify opportunities. This discussion was used to develop a series of potential "Call of the Land" radio interviews, which have not yet aired.

- A number of forage/pasture related articles were written by AF staff throughout the 2018 growing/feeding season, and included in the Agri-News bulletin that is produced weekly by AF. In some cases, "Call of the Land" interviews about the articles were also aired.
- Cow-CalfEnomics sessions held in November and January across the province. Topics included how genetic tools can help identify superior animals to develop productive and profitable herds, the importance of feeding vitamins, the relationship between nutrition, animal health, and productivity, especially in the face of feed shortages
- Jim Gerrish Grazing Schools (4 locations). Topics included grazing principle, soil health under grazing, stocking rates and pasture improvements.
- Three Soil Health Workshops were held in Oyen, Onefour and Stavely, AB. Topics included soil health principles and impacts under grazing.

## Communications

- Updates were provided to the AFIN and ARECA annual meetings, as well as a written update to the Grey Wooded Forage Association. Regular updates are provided to ABP's research committee.
- Website development has been a frustrating process, and we are currently considering alternate development options.
- An ABFGC twitter account has been created: https://twitter.com/ABForageBeef