PEACE COUNTRY BEEF & FORAGE ASSOCIATION

Annual Report 2017

"Strengthening Agriculture, One Farm At A Time"

Peace Country Beef & Forage Association

The Peace Country Beef & Forage Association was founded in 1982 by livestock producers in the Fairview and Hines Creek area for the purpose of demonstrating new forage varieties and technology. The PCBFA is a non-profit, producer driven, unbiased applied research association, focusing primarily on forage and beef research, with a small crops program. We strive to provide leading edge, credible and locally viable information to Peace Country producers, through our applied research and extension programs. Our vision is to create agricultural systems that are profitable, regenerative, self-sustaining and self-maintaining. We are currently made up of 10 producer directors, 4 full-time and 2 part-time staff, and approximately 200 members from across the Peace region.

Mission:

The Peace Country Beef & Forage Association is a producer group with the goal to be a hub of innovative, relevant and local beef, forage and crop information for Peace Country Producers.

Vision

A Peace Country producer's first stop for optimizing beef, forage and crop production to maximize profitability with innovative and credible information.

Mandate:

The Peace Country Beef & Forage Association believes that the sustainability of rural communities in the Peace River region will be dependent upon a strong agricultural economy with livestock production as its foundation.

Our Region:

PCBFA works with producers in an area stretching from High Prairie to the B.C. border and from Manning to Valleyview. Our focus area has 1.9 million acres of pasture land and 118,000 breeding cows.

PCBFA
PEACE COUNTRY BEEF & FORAGE ASSOCIATION

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CHAIRMAN'S REPORT
Jordan Barnfield

2017 - a year of learning, growth and excitement. Being part of the PCBFA board has been a great experience for me. This was my fourth year as a board member and my first year as chairman. It has been a very rewarding role, with a great group of board members, a passionate staff and so many amazing Peace Country producers and ag workers.

Our year started off by welcoming two new board members, Kirk Cowell and Robbie Hale. They have both contributed a lot in their first year. The board and staff kicked 2017 into gear with a day of board development with David Irvine. We worked on developing the roles of the staff, the roles of the board, and the relationship between the two, and we also started developing an orientation process for new board members. We finished the day with reassessing PCBFA's vision, goals, and values. The board decided to pick things up a notch this year by getting a bit more involved. We now do monthly board meetings that have really helped with keeping everyone engaged and updated.

There is an ever growing need for applied research and education in our constantly changing agriculture industry. We have seen this in record attendance at our many workshops and field days, and the increased demand for our staff services. Our board recognizes the importance of education for producers and our youth. With an industry that is made up of busy farm families, PCBFA has worked on making our events more youth and family friendly. We have gotten involved in the Classroom Agriculture Program in the Peace Country schools, offered discounted rates for 4-H members at events, and involved the Farm Safety youth program at our Fairview Research Farm field day.

PCBFA now has its highest number of staff since it started back in 1982, due to an increased demand and work load. We face yearly challenges being a non-profit organization, dependent primarily on government funding. Lobbying for more secure long-term funding has been high on the agenda this year. Some of our staff and board members got to take part in giving input into the development of 'Growing Forward 3' (now called CAP) over the past year. We have had numerous opportunities to meet with MLAs to talk about our challenges and the demands and need for our services.

Carbon sequestration and carbon levies for pastures and grasslands have been a hot topic this past year and will continue to be. The 2017 Western Canada Conference on Soil Health & Grazing was sold out. It is great to see so many producers that are continually working on improving the soil health and productivity of their pastures and crop lands.

Working with and learning from our board, our staff and the many passionate producers that I have met at our workshops, field days, and conferences has been an exciting and great learning experience for me. It is not always easy to be a volunteer in such a busy and diverse industry. But it is so amazing to be part of an industry that is full of such good, strong-rooted people that care so much about the soil health, water cycles, plants and animals that our agriculture industry is made up of. With such a large area and so many producers all across the Peace Country, our staff and our board are sure to be busy this coming year. And we hope that we can be an asset to you all. May 2018 be a very productive year for everyone.

CHEERS
From Your Chairman ,

Jordan Barnfield

MANAGER'S REPORT
Liisa Vihvelin, BSc(Agr), AIT

Hello everyone,

I cannot believe it is Annual Report and AGM time again already - this past year has flown by! It has been a very busy year, and we've had our ups and downs. In July, our wonderful employee Jen Allen moved back to Ontario with her fiancé, and we were very sad to say goodbye. At the same time, we unexpectedly lost our summer student, which made for a very busy and very stressful field season for our staff. However, we persevered, and with lots of hard work and long hours from our very dedicated team, we made it through and none of our trials were compromised. For that, I would like to say a very heartfelt thank you to Akim and Lekshmi, for their passion and determination is what pulled us through.

On a higher note, this past winter we were able to purchase a brand new (and much bigger) tractor to replace the antique John Deere that was just no longer reliable. We also purchased a new gooseneck trailer long enough to transport both the new tractor and our plot drill at the same time. This brought a whole new level of independence to our staff, and for the first time, we were able to travel to both Valleyview and Spirit River to seed the perennial forage demos ourselves, with our own equipment! It was quite a sense of accomplishment, and we look forward to the new doors this will open for us in the future.

In July, we were extremely proud to be able to send Akim all the way to Baltimore, Maryland to present at the Canadian Society of Animal Science and American Society of Animal Science joint conference. Akim was able to give a presentation on the local cocktail cover crop research we've been doing here in the Peace, at an international conference!

In September, we welcomed a new employee to the team – Codie lee Yasieniuk. Codie grew up on a ranch in Central Saskatchewan, and has an Environmental Conservation & Reclamation diploma from Lakeland College. Her diverse background in both agriculture and environmental sciences has proven to be a huge asset to our work, and her outgoing and friendly personality has already helped her get to know many of our members!

Another highlight of the year was being one of the seven applied research associations responsible for planning and hosting the 2017 Western Canada Conference on Soil Health and Grazing in December – which was an epic success! The conference sold out at 525 people, with some of those tickets being standing room only, and we had a waiting list! PCBFA Director Thomas Claydon and myself sat on the Steering Committee for the conference, and I chaired the Promotions Committee. Planning will soon be under way for the 2019 conference!

PCBFA was one of four associations involved in planning and launching a proposal to double the AOF funding from Alberta Agriculture & Forestry for all of Alberta's applied research and forage associations. We have spent countless hours on planning calls, writing letters, and meeting with politicians and bureaucrats alike, and the proposal has gathered quite a bit of support. In December, we brought all of the

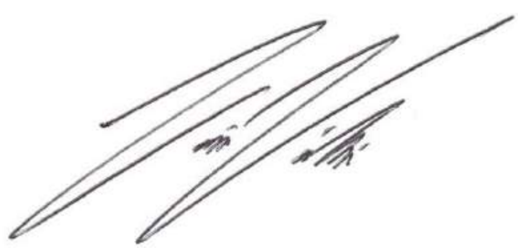
MANAGER'S REPORT
Liisa Vihvelin, BSc(Agr), AIT

associations together and hosted a reception for the MLAs at the Edmonton Federal Building. The turnout was good, and overall the event was a success and created quite a buzz. As we move into 2018 and the new CAP program is rolled out, we keep our fingers crossed and continue to work hard, in hopes that our initiative is successful! If you want to help secure the future and longevity of PCBFA, talk to your local Ag Service Boards, MPs and MLAs! Make sure they know that you see value in what we do.

I'd like to say a special thank you to three of our most dedicated board members, who've served four years on our board – our chairman Jordan Barnfield, treasurer John Prinse, and our equipment guy Thomas Claydon. They all give so much of their time and energy to this association, and it is much appreciated!

As we wrap up this busy and challenging year, I am very much looking forward to seeing what 2018 has in store for PCBFA!

Thank you very much to our many funders, partners and supporters – it takes a village!



PCBFA Staff (left to right): Marianne Krahn, Monika Benoit, Codie lee Yasieniuk, Liisa Vihvelin, Lekshmi Sreekumar, and Akim Omokanye.

2017 BOARD OF DIRECTORS

President:	Jordan Barnfield	Teepee Creek
Vice President:	Preston Basnett	Eureka River
Treasurer:	John Prinse	Enilda
Secretary:	Nancy Van Herk	Eureka River
Directors:	Thomas Claydon	Valleyview
	Faron Steffen	Grimshaw
	Kirk Cowell	Spirit River
	Garry Gurtler	North Star
	Robbie Hale	Hines Creek
	Joyleen Beamish	High Prairie

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Municipalities and Counties

MD of Fairview	MD of Spirit River
MD of Peace	Birch Hills County
Clear Hills County	Big Lakes County
Saddle Hills County	MD of Greenview
County of Grande Prairie	Northern Sunrise County

Alberta Agriculture & Forestry Advisory

Calvin Yoder, Forage Specialist—Alberta Agriculture & Forestry Spirit River

ACKNOWLEDGEMENTS

PCBFA greatly appreciates the following contributors for helping us deliver important extension programs and conduct essential projects in 2017:

Funders

Agriculture Opportunity Fund (AOF)
Alberta Agriculture and Forestry (AAF)
Alberta Beef Producers (ABP)
Alberta Crop Industry Development Fund (ACIDF)
Alberta Wheat Commission (AWC)
Prairie Organic Grain Initiative (POGI)
Alberta Canola Producers Commission (ACPC)
Alberta Barley (ABC)
Alberta Pulse Growers (APG)

Municipal District & County Support

MD of Fairview, No. 136
Clear Hills County, No. 21
MD of Peace, No. 135
Saddle Hills County
MD of Spirit River, No. 133
Birch Hills County
County of Grande Prairie, No. 1
MD of Greenview, No. 16
Big Lakes County
Northern Sunrise County

Corporate Sponsors

Kubota Country
Big Country 93.1FM
Keddies & BrettYoung
Dynamic Seeds Limited

Donations & Support

Agriculture Financial Services Corp. (AFSC)
Barenbrug, USA
BrettYoung, Winnipeg
Canadian Humalite International, Edmonton
Crop Production Services, Fairview
Crop Production Services, Hines Creek
Dynamic Seeds, Fairview
Fairview Seed Cleaning Plant
Falher Seed Cleaning Plant
Fedoruck Seeds, Saskatchewan

Co-operators

Conrad Dolen
Soames Smith
Bill Smith
The Hales
Wally & Christine Lentz
Mark Martin
Mark & Tracy Vetsch
Thomas & Laura Claydon
Annette Rosendal
Jordan Barnfield
Garry Gurtler
John Prinse
Faron Steffen
Allan McLachlan

Partners

SARDA Ag Research
North Peace Applied Research Association
Mackenzie Applied Research Association
Chinook Applied Research Association
Gateway Research Organization
Agriculture & Agri-food Canada
Alberta Agriculture & Forestry
Mighty Peace Watershed Alliance
Lesser Slave Watershed Council
Heart River Watershed Riparian Team
Calvin Yoder, AAF Spirit River

ACKNOWLEDGEMENTS

PCBFA greatly appreciates the following contributors for helping us deliver important extension programs and conduct essential projects in 2017:

Donations & Support (Continued)

Foster Seeds, Beaverlodge
Grande Prairie Regional College
High Prairie Seed Cleaning Plant
Murray Lewis, Cleardale
Nick & Caroline Sekulic, Rycroft
Northstar Genetics, Winnipeg
Performance Seed, Lethbridge
Penergetic, Teepee Creek
Quarry Seed, Manitoba
Ron Heck, Fairview
SeCan, Alberta
Soames Smith (Uddersmith Dairy), Rycroft
Stamp Seeds, Enchant, Alberta
Sunshine Seeds Ltd, Magrath, Alberta
Union Forage
Wanham Grazing Association
Weaver Bros. Auctions Ltd.

THANK YOU!!!

SERVICES PROVIDED BY PEACE COUNTRY BEEF & FORAGE ASSOCIATION

- Extension services: production decision making, technical assistance and problem solving

- Feed Testing and Ration Balancing
  - Ongoing throughout the winter

- CowBytes "Kitchen" Courses-
  Set one up at your kitchen table with some neighbours
  - Use your feed analysis and end up with a balanced ration for your operation

- Soil Testing and Fertilizer Analysis

- Livestock Water Quality Testing

- Environmental Farm Plan Assistance and Workshops

- Growing Forward 2, Water Management Planning Assistance

- Nutrient Management Analysis and Assistance
  - Informing producers on the benefits of manure as a fertilizer source
  - Proper manure testing techniques

- Gallagher Portable Scale and Electronic Tag Readers for Use

- 320 bushel Creep Feeder Available for Use

- Portable Solar Watering Systems Available for Use

2017 IN REVIEW

EXTENSION HIGHLIGHTS

Extension Activities for Every Producer

Highlights from our Extension Activities Across the Peace Country

Peace Beef Cattle Day - February 7th

February started with our annual Peace Country Beef Cattle Day in Fairview, in collaboration with NPARA. This year's topic of discussion was 'Grazing High Legume Pastures' – and featured presentations from Dr. Surya Achurya (AAFC) and Grant Lastiwka of Alberta Agriculture, as well as a Producer Panel made up of several producers experienced with grazing sainfoin. 58 producers came out.

Farm Transition Series Pt.2 - February 16th

On February 16th, we met again in Grande Prairie for the second part of the Farm Transition series. This time, producers were able to meet one –on-one with local lawyers, accountants and financial planners specializing in agriculture.

Soil Health and Carbon Day - February 21st

February 21st saw us in Spirit River for a Soil Health & Carbon Day. Dr. Richard Teague of Texas A&M Agri-Life Research gave a presentation on 'Ranch-Scale Carbon Sequestration & Grazing Management', while Dr. Yamily Zavala (Soil Health Specialist with Chinook Applied Research Association in Oyen) talked to us about managing soil health for carbon sequestration, and Paul Jungnitsch of Alberta Agriculture spoke about carbon offsets and other environmental markets.

Living With Wildlife - February 23rd

Up in Grimshaw on February 23rd, we held a Living with Wildlife Workshop, which featured a number of guest speakers on a wide variety of topics, including predators, elk depredation, wildlife habitats, the ALUS program, and more.

Annual General Meeting - February 24th

Our Annual General Meeting on February 24th was once again a huge success, with 125 producers attending. Our featured guest speaker was Nuffield Scholar Leona Dargis, who brought out both tears and laughter in the crowd as she gave a moving speech on the importance of both farm transition planning, and seizing the day and living in the moment. Akim also gave a very informative presentation on the results of the previous year's cocktail cover crop trials, which pulled numerous questions from the crowd. For the second year in a row, we offered our Bull Sale Corner, and were able to add a complimentary tasting from GP Brewing Co.

Environmental Farm Plan and Growing Forward Workshop - February 28th

We ended February with an Environmental Farm Plan and Growing Forward Workshop in DeBolt on the 28th.

Peace Country Classic Agri-Show - March 9th to 11th

In March, we had a booth at the very well attended Peace Country Classic Agri-Show, and once again were able to get out and talk with a number of local producers, and also got a few new members out of it!

Solar Power Workshop - March 15th

On March 15th, we put on a Solar Power Workshop in Woking, featuring Rob Harlan of the Solar Energy Society of Alberta. The workshop was quite well attended, with 43 producers turning out.

Shelterbelts, Eco-buffers & Beneficial Insects - March 20th & 21st

March also saw us hosting a series of two workshops on Shelterbelts, Eco-buffers & Beneficial Insects, in High Prairie and Bezanson, featuring the Agroforestry & Woodlot Extension Society.

Surface Rights Workshop - March 29th

In Worsley, we hosted both the Alberta Energy Regulator and the Farmer's Advocate Office for highly informative presentations on Surface Rights. The AER walked us through the process oil, gas and other energy companies must go through to obtain access to your land, and how to make sure your concerns are submitted to the right people at the right time. The FAO discussed the resources their office has to help farmers affected by energy developments, and how to reach out to them.

Hines Creek Ag. Tradeshow - April 8th

In April, we once again had a booth at the Hines Creek Ag Tradeshow.

'Cows, Crops, Culverts & Fish - Heart River Watershed Restoration Update - May 4th

In early May, we joined Mighty Peace Watershed Alliance, Cows & Fish, and a number of our other partners in Nampa. We explored the basics of riparian health, the progress of riparian improvement projects in the area, and updates on the Heart River Watershed Restoration Plan.

Soils Workshop - June 9th

In June, we were up in North Star to host the world renowned Dr. Jill Clapperton for a Soils Workshop with NPARA. This event was one of three workshops held across the province, where Dr. Clapperton talked about soil health and in particular, soil organisms and soil respiration, and the effect of different cropping practices on these.

Climate Change Research Meeting - June 14th

On June 14th in Fairview, we held a meeting with two AAFC researchers currently working on a project that assesses the potential impact of future climate change scenarios on land suitability for crop production in the Peace River Region. They spoke to us about the Land Suitability Rating System, currently under development, that will replace the old Canada Land Inventory approach to rating land capability for agriculture, and is able to model the impacts of climate change on land suitability.

Grazing Schools with Jim Gerrish - June 25th & 26th

Also in June, we were able to bring up renowned grazier Jim Gerrish from Idaho to offer two one-day grazing schools in Enilda and Teepee Creek. Jim spoke in great detail on how to effectively manage grazing land to create highly productive pasture systems that are both economically and environmentally sustainable.

We have been contacted by many producers in the Peace Region, not only to do Environmental Farm Plans, but to also help with filling in forms for grants that are available through Growing Forward 2. We always take time to help producers fill out these grant applications and give them tips on the best way to do so. Our staff is also available to help complete Environmental Farm Plans. We are always on the lookout for information to provide to producers on any available programs and help them identify what projects qualify and which do not.

Growing Forward 2 A federal-provincial-territorial initiative

Alberta Government

Canada

Alberta EFP

Photo Credit: Dan Przybylski

Field Day at the Research Farm - July 19th

July saw an unprecedented turnout with 153 producers coming out for our annual Field Day at the Research Farm. We offered educational tours of our 899 small plot trials and demonstrations, and guest speaker topics included plant diseases, beekeeping, and farm safety.

Canadian Beef Industry Conference - August 15th-17th

In August, several staff members attended the second annual Canadian Beef Industry Conference in Calgary, where PCBFA extension materials were distributed, and connections with other industry professionals were forged.

Agricultural Stewardship Project Tour - September 8th

On September 8th, we partnered again with a number of other organizations to put on an Agricultural Stewardship Project Tour, which took participants to a variety of project sites showcasing tree planting, riparian fencing, wetland enhancement and farm water management.

Stockmanship School - September 15th & 16th

September also saw us bringing up Dylan Biggs from Hanna, AB for a two-day Stockmanship School in Gordondale. Dylan both taught and demonstrated stress-free cattle handling techniques, including controlling direction and speed, going through gates, eliminating run backs and much more. On the second day, participants were able to get out in the pasture and put what they had learned to the test, under Dylan's supervision.

Cattle Market Outlook Evening - September 20th

On September 20th in Rycroft, we offered a Cattle Market Outlook Evening, which featured two great speakers. Brian Perillat of Canfax presented a cattle market update and a projection on the future of the market. We also had Rick Dehod of Alberta Agriculture give a presentation called 'Buying Land, Have a Plan' – he discussed everything that should be considered before making a decision on acquiring more land, and how to plan financially for the purchase as well as how to determine if current market conditions make buying or leasing land more economical.

Tools To Build Your Cowherd Workshop– October 31st & November 1st

In partnership with Alberta Agriculture & Forestry, we offered the Tools to Build Your Cowherd Workshop series in both Valleyview and Rycroft. The series featured a number of guest speakers on a variety of topics, including cattle nutrition, genetics, and the importance of building a relationship with your herd vet.

Soil Health Workshops - November 17th & 18th

Mike Dorion of Living Soils Solutions taught us about basic and advanced soil health, regenerative agriculture and soil reclamation techniques for producers. Producers especially enjoyed Mike's advice on how to create healthy soil, and hands-on practices they can implement on their own land.

Energy Efficiency on Your Farm- November 27th & 28th

In late November, we visited High Prairie and Wanham to host our Energy Efficiency On Your Farm events. Gabriel Ribeiro of Agriculture and Agri-food Canada, Mike Hittinger of Alberta Agriculture and Forestry and Kale Scarff of Gateway Research Organization joined us from across the province. Attendees learned about practical energy efficiency on their farm, on-farm energy management, and how to prepare for future funding programs.

Become a PCBFA member to stay up to date on all PCBFA upcoming extension events!

Forage Facts

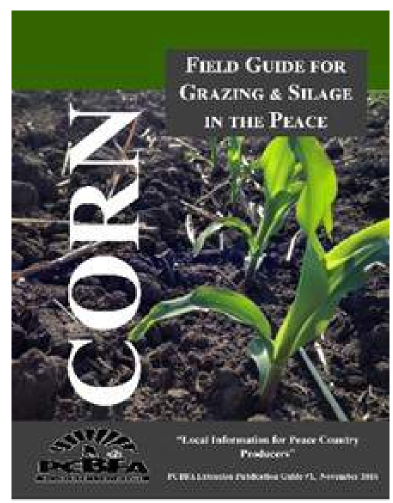
Forage Facts is a monthly newsletter that provides timely information relevant to the beef and forage sector. It is also the best source of information about what extension events we have planned and how you can participate! Forage Facts is sent out to our entire membership, including our participating municipal districts and counties. This newsletter is an invaluable way to communicate information to our members, as well as inform them of new ideas on the horizon.

Forage Country Magazine

Our Association produces a bi-annual publication to highlight past projects, new projects, hot topics, as well as current, past, and future extension events. This publication is distributed to 4000 rural mail boxes in our partnering municipalities throughout the Peace Country. Keep your eye out for both our winter edition and summer edition for 2018!

Corn: Field Guide for Grazing & Silage in the Peace

PCBFA now has its first Corn Guide extension publication available for producers. The guidelines and recommendations within the Corn Guide are based upon research and extension activities conducted across the Peace Country by PCBFA and from studies elsewhere in Canada and the USA. In the future, the Corn Guide will be revised and updated with information such as herbicide options, benefits of using higher seeding rates, and cost-benefit analysis of open pollinated corn varieties versus hybrids. Be sure to stop by either of our PCBFA offices to pick up a copy!



Website

If you haven't already, be sure to check out the PCBFA website at www.peacecountrybeef.ca! Our website got a new look this year, and continues to be a great way to target a larger audience and keep people informed of all the happenings of PCBFA. Information about the Association, upcoming events, ongoing projects, career opportunities, and publications (i.e. Journal Research Papers, Forage Facts, Forage Country, or Annual Reports) are all available on our website.

Social Media

PCBFA is very active on social media, extending our reach to connect with producers in more non-traditional ways. Through our social media accounts, we are able to instantly share news, updates, or stories that are affecting or related to the beef and forage industry. It is also a wonderful tool for advertising our upcoming events and sharing all PCBFA updates right at our fingertips! Stay connected—follow us!

facebook @peacecountrybeef – We currently have 440 follows on Facebook.

twitter @PCBFA – We currently have 665 followers on Twitter.

Instagram @peacecountrybeef – We currently have 224 followers on Instagram.

YouTube We are beginning to be more active on YouTube. Search "Peace Country Beef and Forage Association" and subscribe to our channel!

2017 IN REVIEW
FIELD TRIALS & DEMONSTRATIONS UPDATE

Local information for local producers

Laboratory Analysis, Methods of Statistical Analysis & Reporting

Soil samples were analyzed at Exova (Edmonton) for appropriate fertilizer recommendations. Soil samples were shipped to A & L Canada Laboratories (Ontario) for assessments of biological indicators of soil health.

Forage samples were analyzed at A&L Canada Laboratories and Central Testing Laboratory (Manitoba) using standard laboratory methods for Near Infrared (NIR) spectroscopy and wet chemistry.

Field Data Analysis

Where necessary, field data was subjected to analysis of variance (ANOVA) using a pre-defined model in Costat procedure (CoStat Version 6.4, 2005) or GenStat (12th Edition). When ANOVA indicated significant treatment effects, the means were separated by the least significant difference (LSD) at the 0.05 probability level. Significant differences (*) in the write-up reports refer to $P<0.05$, while NS indicates Not Significant (no differences exist). LSDs are listed at the bottom or side of tables. Differences between treatments (e.g. varieties) are significant only if they are equal to or greater than the LSD value. If a given variety out yields another variety by as much or more than the LSD value, then we are 95% sure that the yield difference is real, with only a 5% probability that the difference is due to chance alone. For example, if variety A is 1000 lbs/acre higher in yield than variety B, then this difference is statistically significant if the LSD is 0.50 or less.

The coefficient of variation (CV, %) is a measure of spread that describes the amount of variability relative to the mean. The CV is therefore a relative measure of variation of the treatment averages that cannot be accounted for by the effects of treatments and replications. Large CVs mean a large amount of variation could not be attributed to differences between treatments. Lower CV % indicates that experimental conditions were relatively uniform. Lower CV values will generally relate to lower experimental error in the trial. Uncontrollable or unmeasured variations in soil fertility, soil drainage, and other environmental factors as well as human factors contribute to greater experimental error and higher CV values. However, higher CV values can also occur simply as a result of the mean yield being low (eg. due to weather conditions), because the CV is a function of the mean yield. So a higher CV will often occur where yields are low despite there being no increase in experimental error.

Presentation of Results

The findings from the 2017 field trials and demonstrations and their implications are highlighted in this report. The feed test results are interpreted with focus on nutrition quality in relation to "*Beef Ration Rules of Thumb"* by Alberta Agriculture, Food & Rural Development (2004), and National Research Council (NRC) nutrient requirements of beef cattle (NRC, 1996 & 2000).

Nutrients Required by Beef Cattle

Feed costs represent the largest annual operating cost for cow-calf operations in the Peace. In order to maintain an optimum balance between feed costs and production, feeds should be analyzed and these analyses used to formulate rations and/or supplements.

Beef cattle require nutrients to support body maintenance, reproduction, lactation, and growth. The nutritional needs of beef cattle vary by age, class, stage of production, performance level, and weight. Table 1 shows suggested nutrient requirements for beef cattle according to the recommendations of Alberta Agriculture, Food & Rural Development (2004) and NRC (1996, 2000). The Table can assist producers in determining specific beef cattle nutrient requirements.

The values listed in Table 1 serve as a general guide for matching forage and feeding programs to cattle nutrient needs. Actual nutrient requirements vary depending on many animal and environmental factors.

Crude Protein (CP): Feed protein content is often considered a good determinant of quality. In actuality protein cannot be directly measured, instead it is estimated from feed sample nitrogen (N) content. On average all biological proteins contain 16% N, therefore protein content is estimated by multiplying N% by 6.25. Thus, CP does not differentiate the N in feed samples between those coming from true protein, and other non-protein nitrogen (NPN) compounds, nor does it differentiate between available and unavailable protein.

Table 1. Suggested nutrient requirements for beef cows from NRC (1996, 2000) and Alberta Agriculture, Food & Rural Development (2004)

Nutrient	Requirement		
	Growing & finishing calves	Dry gestating cows	Lactating cows
CP (%)	14-Dec	7-9*	12-Oct
Ca (%)	0.31	0.18	0.58
P (%)	0.21	0.16	0.26
Mg (%)	0.1	0.12	0.2
K (%)	0.6	0.6	0.7
Na (%)	0.06-0.08	0.06-0.08	0.1
S (%)	0.15	0.15	0.15
Cu (ppm)	10	10	10
Zn (ppm)	30	30	30
Fe (ppm)	50	50	50
Mn (ppm)	20	40	40
NE_M (MCal kg^{-1})	1.08-2.29	0.97-1.10	1.19-1.28
NE_G (MCal $kg^{-1)}$	0.53-1.37	NA^Y	NA
TDN (%)	$65\text{-}70^W$	$55\text{-}60^Z$	65

* 7% for middle $^1/_3$ of pregnancy, 9% for late $^1/_3$ of pregnancy.
Z - 55% for middle $^1/_3$ of pregnancy, 60% for late $^1/_3$ of pregnancy.
Y - NA, not available. W - for 6-10 months old growing bulls.

Detergent Fibres: The detergent feed analysis system is used to characterize fibre or total cell wall content of a forage or feed. The portion of a forage or feed sample that is insoluble in neutral detergent is termed neutral detergent fibre (NDF), which contains the primary components of the plant cell wall: hemicellulose, cellulose, and lignin. As cell wall production increases, which occurs with advancing plant maturity, NDF content will increase. As NDF content of a feed increases, dry matter intake will decrease and chewing activity will increase. Within a given feed, NDF is a good measure of feed quality and plant maturity.

Another measure of fibre is *acid detergent fibre (ADF)*, a subset of NDF. Acid detergent fibre consists of the poorly digestible cell wall components, such as cellulose, lignin, and other very resistant substances. Due to its nature, ADF is often used to predict energy content of feeds. Like NDF, ADF is a good indicator of feed quality; higher values within a feed suggest lower-quality feed. A goal would be to have < 35% ADF in either legume or grass forages.

Energy: Energy is probably the most important nutritional consideration in beef cattle production in cold climates. Energy content is often used to compare feeds and evaluate quality. Feed energy content is not directly measured like other nutrients but derived through regression equations. There are generally six measures for energy, but in this report Total Digestible Nutrients (TDN) has primarily been used to interpret the feed tests from our trials and demonstrations.

Non-Fibre Carbohydrates (NFC): The neutral detergent soluble carbohydrate fraction of feed is termed non-fibre carbohydrates. This fraction is not directly measured, but determined by difference. Inherently, all laboratory analytical method errors associated with other feed fractions will be compiled into the NFC fraction. Although susceptible to error, NFC represents a highly available portion of a feed and as such positively reflects on evaluation of feed quality. More recently some laboratories have offered an enzymatic analysis for feed starch content; helping to further define the more digestible portion of NFC, termed *non-structural carbohydrates (NSC)*. Higher values for NFC and NSC would reflect higher quality forages. For grasses and legume forages, NFC values >20 and >30%, respectively, would be considered higher quality, especially if associated with lower fibre values.

The Relative Feed Value index (RFV) estimates digestible dry matter (DDM) from acid detergent fibre (ADF) , and calculates the dry matter (DM) intake potential (as % of body weight, BW) from neutral detergent fibre (NDF). For years, RFV has been used to compare the quality of legume and legume/grass hays and silages.

Beef & Forage Projects

Regional Silage Variety Trials: 1. Barley Varieties

By Akim Omokanye, PCBFA

According to the Alberta Agriculture & Forestry publication "Barley Production in Alberta", of the major cereal crops, barley is the most sensitive and responsive to the environment. Its wide distribution is the result of very wide genetic variation within the crop, with specific varieties adapted to specific environments. The Regional Silage Variety Trials (RSVTs) are replicated province wide and they are an important source of information for forage-based livestock production regarding the forage yield potential and quality performance of new crop varieties as they become available. The RSVTs are carried out in small plot replicated trials. PCBFA's yearly trials provide unbiased, comprehensive information that assists producers to make better crop choices for silage or greenfeed production. The results from this site and other parts of the province will also be reported in the Alberta Seed Guide (www.seed.ab.ca).

Objective

To identify barley varieties with superior forage yield and quality, for use as silage in beef cattle production systems.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: Alfalfa for over 10 years before spraying out in 2016 (chemical fallow)
- Site Soil Information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0 %.
- The field was cultivated (disked & harrowed) before seeding.
- Experimental Design: Randomized complete block design in 4 replications.
- Treatments (barley varieties): The following 14 barley varieties were tested:
    1. Conlon - 2-row, feed and malting barley
    2. AC Ranger - 6-row, forage/feed barley, smooth awns
    3. Amisk - 6-row, rough awned, semi-dwarf, general purpose barley
    4. **CDC Austenson (Check)** - 2-row, rough awned variety, high feed yield
    5. CDC Maverick - a new 2-row forage variety, smooth awned for improved palatability
    6. Altorado - 2-row, feed barley, erect to semi-erect growth habit at tillering
    7. CDC Coalition - 2-row, feed barley
    8. Gadsby - 2-row, rough awned, general purpose barley
    9. CDC Meredith - 2-row, malting barley
    10. Claymore - 2-row, semi-erect, feed barley
    11. Sundre - 6 row, smooth-awned, feed barley for grain and forage
    12. Canmore - a new 2-row general purpose barley
    13. CDC Cowboy - 2-row, forage variety
    14. Champion - 2-row, feed barley
- Seeding Rate: 300 plants/m^2 (27.8 plants/ft^2)
- Seeding Method: 6-row Fabro plot drill with 9" row spacing
- Seeding Date: May 30
- Fertility (actual lbs/acre): 89 N + 50 P + 29 K + 24 S
- Plot size: 11.04 m^2 (118.8 ft^2)
- Spraying: In-crop spraying was done once with

Curtail M (800 ml/acre) + Fluroxyoyr (170ml/acre)
- Measurements taken at soft dough stage on August 8: height, lodging, forage yield & forage quality.

Results and Interpretation

Forage Dry Matter (DM) Yield & Crop Growth

Forage DM yield was significantly affected by barley variety. CDC Cowboy, Canmore and CDC Maverick were in the top 3, producing over 9000 lbs DM/acre (Table 1). Two of the top 3 forage DM yields came from newer barley varieties (CDC Maverick and Canmore. Forage DM yield value was lower for Amisk, Ranger and Conlon (with <8000 lbs DM/acre) than other barley varieties tested. The barley varieties (Amisk, Ranger and Conlon) that produced lower forage DM yield in this study were mostly either early maturing or dwarf types.

CDC Maverick and CDC Cowboy grew taller than other varieties, while Conlon and Amisk appeared to be shorter in height than others. No lodging was observed with any of the varieties tested.

Forage Quality

Crude Protein (CP): The forage CP varied from 8.2% for Canmore to about 11% for CDC Cowboy barley (Table 1). Except for the Canmore variety, which fell slightly short of 9% CP, the forage CP from all barley varieties was generally sufficient for a dry gestating beef cow that requires 7% CP at mid-pregnancy stage and 9% CP at late-pregnancy stage.

Energy: Energy is probably the most important nutritional consideration in beef cattle production in cold climates. The total digestible nutrients (TDN) and other forms of energy (net energy for lactation, NE_L; net energy for gain, NE_G; net energy for maintenance, NE_M) measured here all showed similar values for barley varieties.

The forage TDN varied from 66.6% for Claymore to 71.5% for Conlon. The forage NE_L, NE_G and NE_M respectively varied from 1.52-1.63 Mcal/kg, 0.92-1.06 Mcal/kg and 1.64-1.78 Mcal/kg (Table 1).

Taking into consideration the TDN requirements of a mature beef cow (65% TDN), all barley varieties tested here had adequate TDN.

A dry gestating cow requires a NE_M value of 0.97-1.10 Mcal/kg and 1.19-1.28 Mcal/kg during lactation. All barley varieties tested here have exceeded the NE_M requirements of these categories of beef cows. All varieties were well within the 1.08-2.29 Mcal/kg NE_M required by growing and finishing calves. Similarly, all varieties were within the 0.53-1.37 Mcal/kg NE_G needed by growing and finishing calves.

The ability of the tested barley varieties to meet the energy requirements (TDN and NE_m) of a mature beef cow, as well as the NE_G for growing and finishing calves is important to cow-calf producers in the Peace Region. It is particularly important during winter, as this will mean a substantial savings in feed energy costs.

Minerals: The results of macro- and trace-minerals measured here are shown in Table 1.

For the macro-minerals, the barley varieties tested differed slightly in forage Ca, P, Mg and S. Forage Ca value was highest (0.45% Ca) for the AC Ranger variety. Forage P value was highest (0.21% P) for CDC Coalition. Both AC ranger and CDC Cowboy had higher forage Mg value (0.20% Mg) than other varieties. Both forage K and Na however showed similar values for all varieties tested.

Table 1. Forage DM yield and quality (DM basis) of 14 barley varieties tested in Fairview in 2017. *NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

Measurement	CDC AUESTENSON	GADSBY	AMISK	CHAMPION	CLAYMORE	CDC MEREDITH	RANGER	ALTORADO	SUNDRE	CDC MAVERICK	CDC COALITION	CDC COWBOY	CANMORE	CONLON	*Mean*	*Significance*	*$LSD_{0.05}$*	*CV %*
Moisture, %	**66.8**	66.4	65.6	65.5	65.5	65.4	64.7	64.6	64.1	63.5	62.7	62.2	62.1	61.6	*64.3*	*	*2.67*	*2.9*
DM Yield, lb/acre	**8442**	8716	7513	8399	8365	8851	7472	8430	8849	9263	8996	9434	9417	6894	*8503*	*	*1511*	*12*
CP, %	**10.5**	10.1	10.5	10.0	10.0	9.90	9.50	8.90	10.4	8.90	9.70	10.9	8.20	9.40	*9.80*	NS	*1.71*	*8.1*
Soluble protein, %	**49.5**	50.6	59.6	42.1	37.6	43.4	52.7	49.5	53.7	42.5	53.1	57.4	51.0	50.4	*49.5*	NS	*14.7*	*14*
ADF-CP,%	**0.62**	0.46	0.49	0.60	0.58	0.70	0.62	0.41	0.51	0.78	0.62	0.58	0.57	0.57	*0.58*	NS	*0.26*	*21*
NDF-CP,%	**2.05**	1.86	2.00	2.38	2.78	1.95	2.03	2.03	2.32	2.62	1.85	2.09	1.58	2.02	*2.11*	*	*0.44*	*9.7*
UIP,%	**25.2**	24.7	20.2	28.9	31.2	28.3	23.6	25.3	23.2	28.8	23.5	21.3	24.5	24.8	*25.2*	NS	*7.36*	*14*
ADF,%	**26.8**	25.7	26.6	24.5	28.6	25.9	27.1	24.6	25.4	27.2	24.1	27.5	26.6	22.4	*25.9*	NS	*3.84*	*6.9*
NDF,%	**51.3**	46.5	47.4	44.6	50.3	45.5	47.2	43.7	44.6	48.6	45.3	49.3	47.9	39.6	*46.6*	*	*3.72*	*3.7*
TDN,%	**67.9**	68.8	68.1	69.8	66.6	68.7	67.7	69.7	69.1	67.7	70.1	67.5	68.2	71.5	*68.7*	NS	*2.99*	*2*
NE_L, Mcal/kg	**1.55**	1.57	1.55	1.59	1.52	1.57	1.54	1.59	1.58	1.54	1.60	1.53	1.55	1.63	*1.57*	NS	*0.07*	*2.3*
NE_G, Mcal/kg	**0.96**	0.98	0.96	1.01	0.92	0.98	0.96	1.01	0.99	0.96	1.02	0.95	0.97	1.06	*0.98*	NS	*0.08*	*4.2*
NE_M, Mcal/kg	**1.68**	1.71	1.69	1.73	1.64	1.70	1.68	1.73	1.71	1.68	1.75	1.67	1.69	1.78	*1.70*	NS	*0.08*	*2.4*
Ca,%	**0.27**	0.27	0.35	0.28	0.24	0.27	0.45	0.25	0.34	0.31	0.29	0.36	0.24	0.29	*0.30*	*	*0.06*	*9.8*
P,%	**0.19**	0.18	0.17	0.17	0.18	0.19	0.16	0.19	0.15	0.17	0.21	0.14	0.17	0.19	*0.18*	*	*0.02*	*7.5*
K,%	**1.59**	1.59	1.30	1.36	1.46	1.42	1.74	1.39	1.47	1.31	1.46	1.26	1.44	1.18	*1.42*	NS	*0.26*	*8.8*
Mg,%	**0.14**	0.14	0.15	0.14	0.14	0.14	0.20	0.13	0.16	0.17	0.17	0.2	0.15	0.15	*0.16*	*	*0.02*	*8*
Na,%	**0.06**	0.06	0.09	0.07	0.04	0.06	0.09	0.04	0.07	0.08	0.06	0.14	0.07	0.07	*0.07*	NS	*0.05*	*32*
S,%	**0.15**	0.12	0.13	0.15	0.13	0.14	0.13	0.11	0.11	0.13	0.14	0.15	0.13	0.15	*0.13*	*	*0.02*	*8.2*
Cu, ppm	**5.40**	5.50	5.14	6.50	6.11	5.96	6.29	5.27	3.75	5.92	6.85	4.62	5.14	4.88	*5.53*	*	*1.12*	*9.4*
Fe, ppm	**58.7**	58.4	44.8	61.6	51.3	56.1	61.0	114.7	55.6	46.6	49.9	48.2	39.9	65.5	*58*	NS	*52.2*	*42*
Zn, ppm	**43.3**	47.5	43.4	45.7	40.5	45.4	46.5	42.8	48.0	41.3	38.4	36.9	32.9	49.0	*42.9*	*	*6.68*	*7.2*
Mn, ppm	**30.3**	28.8	27.1	25.6	21.2	27.8	28.3	30.0	28.9	33.0	28.5	38.8	28.2	38.9	*29.7*	NS	*9.93*	*16*
NFC,%	**26.7**	31.8	30.5	33.9	28.1	33.1	31.7	35.9	33.5	30.9	33.5	28.3	32.2	39.5	*32.1*	*	*3.93*	*5.7*
RFV	**123**	137	133	145	123	141	133	148	144	130	144	127	132	168.0	*138*	*	*16.2*	*5.5*

Like CP and TDN, animal mineral requirements can also vary with the stage and level of production. All barley varieties tested in the current study had sufficient amounts of Ca, P, and Mg for dry gestating beef cows. However, none of the varieties were able to meet the 0.58% Ca, 0.26% P and 0.20% Mg (except AC Ranger & CDC Cowboy) required by lactating beef cows. Two varieties (Claymore and Altorado) fell short of meeting the 0.06-0.08% Na required by a dry gestating cow. Most of the varieties also fell short of the 0.15% S needed by a dry gestating beef cow. The K requirement of a mature beef cow (0.70% K) was met by all varieties.

For the trace minerals, all barley varieties tested in this study fell short of the 10 ppm Cu needed by mature beef cows. Most varieties had adequate Fe (50 ppm) and all varieties had sufficient Zn (30 ppm) for mature beef cows. All varieties fell short of the 40 ppm Mn needed by mature beef cows.

Because of the inability of any particular varieties tested in this study to meet the mineral requirements of mature beef cows at different physiological stages, it therefore indicates that some form of mineral supplementation to address the short fall of both macro and trace minerals is needed.

A Few Notes on Loose Smut
This year, we observed a few barley stands with loose smut disease (see attached pictures). The smut diseases take a large annual toll by reducing yields and quality of the crop. Seed treatment prior to seeding is recommended. Even with treated seed, soil infection often prevents complete control. Loose smut can easily be identified in the field.

Disease management is critical for those interested in maximizing small grains yield and grain quality.

General Symptoms: Heads will contain a black/brown dusty mass of spores in the place of kernels and chaff. These spores eventually blow away, leaving a bare spike with a sooty appearance. Heads of infected tillers emerge from the boot earlier than healthy tillers and prior to heading, diseased plants may appear darker than healthy plants.

Description: The disease is caused by the fungus, *Ustilago tritici* and yield losses can be significant in some situations. Spores of the fungus often enter the field on infested seed. After seed germination, the fungus grows within the plant without producing symptoms. When the head emerges the fungus invades the contents of the head, converting everything except the pericarp membrane and rachis to a mass of black fungal spores.

Management: Plant certified disease-free seed. Utilize recommended seed treatment fungicides.

Conclusion
Overall, most of the barley varieties tested have potential for forage production for beef cattle. Three varieties in particular, CDC Cowboy, Canmore and CDC Maverick, stand out as producing over 9000 lbs acre compared to others with lower values. Two of the top 3 forage DM yields came from newer barley varieties (CDC Maverick and Canmore). Some form of mineral supplementation is needed to address the short fall of both macro and trace minerals for the barley varieties tested here.

Regional Silage Variety Trials: 2. Oat Varieties

By Akim Omokanye, PCBFA

In the Peace Country, oats have become a reliable source of conserved forage for over-wintering beef cattle. There is a need for continued local testing (for agronomic adaptation, forage yield and quality, and animal performance) as new crop varieties become available. The Regional Silage Variety Trials (RSVTs) are replicated province wide and they are an important source of information for forage-based livestock production regarding the forage yield potential and quality performance of new crop varieties as they become available. The RSVTs are carried out in small plot replicated trials. PCBFA's yearly trials provide unbiased, comprehensive information that assists producers to make better crop choices for silage or greenfeed production. The results from this site and other parts of the province will also be reported in the Alberta Seed Guide (www.seed.ab.ca).

Objective

The objective of this study was to identify oat varieties with superior forage yield and feed quality for beef cattle production, when grown in the Peace Region of Alberta.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: Alfalfa for over 10 years before spraying out in 2016 (chemical fallow)
- Site Soil Information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0%.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 4 replications.
- Treatments (oat varieties): Nine (9) oat varieties tested are listed below:
  1. **CDC Baler (Check)**
  2. AC Juniper
  3. Waldern
  4. CDC SO-I
  5. AC Morgan
  6. Murphy
  7. AC Mustang
  8. CDC Haymaker
  9. CDC Seabiscuit

- Seeding Rate: 300 plants/m^2 (27.8 plants/ft^2)
- Seeding method: 6-row Fabro plot drill with 9" row spacing
- Seeding Date: May 30
- Fertility (actual lbs/acre): 89 N + 50 P + 29 K + 24 S
- Plot size: 11.04 m^2 (118.8 ft^2)
- Spraying: In-crop spraying was done once with Curtail M (800 ml/acre) + Fluroxyoyr (170ml/acre)
- Measurements taken at milk stage on August 10: height, lodging, forage yield & forage quality.

Results and Interpretation

Forage Dry Matter (DM) Yield (Table 1)

The forage DM yield differed significantly between oat varieties tested here. The top 4 varieties tested (CDC Seabiscuit, CDC Haymaker, AC Morgan and AC Mustang) had forage DM yields of 6086-6391 lbs DM/acre. CDC Baler appeared to produce the lowest forage DM yield value in this study.

Forage Quality (Table 1)

Crude Protein (CP): The forage CP content varied from 8.8% for AC Mustang to 10.6% for CDC Baler. Generally, the forage CP values obtained here were adequate for a dry gestating beef cow, which requires 7% CP in the mid-pregnancy stage and 9% CP when in the late-pregnancy stage. For a mature lactating beef cow, which requires 11% CP, oat varieties fell short of meeting the protein needed.

Table 1. Forage dry matter (DM) yield and quality (on DM basis) of 9 oat varieties tested in Fairview in 2017.

*NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

Measurement	CDC BALER (Check)	MURPHY	WALDERN	AC JUNIPER	CDC HAYMAKER	AC MUSTANG	AC MORGAN	CDC SO-1	CDC SEABISCUIT	*Mean*	*Significance*	*$LSD_{0.05}$*	*CV %*
Moisture, %	**69.2**	67.9	67.6	67.5	67.5	65.7	64.5	64.4	64.1	*66.5*	*	*1.66*	*1.72*
DMY, lb/acre	**5476**	5689	5752	5769	6318	6086	6317	5781	6391	*5953*	*	*295*	*3.39*
CP, %	**10.6**	9.90	9.30	10.4	9.90	8.80	9.90	9.30	9.7	*9.77*	*NS*	*1.47*	*10.3*
Soluble protein, %	**48.4**	68.6	55.7	57.6	71.2	68.2	70.1	67.9	70.8	*64.3*	*	*12.5*	*8.49*
ADF-CP, %	**0.77**	0.82	0.63	0.82	0.66	0.7	0.73	0.66	0.65	*0.72*	*NS*	*0.15*	*9.59*
NDF-CP, %	**2.70**	2.63	2.41	2.37	1.48	1.90	2.39	2.61	1.63	*2.24*	*	*0.71*	*13.8*
UIP, %	**25.8**	15.7	22.2	21.2	14.4	15.9	14.9	16.0	14.6	*17.8*	*	*6.30*	*15.3*
ADF, %	**33.6**	36.1	33.8	34.5	33.8	33.7	32.2	29.1	32.7	*33.3*	*NS*	*3.82*	*4.98*
NDF, %	**58.7**	60.8	59.6	58.6	57.2	58.9	55.8	53.1	56.3	*57.7*	*NS*	*5.87*	*4.42*
TDN, %	**62.7**	60.7	62.6	62.0	62.5	62.7	63.8	66.2	63.4	*62.9*	*NS*	*2.97*	*2.05*
NE_L, Mcal/kg	**1.42**	1.37	1.41	1.40	1.42	1.42	1.44	1.50	1.42	*1.43*	*NS*	*0.07*	*2.27*
NE_G, Mcal/kg	**0.81**	0.75	0.81	0.79	0.80	0.81	0.84	0.91	0.83	*0.82*	*NS*	*0.08*	*4.49*
NE_M, Mcal/kg	**1.53**	1.47	1.53	1.51	1.53	1.53	1.56	1.63	1.55	*1.54*	*NS*	*0.08*	*2.51*
Ca, %	**0.26**	0.27	0.31	0.27	0.27	0.25	0.27	0.25	0.24	*0.27*	*	*0.02*	*4.53*
P, %	**0.20**	0.20	0.18	0.18	0.17	0.19	0.19	0.18	0.19	*0.19*	*NS*	*0.07*	*16.4*
K, %	**1.71**	1.88	1.73	1.91	1.69	1.58	1.60	1.53	1.72	*1.71*	*NS*	*0.29*	*7.49*
Mg, %	**0.17**	0.20	0.19	0.20	0.21	0.19	0.20	0.21	0.20	*0.19*	*NS*	*0.02*	*4.65*
Na, %	**0.34**	0.5	0.29	0.28	0.36	0.35	0.42	0.41	0.42	*0.38*	*NS*	*0.38*	*44.2*
S, %	**0.17**	0.19	0.16	0.18	0.19	0.18	0.18	0.18	0.2	*0.18*	*NS*	*0.04*	*10.5*
Cu, ppm	**4.29**	4.40	4.28	4.58	3.51	4.15	4.18	4.47	4.05	*4.21*	*NS*	*0.92*	*9.47*
Fe, ppm	**93.7**	67.0	83.4	83.3	85.3	74.4	77.6	79.1	78.9	*80.3*	*NS*	*17.9*	*9.71*
Zn, ppm	**37.1**	34.4	34	36.8	33.9	36.4	34.9	33.9	34.6	*35.1*	*NS*	*11.8*	*14.6*
Mn, ppm	**88.5**	77.7	84.4	79.3	103	93.2	88.0	89.5	90.3	*88.2*	*NS*	*29.9*	*14.7*
NFC, %	**20.0**	17.4	20.1	18.9	21.1	20.8	22.6	25.4	22.9	*21.0*	*NS*	*5.26*	*10.8*
RFV	**99**	93	98	99	102	99	107	116	105	*102*	*NS*	*15.2*	*6.49*

Minerals: With the exception of forage Ca content, all minerals (macro & trace) had similar values for all oat varieties. Waldern oat variety had the highest forage Ca content (0.31% Ca), while CDC Seabiscuit gave the least forage Ca content (0.24% Ca).

In terms of macro mineral requirements for mature beef cattle, all oat varieties tested here were only able to meet the Ca (0.18% Ca) and P (0.16% P) requirements of a dry gestating mature beef cow. None of the oat varieties tested had enough forage Ca & P for a lactating beef cow.

All oat varieties tested here exceeded the K, Mg, Na & S requirements of mature beef cattle.

Except for forage Cu content, which was below 5.00 ppm, all trace minerals measured here were adequate for mature beef cattle.

Detergent Fibres & Non-Fibre Carbohydrates (NFC): All oat varieties had similar acid detergent fibre (ADF), neutral detergent fibre (NDF) and NFC contents. It is important to note that CDC SO-I seemed to fare better than other varieties because of its lower ADF & NDF and higher NFC values. Lower values of NDF and ADF and higher NFC values are preferred.

Energy: The forage total digestible nutrients (TDN) and other forms of energy (NE_L, NE_G & NE_M) measured here all showed similar values for the tested oat varieties. CDC SO-I oat however, appeared to also fare better than other varieties in terms of forage energy contents.

All oat varieties tested had adequate TDN for a dry gestating beef cow, which needs 55% TDN at the second -trimester and 60% TDN at third-trimester. For a lactating beef cow, which requires 65% TDN, only CDC SO-I met and even exceeded the TDN requirement.

All oat varieties had more than the recommended NE_M for mature beef cattle (1.19-1.28 Mcal/kg) and for growing and finishing calves. (1.08-2.29 Mcal/kg).

Conclusion

All oat varieties had adequate forage CP and TDN for a dry gestating beef cow. CDC SO-I seemed to be slightly better in terms of forage quality than others. Due to their slightly higher forage yield potential, CDC Haymaker, AC Mustang, AC Morgan and CDC Seabiscuit could be the best oats out of the 9 tested here.

Regional Silage Variety Trials: 3. Triticale Varieties

By Akim Omokanye, PCBFA

Triticale has the potential to introduce valuable economic benefits to forage production systems. Triticale is a very important alternative forage crop to increase cultivated forage crop areas, due to its great adaptation capacity. Triticale can be used for silage and swath grazing, and can be included in cocktail mixtures for beef cattle production. Earlier studies by McCartney & Vaage at AgCanada showed that a silage yield advantage of around 10% over barley and oats under dryland conditions could make triticale an excellent choice for livestock producers. Triticale also does well under stress, showing good yields in marginal lands, or in drought conditions. Several years of studies by PCBFA & SARDA in parts of the Peace Country have shown that triticale generally ranks between barley and oats for silage quality. In studies comparing to a general purpose or feed wheat or barley, triticale showed superior yields. In addition to the report presented here, results from this site and other parts of the province will also be reported in the Alberta Seed Guide (www.seed.ab.ca).

Objective

The objective of the present study was to determine forage yield and quality of different triticale cultivars for beef cattle production.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Alfalfa for over 10 years before spraying out in 2016 (chemical fallow)
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0 %.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 4 replications.
- Treatments: The following 4 spring triticale varieties and one soft white spring wheat variety were tested in 2017:
  1. Tyndal triticale
  2. Bunker triticale
  3. Taza triticale
  4. Sunray triticale
  5. AAC Chiffon soft white wheat
- Seeding Date & Rate: Seeding was done on May 30 at 370 plants/m^2 (34.3 plants/ft^2)
- Seeding method: 6-row Fabro plot drill with 9" row spacing
- Fertility (actual lbs/acre): 89 N + 50 P + 29 K + 24 S
- Plot size: 11.04 m^2 (118.8 ft^2)
- Spraying: In-crop spraying was done once with Curtail M (800 ml/acre) + Fluroxyoyr (170ml/acre)
- Measurements taken at late milk stage on August 15: height, lodging, forage yield & forage quality.

Table 1. Forage dry matter (DM) yield and quality (on DM basis) of 4 triticale varieties and one soft white wheat tested in Fairview in 2017. *NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

Measurement	TAZA	TYNDAL	AAC CHIFFON	BUNKER	SUNRAY	*Mean*	*Significance*	*$LSD_{0.05}$*	*CV %*
Moisture, %	62.4	61.4	60.7	58.9	58.8	*60.4*	*	*2.28*	*2.45*
DMY, lb/acre	7586	8060	7539	8150	7826	*7832*	*NS*	*1305*	*10.8*
CP, %	9.00	10.5	10.3	9.50	10.4	*9.95*	*NS*	*3.76*	*13.6*
Soluble protein, %	65.8	56.6	61.8	72.9	65	*64.4*	*	*3.24*	*1.81*
ADF-CP, %	0.45	0.70	0.47	0.39	0.39	*0.48*	*NS*	*0.22*	*17.1*
NDF-CP, %	1.06	2.2	0.97	0.73	0.74	*1.14*	*	*0.82*	*25.9*
UIP, %	17.1	21.7	19.1	13.5	17.5	*17.8*	*	*1.62*	*3.28*
ADF, %	30.6	30.9	29.5	30.1	26.5	*29.5*	*NS*	*4.71*	*5.75*
NDF, %	52.1	50.5	49.9	51.9	45.1	*49.9*	*NS*	*6.92*	*4.99*
TDN, %	65.1	64.8	65.9	65.4	68.3	*65.9*	*NS*	*3.67*	*2.01*
NE_L, Mcal/kg	1.48	1.47	1.50	1.49	1.55	*1.50*	*NS*	*0.09*	*2.24*
NE_G, Mcal/kg	0.88	0.87	0.90	0.89	0.97	*0.90*	*NS*	*0.1*	*4.26*
NE_M, Mcal/kg	1.60	1.59	1.62	1.61	1.69	*1.62*	*NS*	*0.1*	*2.37*
Ca, %	0.18	0.20	0.17	0.21	0.22	*0.19*	*NS*	*0.08*	*15.3*
P, %	0.17	0.20	0.14	0.16	0.16	*0.17*	*NS*	*0.09*	*20.7*
K, %	1.42	1.01	1.41	1.29	1.57	*1.34*	*NS*	*1.01*	*27.3*
Mg, %	0.12	0.13	0.15	0.15	0.14	*0.14*	*NS*	*0.04*	*12*
S, %	0.13	0.15	0.16	0.13	0.17	*0.15*	*NS*	*0.04*	*9.53*
Cu, ppm	4.17	5.67	3.96	4.05	3.92	*4.36*	*NS*	*1.71*	*14.2*
Fe, ppm	29.8	42.4	41.6	116.9	48.4	*55.8*	*NS*	*170*	*110*
Zn, ppm	35.7	33.3	42.5	47.8	48.2	*41.5*	*NS*	*18.3*	*15.9*
Mn, ppm	48.1	70.3	56.3	63.6	67.6	*61.2*	*NS*	*25.1*	*14.8*
NFC, %	27.4	27.4	28.2	27.0	32.9	*28.6*	*NS*	*9.4*	*11.8*
RFV	116	119	123	117	142	*124*	*NS*	*27.1*	*7.92*

Results and Interpretation

Forage DM Yield (Table 1)

The forage DM yield was similar for all triticales and the soft white wheat tested. Forage DM yield varied from 7539-8150 lbs/acre.

Forage Quality (Table 1)

Crude Protein (CP): The forage CP was also similar for all triticales and the soft white wheat tested and the forage CP varied from 9.00-10.5 % CP.

Protein is a building block. The Beef Cow Rule of Thumb with protein is 7-9-11, which means an average mature beef cow requires a ration with crude protein of 7% in mid pregnancy, 9% in late pregnancy and 11% after calving. The forage CP for all of the varieties tested here was adequate for a dry gestating beef cow from mid to late pregnancy. None of the varieties had adequate CP for a lactating beef cow.

Energy: Energy gives the ability to use the building blocks for growth and other productive purposes. The forage total digestible nutrients (TDN, %) was similar for all triticales and soft white wheat tested, with forage TDN varying only from about 65-68%.

The forage TDN content obtained here for all varieties was adequate for a mature beef cow. Also, forage net energy for maintenance (NE_M) values obtained for all varieties exceeded the 1.19-1.28 Mcal/kg NE_M requirements of mature beef cattle. The forage NE_M values obtained for all varieties fell within the 1.08-2.29 Mcal/kg NE_M suggested for young beef cattle.

Minerals: The forage macro minerals (Ca, P, K, Mg and S) and trace minerals (Cu, Fe, Zn and Mn) measured here had similar contents for all varieties tested.

All varieties had sufficient amounts of Ca, P (except for AAC Chiffon) and Mg for a dry gestating beef cow. None of the varieties were able to meet the Ca and P requirements of a lactating beef cow.

Except for Taza and Bunker triticale varieties, the S requirements of a mature beef cow have been met by most triticale varieties and the soft white wheat.

The K requirements of mature beef cattle at different physiological stages were met by all varieties.

None of the varieties were able to consistently meet the mature beef cow's trace mineral requirements.

Because of the inconsistencies of any particular variety in meeting the mineral requirements of mature beef cattle, some form of commercial mineral supplement would be required.

Conclusion

Triticale for swath grazing is one of the available options for beef cattle producers to extend fall grazing in parts of the Peace Region of Alberta. The varieties tested here met the protein requirements and exceeded the energy requirements for dry gestating beef cows. In general, taking into consideration the similarities in forage DM yield, CP and TDN of all triticales and the soft white wheat tested, any of the triticales and the soft white wheat tested here can be grown for silage, swath grazing or inclusion in annual crop cocktail mixtures for silage, grazing or greenfeed in the area. The triticale/soft white wheat varieties were not consistent in meeting some of the mineral requirements of growing and finishing beef cattle, dry gestating and lactating cows. Because of these inconsistencies, some form of commercial mineral supplement would be required.

Regional Silage Variety Trials: 4. Pea-Cereal Mixtures

By Akim Omokanye, PCBFA

Planting and growing two crops simultaneously on the same field, particularly growing of legumes with cereals, is known to offer scope for developing energy-efficient cropping systems and sustainable agriculture. Peas are usually included in mixes to improve the quality of the feed. Pea silage could be 13-18% protein so theoretically a pea/cereal mix should have higher protein than a cereal silage alone, which is usually about 10% protein. In reality however, the potential protein benefits of peas in silage mixtures often are not attained because of the competitive effects of the cereal crop. Pea/cereal mixtures can produce better quality silage than cereals alone, but the success of these intercrops is highly dependent on the seeding rates for both crops, and making sure there are enough peas in the mixture to influence feed quality (for more information, please visit http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/faq8444). In addition to the report presented here, results from this site and other parts of the province for the pea-cereal mixtures will also be reported in the Alberta Seed Guide (www.seed.ab.ca).

Objective

To compare the performance of intercropping spring oats, barley and triticale with pea varieties for forage yield and feed quality for beef cattle production

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Alfalfa for over 10 years before spraying out in 2016 (chemical fallow)
- Site soil information (0-6” depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0 %.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 4 replications.
- Treatments: 3 cereals (1 barley, 1 oat & 1 spring triticale) & 2 pea varieties (CDC Meadow & CDC Horizon) were used in the following pea-cereal mixtures:
    1. AAC Austenson barley (monocrop)
    2. Taza triticale (monocrop)
    3. CDC Baler oat (monocrop)
    4. CDC Austenson barley/CDC Leroy pea
    5. CDC Austenson barley/CDC Meadow pea
    6. Taza triticale/CDC Leroy pea
    7. Taza triticale/CDC Meadow pea
    8. CDC Baler oat/CDC Leroy pea
    9. CDC Baler oat/CDC Meadow pea


Taza triticale/Meadow peas

- Seeding Date & Rate: seeding was done on May 30 at the following rates:
    1. CDC Austenson barley- 300 plants/m^2 (27.8 plants/ft^2)
    2. CDC Baler oat - 300 plants/m^2 (27.8 plants/ft^2)
    3. Taza triticale - 370 plants/m^2 (34.3 plants/ft^2)
    4. Pea-cereal mixtures - 75% of pea seeding rate + 50% of cereal seeding rate
- Seeding method: 6-row Fabro plot drill with 9” row spacing
- Fertility (actual lbs/acre):
    1. Pea/cereal mixtures - 50 lbs/acre of 11-52-0 for peas
    2. Pure cereal stands- 89 N + 50 P + 29 K + 24 S
- Plot size: 11.04 m^2 (118.8 ft^2)

- Spraying: In-crop spraying was done once with Curtail M (800 ml/acre) + Fluroxyoyr (170ml/acre) for the monocrop cereals. Basagran Forte was used on pea/cereal mixtures once.
- Measurements
  1. Plant height was taken from 5 plants at random for the pure cereal stands and for the cereals and peas in the mixtures just before harvest.
  2. Barley and pea/barley mixtures were harvested at the soft-dough stage
  3. Oats and pea/oats mixtures were harvested at the milk stage
  4. Triticale and pea/triticale mixtures were harvested at the late milk stage

Results and Interpretation

Forage Dry Matter (DM) Yield (Table 1)

The Taza triticale/CDC Meadow pea mixture had higher forage DM yield value (9091 lbs/acre) than the 3 monocrop cereals (6489-7628 lbs/acre) and the other pea-cereal mixtures (5959-8425 lbs/acre). Generally, monocrop triticale and its mixtures with any of the peas (CDC Leroy & CDC Meadow) appeared to have slightly higher forage DM yield than other monocrop cereals and pea/cereal mixtures. Except for CDC Baler/ CDC Leroy mixtures, pea/cereal mixtures which had CDC Leroy peas did not do as well as mixtures which had CDC Meadow peas. Overall, there appeared not to be any significant forage DM yield advantage from pea/cereal mixtures over the monocrop cereals tested here.

Forage Quality (Table 1)

Crude Protein (CP): All monocrop cereals, as well as pea/cereal mixtures, had similar forage CP content, but with Taza/CDC Leroy being slightly higher. All monocrop cereals and their mixtures had adequate CP for a dry gestating beef cow, which requires 7% CP at second-trimester and 9% CP at third-trimester. For a lactating beef cow, which requires 11% CP, only CDC Austenson/CDC Leroy and Taza/CDC Leroy mixtures met the requirement.

Energy: The forage total digestible nutrients (TDN) and other forms of energy [net energy for maintenance (NE_M), lactation (NE_L) and gain (NE_G)] measured here were all higher for monocrop CDC Austenson than other monocrop cereals and all of the mixtures. Except for pure Taza and Taza/CDC Meadow pea mixture, the forage TDN contents obtained here were adequate for a mature beef cow. Also, forage net energy for maintenance (NE_M) values obtained for all monocrop cereals and mixtures far exceeded the 1.19-1.28 Mcal/ kg NE_M requirements by mature beef cattle.

Minerals: An essential mineral performs specific functions in the body and must be supplied in the diet, but too much of any mineral may be harmful or even dangerous. The forage macro minerals measured in this study were Ca, P, K, Mg, Na and S.

Ca and P are the most abundant minerals in the animal. They are also the ones most often added to ruminant diets. Both are found in the teeth and bones, but calcium is also found in milk. In addition, Ca is necessary for the clotting of blood and the contraction of muscles. Ca works in conjunction with phosphorus and other nutrients to perform numerous biochemical reactions in the body. Phosphorus is required in all biochemical reactions, including the conversion of feed energy into a form utilized by the animal. Animals require a minimum of 1.5 parts Ca for every part of P.

The forage Ca content was highest for Taza/CDC Leroy mixture (0.55 % Ca). Monocrop cereals had lower forage Ca than their respective mixtures. The 2 triticale/pea mixtures seemed to improve forage Ca more than other cereal/pea mixtures. The forage P value was higher for both CDC Austenson/CDC Meadow pea and Taza/CDC Leroy pea mixtures than monocrop cereals and other mixtures. Monocrop Taza triticale appeared to have lower forage P value than its mixtures with peas.

Table 1. Forage dry matter (DM) yield and quality (on DM basis) of monocrop cereals and their mixtures with 2 pea varieties (CDC Meadow and CDC Leroy peas) tested in Fairview in 2017. *NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

Measurement	CDC BALER	CDC BALER/CDC MEADOW	CDC BALER/CDC LEROY	CDC AUSTENSON	CDC AUSTENSON/ CDC MEADOW	CDC AUSTENSON/ CDC LEROY	TAZA	TAZA/CDC MEADOW	TAZA/CDC LEROY	*Mean*	*Significance*	*$LSD_{0.05}$*	*CV, %*
Moisture, %	63.7	67.9	67	64.1	63.9	67.5	60.8	62.7	59.5	*64.1*	*****	*2.59*	*2.77*
DM Yied, lb/acre	6489	7201	6493	6864	7382	5959	7628	9091	8425	*7235*	***	*2045*	*19.4*
CP, %	9.5	10.5	10.2	10.6	10.8	11.7	10.4	10.4	12.1	*10.7*	*NS*	*1.38*	*5.62*
Soluble protein, %	67.1	74.0	72.7	61.9	63.1	72.4	71.5	70.3	78.4	*70.2*	***	*8.75*	*5.41*
ADF-CP, %	1.29	1.12	1.20	1.02	1.26	1.37	0.42	0.53	0.5	*0.97*	*****	*0.27*	*12.26*
NDF-CP, %	1.46	1.22	1.17	1.89	1.81	1.84	2.86	2.63	1.68	*1.84*	****	*0.76*	*17.9*
UIP, %	16.5	12.9	13.6	19.0	18.4	13.7	14.2	14.9	10.8	*14.9*	***	*4.37*	*12.72*
ADF, %	30.2	29.3	30.6	24.6	26.9	27.9	32.6	33.2	27.2	*29.1*	***	*3.71*	*5.52*
NDF, %	54.7	54.0	52.1	47.9	48.3	48.5	53.7	48.1	43.6	*50.1*	*NS*	*7.92*	*6.85*
TDN, %	65.4	66.1	65.1	69.7	67.9	67.2	63.5	63.1	67.7	*66.2*	***	*2.89*	*1.89*
NE_L, Mcal/kg	1.48	1.50	1.48	1.59	1.55	1.53	1.44	1.43	1.54	*1.51*	****	*0.07*	*2.01*
NE_G, Mcal/kg	0.88	0.91	0.87	1.01	0.96	0.94	0.83	0.82	0.94	*0.91*	****	*0.08*	*3.97*
NE_M, Mcal/kg	1.61	1.63	1.60	1.74	1.68	1.66	1.55	1.54	1.67	*1.63*	****	*0.08*	*2.27*
Ca, %	0.25	0.34	0.45	0.23	0.38	0.41	0.17	0.48	0.55	*0.36*	***	*0.23*	*28.3*
P, %	0.16	0.17	0.16	0.17	0.18	0.16	0.15	0.16	0.18	*0.17*	*NS*	*0.04*	*12.8*
K, %	1.62	1.81	1.61	1.42	1.85	1.71	1.27	1.52	1.41	*1.58*	*NS*	*0.50*	*13.8*
Mg, %	0.18	0.19	0.19	0.15	0.18	0.18	0.11	0.18	0.22	*0.18*	*NS*	*0.05*	*14.1*
Na, %	0.27	0.29	0.28	0.05	0.08	0.06	0.01	0.01	0.01	*0.12*	***	*0.18*	*67.43*
S, %	0.17	0.18	0.15	0.15	0.19	0.16	0.13	0.14	0.14	*0.16*	*NS*	*0.04*	*11.8*
Cu, ppm	4.65	4.46	4.91	6.10	4.82	5.18	4.31	3.87	4.53	*4.76*	***	*1.04*	*9.55*
Fe, ppm	71.2	73.9	88.3	54.9	59.5	56.4	26.1	42.9	35.1	*56.5*	*****	*16.8*	*12.9*
Zn, ppm	31.4	35.7	40.5	40.3	40.4	41.3	30.0	43.7	43.2	*38.5*	*NS*	*10.7*	*12.1*
Mn, ppm	66.7	74.6	76.6	30.7	30.9	28.7	35.6	52.9	54.4	*50.1*	***	*25.9*	*22.5*
NFC, %	24.2	23.9	26.1	29.9	29.4	28.3	24.3	30.0	32.8	*27.7*	*NS*	*8.03*	*12.6*
RFV	111	114	116	136	131	129	110	123	146	*124*	*NS*	*27.8*	*9.73*

Taza triticale/CDC Leroy had higher forage Mg (0.22% Mg) than other monocrop cereals and mixtures.

Monocrop barley and its mixtures had significantly higher forage Na than other monocrop cereals and their mixtures.

Monocrop Taza triticale had lower forage K, Mg, Na & S than other monocrop barley, oats and pea/cereal mixtures.

Taking into consideration the macro mineral requirements for young and mature beef cattle, only the forage Mg (except monocrop Taza triticale, only for a lactating beef cow) and K requirements of all categories of beef cattle have been met by monocrop cereals and their mixtures. With the exception of monocrop Taza triticale, all monocrop cereals and pea/cereal mixtures had sufficient amounts of forage Ca and P for a dry gestating beef cow. None of the monocrop cereals and their mixtures were able to meet the Ca & P requirements of a lactating beef cow. The forage P values obtained for monocrop cereals and their mixtures were also not adequate for growing and finishing calves.

A young beef calf and a mature beef cow respectively require 0.06-0.08% Na and 0.10% Na. Monocrop barley cereal and its mixtures far exceeded the Na requirements of both young and mature beef cattle. Pure barley cereal fell slightly short of meeting the Na requirements of a mature beef cow, while pea/barley mixtures were only able to meet the 0.06-0.08% Na needed by a dry gestating beef cow. Pure Taza triticale and its mixtures with peas failed to meet the Na requirements of both young and mature beef cattle.

For the trace minerals measured here (Cu, Fe, Zn & Mn), only the barley/CDC Leroy peas mixture appeared to improve forage Cu, Fe, Zn & Mn contents over monocrop barley. Other mixtures did not show any improvements in forage trace minerals over their respective monocrop cereal crops.

None of the monocrop cereals and their mixtures contained the required amount of Cu (10 ppm) for young and mature beef cattle.

Monocrop barley and its mixtures with peas had sufficient forage Fe, Zn and Mn for all categories of beef cattle. Monocrop oats and its mixtures met the requirements for Fe and Zn of different categories of beef cattle. Monocrop oats and its mixtures had enough Mn for growing and finishing calves (20 ppm Zn), but fell short of the 40 ppm Zn needed by mature beef cattle. Monocrop triticale and its mixtures did not meet the 50 ppm Fe and 40 ppm Mn needed by mature beef cattle. Mixtures of Taza triticale and peas however, exceeded the 40 ppm Mn needed by mature beef cattle. Monocrop triticale and its mixtures had adequate forage Zn for all categories of beef cattle.

None of the monocrop cereals and their mixtures were able to meet the macro and trace mineral requirements of any class of beef cattle, so a supplemental mineral program is required.

Trace minerals are only required in very small amounts. Some trace minerals fed in excess amounts may cause a deficiency in others. A slight deficiency or excess trace-minerals may cause a decrease in performance that is hard to pinpoint. Trace minerals can be effectively supplemented in cattle diets by using the proper trace mineralised salt.

Conclusion

The monocrop cereals and mixtures with CDC Leroy peas had lower forage DM yields than the respective oat, barley and triticale mixtures with CDC Meadow peas. The CDC Meadow pea/cereal mixtures consistently had higher forage DM yield than each monocrop cereal type tested. In some cases, intercrops appeared to improve forage crude protein (CP) content over the respective monocrops. The forage energy (%TDN) from monocrop cereals and their mixtures was in most cases adequate for mature beef cattle. Some form of commercial mineral supplement would be required during feeding to beef cattle.

Peace Common Oat & Barley Varieties Versus Soft White Wheat Varieties for Silage

By Akim Omokanye, PCBFA

Winter feed costs typically represent the largest portion of cow/calf expenses. In the Peace, oats and barley are the two most commonly used cool season cereals in beef cattle production. They are grown for greenfeed, swath grazing, pastures and silage, and very recently, they are being included in cocktail mixtures. This year (2017), PCBFA tested several barley and oat varieties commonly grown in the Peace for greenfeed/silage against 4 soft white wheat varieties and bunker triticale. There is a lot more soft white wheat being used for silage in central/southern Alberta as it handles stresses better than barley and stands better. The down side is that harvest of soft white wheat is quite a bit later than traditional barley silage, but producers have reported 25-50% higher yields from soft white wheat grown for silage in those areas.

Objectives

1. To assess forage yield and quality of common oat and barley varieties in parts of the Peace with newly registered varieties, which have been used as checks.
2. To compare forage-type oat and barley varieties that are commonly grown in the Peace with soft white wheat and bunker triticale for forage yield and beef cattle nutrient requirements.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Alfalfa for over 10 years before spraying out in 2016 (chemical fallow)
- Site soil information (0-6” depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0 %.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 4 replications.
- Crops tested: the treatments consisted of 6 oats, 5 barley, 4 soft-white wheat and bunker triticale as shown below:

  <u>Oats:</u>
  CDC SO-1
  RUFFIAN
  AC MORGAN
  DERBY
  ORAVENA (new organic oat, Check)
  CDC HAYMAKER (Check)
  <u>Barley:</u>
  CHAMPION - 2 row
  LEGACY - 6 row
  METCALFE - 2 row
  CDC AUSTENSON- 2 row
  CDC MAVERICK- 2 row (Check)
  <u>Soft white wheat:</u>
  AAC PARAMOUNT
  SADASH
  AAC INDUS
  AC ANDREW
  <u>Triticale:</u>
  BUNKER

- Seeding Date & Rate: Seeding was done on May 30 at 300 plants/m^2 (27.8 plants/ft^2) for oats and barley, and 370 plants/m^2 (34.2 plants/ft^2) for soft white wheat and triticale.
- Seeding method: 6-row Fabro plot drill with 9" row spacing
- Fertility (actual lbs/acre): 89 N + 50 P + 29 K + 24 S
- Plot size: 11.04 m^2 (118.8 ft^2)
- Spraying: In-crop spraying was done once with Curtail M (800 ml/acre) + Fluroxyoyr (170ml/acre)
- Plant height, lodging, forage yield & forage quality were determined at the following crop growth stages:
  1. Oats - milk stage
  2. Barley -soft dough stage
  3. Soft white wheat -late milk/early dough
  4. Triticale -late milk

Results and Interpretation

Forage Dry Matter (DM) Yield

The highest forage DM yield was from AAC Indus (10,240 lbs DM/acre). The 4 soft white wheat varieties and Bunker triticale seemed to have higher forage DM yield than all oat and barley varieties tested here. The 4 soft white wheat varieties and Bunker triticale produced >9000 lbs DM/acre, compared to 6830-8600 lbs DM/acre for oat and barley varieties as well as their checks.

For the oat varieties, CDC SO-I had the lowest forage DM yield. Metcalfe barley produced the lowest forage DM yield among the barley varieties tested.

The soft white wheat varieties tested here yielded 660-3410 lbs DM/acre more than oat varieties. The differences in forage DM yield between soft white wheat varieties and barley were 885-3301 lbs DM/acre in favour of soft white wheat varieties.

The forage DM yield of Bunker triticale as % of oats and barley were respectively 112-140% and 115-138%.

Forage Quality

Crude Protein (CP): The forage CP varied from 9.40% CP for bunker triticale to 12.7% CP for Champion barley. Except for the AC Andrew variety of soft white wheat (12.1% CP), barley varieties had higher forage CP values than oats, soft white wheat and bunker triticale.

Protein is a building block, and is a critical nutrient in all beef cattle diets. Although protein supplementation is often a high cost item in beef cattle feeding programs, sometimes protein supplementation is needed to meet the animal's nutrient requirements. Providing adequate protein in beef cattle diets is important for animal health and productivity as well as ranch profitability.

The Beef Cow Rule of Thumb with protein is 7-9-11, which means an average mature beef cow requires a ration with CP of 7% in mid pregnancy, 9% in late pregnancy and 11% after calving. All varieties of oats, barley, soft white wheat and triticale tested here had adequate CP for dry gestating beef cows in mid to late pregnancy. For lactating beef cows, CDC Haymaker oat, Ruffian oat, Champion barley, CDC Maverick barley, Legacy barley, Metcalfe barley and AC Andrew soft white wheat met the 11% CP needed by this category of beef cows.

Signs of protein deficiency include reduced appetite, weight loss, poor growth, depressed reproductive performance, and reduced milk production.

Table 1. Forage DM yield and quality (DM basis) of common oat and barley varieties in the Peace compared to Bunker triticale and 4 soft white wheat varieties tested in Fairview in 2017. *NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

	OATS						BARLEY					SOFT WHITE WHEAT								
Measurements	**CDC HAYMAKER**	**CDC SO-1**	**RUFFIAN**	**ORAVENA**	**AC MORGAN**	**DERBY**	**CHAMPION**	**CDC MAVERICK**	**LEGACY**	**CDC AUSTENSON**	**METCALFE**	**AAC PARAMOUNT**	**AAC INDUS**	**SADASH**	**AC ANDREW**	**BUNKER Triticale**	**Mean**	**Significance**	**LSD (0.05)**	**CV %**
Moisture, %	67.0	67.0	66.8	66.0	65.6	64.8	63.2	63.2	63.0	61.9	57.1	60.1	59.6	59.3	63.1	58.7	62.9	*	3.50	3.34
DM Yield, lb/acre	8580	6830	7343	7823	8600	8031	7417	8156	7044	8375	6939	9437	10240	9778	9260	9593	8210	*	2114	15.4
CP, %	11.8	10.7	11.0	10.8	10.3	10.7	12.7	12.0	12.0	10.8	11.1	10.6	10.7	9.90	12.1	9.40	11.0	NS	2.77	11.7
Soluble protein, %	51.4	57.4	55.1	62.3	51.4	57.4	58.9	43.0	66.0	45.0	43.8	63.6	62.0	66.0	63.9	72.4	57.5	*	10.1	8.25
ADF-CP, %	1.28	1.19	1.33	1.30	1.29	1.07	1.15	1.24	1.17	1.22	1.29	1.14	1.07	1.38	1.03	1.35	1.22	NS	0.29	11.2
NDF-CP, %	1.52	0.94	1.32	0.55	0.86	1.03	1.77	1.92	1.70	1.12	1.37	2.27	2.49	2.37	2.73	2.29	1.64	*	0.70	20.0
UIP, %	24.2	21.2	22.4	18.8	24.2	21.2	20.5	28.4	16.9	27.4	28.0	18.1	18.9	16.9	18.0	13.7	21.2	*	5.05	11.1
ADF, %	32.7	31.4	33.0	32.5	31.5	32.2	24.3	27.8	24.8	24.3	24.9	26.9	28.2	30.4	26.5	32.7	29.0	*	3.70	5.98
NDF, %	59.0	55.6	55.0	56.4	55.9	55.0	44.0	50.3	45.5	46.8	45.8	48.6	49.8	47.3	48.8	50.9	50.9	*	4.95	4.56
TDN, %	63.3	64.4	63.1	63.5	64.3	63.7	69.9	67.2	69.5	69.9	69.4	67.9	66.9	65.1	68.2	63.4	66.2	*	2.88	2.04
NE_L, Mcal/kg	1.43	1.46	1.43	1.44	1.46	1.44	1.60	1.53	1.58	1.60	1.59	1.54	1.52	1.48	1.55	1.44	1.50	*	0	2.25
NE_G, Mcal/kg	0.83	0.86	0.82	0.83	0.85	0.84	1.02	0.94	1.01	1.02	1.00	0.96	0.93	0.88	0.97	0.83	0.91	*	0.08	4.28
NE_M, Mcal/kg	1.55	1.58	1.54	1.55	1.57	1.56	1.74	1.66	1.73	1.74	1.72	1.68	1.65	1.60	1.69	1.55	1.63	*	0.08	2.37
Ca, %	0.31	0.29	0.25	0.32	0.28	0.31	0.28	0.36	0.43	0.25	0.25	0.17	0.21	0.20	0.20	0.22	0.27	*	0.05	9.35
P, %	0.17	0.16	0.16	0.16	0.19	0.18	0.16	0.18	0.17	0.14	0.13	0.16	0.15	0.15	0.19	0.16	0.16	NS	0.04	12.4
K, %	1.60	1.60	1.50	1.55	1.40	1.39	1.49	1.52	1.52	1.33	1.33	1.37	1.36	1.54	1.66	1.28	1.46	NS	0.39	12.5
Mg, %	0.21	0.23	0.16	0.24	0.20	0.23	19.0	0.23	0.21	0.19	0.19	0.18	0.19	0.19	0.22	0.20	0.20	NS	0.05	11.9
Na, %	0.62	0.54	0.46	0.62	0.47	0.32	0.20	0.28	0.18	0.16	0.20	0.01	0.02	0.01	0.01	0.01	0.25	*	0.22	40.7
S, %	0.21	0.22	0.20	0.19	0.20	0.20	0.25	0.23	0.22	0.19	0.20	0.19	0.20	0.20	0.22	0.18	0.20	NS	0.03	8.76
Cu, ppm	3.67	4.82	4.27	2.73	3.27	4.23	5.22	5.22	6.25	4.78	4.86	5.21	3.43	3.69	4.66	4.25	4.38	NS	1.85	19.7
Fe, ppm	84.6	88.3	79.6	93.1	65.0	71.3	73.7	63.0	62.1	65.9	61.6	82.1	43.9	56.3	50.9	40.2	113	*	5.55	22.8
Zn, ppm	30.8	32.0	32.9	29.0	32.0	31.6	43.7	49.7	46.2	37.4	40.2	42.2	39.0	36.8	50.8	41.4	38.5	*	7.08	8.62
Mn, ppm	73.8	89.7	87.1	82.0	92.4	74.3	34.3	42.7	35.6	30.0	34.8	86.6	65.2	57.7	83.8	66.0	64.7	*	21.8	15.8
NFC, %	17.6	22.0	22.4	21.2	22.1	22.7	31.7	26.1	30.8	30.8	31.4	29.2	27.9	31.1	27.5	28.1	26.4	*	6.43	11.4
RFV	99	107	106	104	106	107	147	125	142	138	140	130	124	127	130	115	122	*	16.9	6.50

Energy: Energy is probably the most important nutritional consideration in beef cattle production in cold climates. Energy provides the body with the ability to do work. Work includes growth, lactation, reproduction, movement and feed digestion. Energy is the nutrient required by cattle in the greatest amount, and usually accounts for the largest proportion of feed costs.

The total digestible nutrients (TDN) and other forms of energy (net energy for lactation, NE_L; net energy for gain, NE_G; net energy for maintenance, NE_M) measured here had similar values for all barley varieties.

The TDN from all crops tested here was generally above 63%. Barley varieties seemed to have slightly highly TDN than varieties of oats, soft white wheat and triticale. Bunker triticale had similar TDN to oats.

All crops tested had adequate TDN for a dry gestating beef cow, which needs 55% TDN at the second-trimester and 60% TDN at third-trimester. For a lactating beef cow, which requires 65% TDN, all varieties of barley and soft white wheat met and in most cases exceeded the TDN requirement of a nursing beef cow. All varieties of oats and bunker triticale fell short of meeting the 65% TDN needed by a lactating beef cow.

All crop varieties tested had more than the recommended NE_M for mature beef cattle (1.19-1.28 Mcal/kg) and were within the 1.08-2.29 Mcal/kg required by growing and finishing calves. Similarly, all crop varieties were within the 0.53-1.37 Mcal/kg NE_G needed by growing and finishing calves.

Minerals: Macro minerals are those that are required in relatively large amounts. This group consists of Ca, P, Mg, S, K and salt (sodium chloride). The forage Ca content was highest for Legacy barley (0.43% Ca) and lowest for AAC Paramount soft white wheat (0.17% Ca). The forage P, K, Mg & S contents were not significantly different for crop varieties tested.

All crop varieties had sufficient forage Ca and Mg for dry gestating beef cows.

The requirements of K and S by mature beef cattle were met by all crops tested.

The forage Na content was generally higher for oats than barley, soft white wheat and triticale. Varieties of oats and barley tested here exceeded the 0.06-0.08% Na needed by dry gestating beef cows and 0.10% Na required by a lactating beef cow. All soft white wheats and triticale fell short of meeting the requirements of mature beef cattle.

Overall, all oats and 3 barley varieties (Champion, CDC Maverick and Legacy barley) were able to completely meet the requirements of Ca, P, K, Mg & S needed by a dry gestating beef cow. Other crop varieties would fall short of providing enough of these minerals to all categories of cattle.

Essential trace minerals are necessary for the well being of the animal. These are needed in sufficient quantities to promote health and to optimize production and reproduction. All trace minerals are toxic when fed in excessive quantities. In this study, the requirements of Fe (except for Bunker triticale & AAC Indus soft white wheat) and Zn (except for Oravena oats) have both been met by all crop varieties tested here. The Mn requirement by mature beef cattle (40 ppm) was mostly met by crop varieties tested.

All crop varieties did not have sufficient forage Cu for mature beef cattle (10 ppm).

Relative Feed Value (RFV)- A prediction of feeding value that combines estimated intake (NDF) and estimated digestibility (ADF) into a single index. In this study, Bunker triticale, barley and soft white wheat had higher RFVs than oats.

Conclusion

The common varieties of oats and barley grown in the Peace tested here compared well with the newly registered varieties in terms of forage yield and quality. However, the newly registered oats or barley may in some cases have slightly higher forage quality indicators than their counterparts. For instance CDC haymaker oats seemed to have higher forage CP than other oats. Bunker triticale had more forage DM than oats and barley. Overall, the soft white wheat varieties tested here yielded 660-3410 lbs DM/acre more than oat varieties. The differences in forage DM yield between soft white wheat varieties and barley were 885-3301 lbs DM/acre in favour of soft white wheat varieties. The forage DM yield of Bunker triticale as % of oats and barley was 112-140% and 115-138%, respectively.

Annual & Italian Ryegrass Variety Trial For Forage and Regrowth Potential

By Akim Omokanye, PCBFA

It is important to choose a variety of annual or Italian ryegrass that establishes quickly, a variety that is well-adapted to the area, yields plenty, is very palatable and yields consistently throughout the season after harvesting. The extension publication by Dr. Lemus of Extension Service of Mississippi State University indicates that annual ryegrass varieties fall into two types, which are called tetraploid (4n) or diploid (2n). Tetraploid varieties are usually marketed as producing more forage biomass than diploids, but this could depend on location, management, fertility, and environmental conditions. Diploids have the advantage of a greater cold tolerance and quicker recovery. Some varieties are both a tetraploid and an Italian ryegrass. This makes them very useful. First, as a tetraploid ryegrass, they have twice the chromosomes of a diploid ryegrass, higher sugar content, and bigger, more succulent leaves. They are also a true Italian ryegrass, meaning that when planted in cool-season regions they normally will not go to seedhead until following summer. Annual ryegrass as a cover crop has the following benefits: tolerance to a wide range of soils, can tolerate compacted soils, minimizes soil compaction, N scavenger, suppresses weeds in 4-6 weeks, good erosion control and improves soil aggregate.

Objective

To test annual and Italian ryegrass varieties for their forage yield, re-growth potential and suitability for fall grazing.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Chemical fallow in 2016; forage-type brassicas in 2015
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0 %.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications.
- Treatments: 8 annual & Italian ryegrass varieties listed in Table 1 below were tested-

Table 1. Varieties of annual & Italian ryegrasses

Variety	Plant Type[1]
1. Meroa	4n
2. Green Spirit	2n & 4n
3. Danegro	4n
4. Gulf	2n
5. Sabroso	4n
6. Tetilla	4n
7. Italian	4n
8. Common (no variety name provided, check)	

[1]Type: 2 n= diploid, 4n=tetraploid

- Seeding Date & Rate: Seeding was done on May 30 at 12 lbs/acre
- Seeding method: 6-row Fabro plot drill with 9" row spacing
- Fertility (actual lbs/acre): 89 N + 50 P + 29 K + 24 S
- Plot size: 11.04 m^2 (118.8 ft^2)
- Spraying: In-crop spraying – 2,4-D-700

Measurements: Plant height and forage yield were determined on August 12. Forage samples were analyzed for quality. Notes were taken on re-growth potential a few weeks after harvest.

Results and Interpretation

Forage Dry Matter (DM) Yield

Both Italian and Sabroso varieties produced forage DM yield of 4000 lbs DM/acre or more, while other varieties produced less than 4000 lbs DM/acre forage yield. Common (Check) had the least forage DM yield (2640 lbs/acre). Expect for Sabroso and Common (check) varieties, the re-growth potential was very good for all varieties tested, with ability to regrow for a second cut or fall grazing.

Forage Quality

Crude Protein (CP): The forage CP values of varieties tested varied from 13.8% CP for both Sabroso and Common to 27.6% CP for Meroa. Only 3 (Meroa, Green Spirit and Danegro) of the 8 varieties tested had >20% CP. Others had <20% CP (13.8-19.0% CP). Comparing to other cool season cereals, annual ryegrasses would generally have far higher CP than barley, oats and triticale as well as soft white wheat. In the present study, all annual ryegrasses had far more than what mature beef cattle need for CP. The CP requirements of growing and finishing calves (12-14% CP) were mostly exceeded by annual ryegrass varieties tested.

Table 1. Forage DM yields and forage quality indicators of 8 annual ryegrasses. *NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

Parameters	**Meroa**	**Green Spirit**	**Tetilla**	**Danegro**	**Gulf**	**Italian**	**Sabroso**	**Common**	***Mean***	***Significance***	***$LSD_{0.05}$***	***CV %***
Moisture, %	82.1	78.3	76.6	76.5	76.5	76.1	73.9	72.2	*76.5*	*NS*	*7.54*	*5.62*
DM Yied, lb/acre	3285	3619	3482	3736	3539	4051	4484	2640	*3551*	*NS*	*1353*	*21.7*
CP, %	27.6	21.3	18.2	22.7	19.0	18.6	13.8	13.8	*19.4*	*NS*	*7.94*	*17.3*
Soluble protein, %	64.4	59.9	55.6	44.0	49.4	54.3	57.4	57.4	*55.3*	*NS*	*10.8*	*8.30*
ADF-CP, %	1.46	0.67	1.32	0.62	0.79	0.58	0.81	0.83	*0.88*	*	*0.53*	*25.7*
NDF-CP, %	5.38	5.22	4.19	6.88	4.74	5.24	3.39	3.41	*4.81*	*NS*	*3.85*	*33.9*
UIP, %	17.7	20.0	22.1	27.9	25.2	22.8	21.2	21.3	*22.3*	*NS*	*5.43*	*10.3*
ADF, %	25.2	24.1	26.9	22.2	25.1	24.5	32.7	32.9	*26.7*	*	*3.78*	*5.97*
NDF, %	43.4	44.3	45.5	43.3	44.8	45.1	54.6	55.1	*46.9*	*	*4.59*	*4.13*
TDN, %	69.2	70.0	67.9	71.5	69.3	69.7	63.3	63.1	*68.0*	*	*2.94*	*1.82*
NE_L, Mcal/kg	1.58	1.60	1.55	1.63	1.58	1.59	1.43	1.42	*1.55*	*	*0.06*	*1.89*
NE_G, Mcal/kg	1.00	1.02	0.96	1.06	1.00	1.01	0.83	0.81	*0.96*	*	*0.08*	*3.80*
NE_M, Mcal/kg	1.72	1.74	1.68	1.78	1.72	1.73	1.55	1.53	*1.68*	*	*0.08*	*2.06*
Ca, %	0.65	0.54	0.50	0.51	0.51	0.54	0.55	0.52	*0.54*	*NS*	*0.15*	*12*
P, %	0.21	0.17	0.19	0.18	0.27	0.18	0.15	0.18	*0.19*	*	*0.05*	*12.1*
K, %	3.30	3.26	2.79	2.7	3.68	2.77	1.57	2.07	*2.76*	*	*0.75*	*11.5*
Mg, %	0.36	0.33	0.31	0.32	0.47	0.31	0.25	0.25	*0.32*	*	*0.05*	*6.73*
Na, %	0.63	0.47	0.55	0.61	0.61	0.52	0.32	0.32	*0.5*	*	*0.23*	*22.7*
S, %	0.28	0.22	0.22	0.24	0.35	0.21	0.19	0.22	*0.24*	*	*0.06*	*11.2*
Cu, ppm	6.95	5.42	7.65	8.13	7.62	7.64	4.81	5.08	*6.66*	*	*0.91*	*5.82*
Fe, ppm	184	134	110	112	141	107	65	81	*117*	*	*30*	*10.9*
Zn, ppm	52.4	42.5	44.4	41.9	68.2	45.9	44.7	36.2	*47*	*	*13.5*	*12.1*
Mn, ppm	64.8	54.1	57.2	56.2	73.3	71.20	58.3	47.3	*60.3*	*NS*	*21*	*14.7*
NFC, %	17.4	22.7	25.7	21.3	25.0	24.6	20.0	20.0	*22.1*	*NS*	*11.9*	*22.8*
RFV	148	147	138	153	144	144	107	107	*136*	*	*19.4*	*6.02*

Energy: The total digestible nutrients (TDN) values were generally high and mostly about 70% for annual ryegrass varieties tested. Using %TDN, the Rule of Thumb is 55-60-65. This rule says that for a mature beef cow to maintain her body condition score (BCS) through the winter, the ration must have a TDN energy reading of 55% in mid pregnancy, 60% in late pregnancy and 65% after calving. All varieties tested here exceeded the TDN requirements for pregnant beef cows. For lactating beef cows, only Sabroso and Check fell short of meeting the 65% TDN needed by lactating beef cows.

Minerals: Meroa had the highest forage Ca content. Green Spirit had the highest forage P, K, Mg, S, Zn and Mn. The forage Cu and Fe values were respectively higher for Danegro and Meroa than others. Meroa, Green Spirit and Danegro had higher forage Na than others.

All varieties tested here far exceeded the Ca requirements of growing and finishing beef cattle, as well as dry gestating beef cows in mid and late pregnancy, but only Meroa had the 0.58% Ca needed by a lactating beef cow.

Except for Sabroso, the P requirements by pregnant cows have been met by all varieties. Only Green Spirit was able to meet the P requirement of a lactating beef cow, which is 0.26% P.

The requirements of K, Mg, Na, S, Fe, Zn and Mn by mature beef cattle have been met by all varieties tested.

However, all varieties did not have sufficient forage Cu for young and mature beef cattle.

Field notes

All annual ryegrasses tested in this study grew fast and seemed to be ready for grazing 6-8 weeks after seeding. In most cases, they would require a regrowth period of 2-4 weeks after cutting or grazing in this area. Sabroso variety had the least regrowth potential of the varieties tested.

Conclusion

Though annual ryegrasses are low in dry matter and would normally have lower forage DM yield than oats, barley and triticale, they are highly digestible and have high CP. On beef and sheep farms, producers use annual ryegrasses for grazing animals having a high nutrient requirement such as young, growing stock. When supplemented with perennial forages, annual ryegrasses extend the grazing season beyond its normal range. Having high-quality supplemental forage for a longer season increases animal returns and lowers storage costs. Farmers can also make better use of land and equipment. All annual ryegrasses tested in this study had good forage quality value, with their forage CP and TDN values far exceeding the needs of a dry gestating beef cow. For the purpose of one cut only, Sabroso would probably be a better option than most other annual ryegrasses tested here. For additional benefits, especially where more than one cut is required, where fall grazing is the objective, or where a good soil cover is needed - Italian, Dangero and Green Spirit varieties would probably be a better choice. Cover crops have become a popular option in the Peace, providing vegetative cover and building soil on land traditionally left black or in stubble after harvest. Annual plant species offer the majority of cover crop options, serving a dual function in livestock/cropping systems.

Warm Season and Cool Season Cereals: Forage Yield & Quality

By Akim Omokanye, PCBFA

Because of the increasing number of acres of cocktail mixtures in parts of the Peace, there is a need to regularly test new annual crops as they are introduced to the Peace for their adaptation, potential forage yield, and suitability for soil health improvement and inclusion in cocktail mixtures. Warm season crops such as red proso millets have been grown for greenfeed for some time now in the Peace region. Reports by Saskatchewan Agriculture and Food (SAF) at Weyburn have shown that in Western Canada warm season crops can provide a high-yielding alternative to barley and oats, and they can be utilized for greenfeed and swath grazing. Warm season plants require higher soil temperatures for germination in spring and they grow well under high temperatures. It is important to note that, warm-season grasses cannot tolerate frost.

Objectives

1. To continue to assess the performance of warm season annual forage-type cereal grasses for forage yield and feed quality, and for their suitability for inclusion in cocktail mixtures for beef cattle production.
2. To compare forage yield and quality of warm season cereals with cool season cereals.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Chemical fallow in 2016; forage-type brassicas in 2015
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0 %.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications.
- Treatments: 3 cool season forage-type spring cereal crops (checks 1, 2 & 3) and 6 warm season grasses listed below were tested:

  Cool season forage-type cereals
  1. CDC Maverick barley (check 1) seeded @ 27.8 plants/ft^2
  2. Bunker triticale (check 2) seeded @ 34.2 plants/ft^2
  3. CDC Haymaker oats (check 3) seeded @ 27.8 plants/ft^2

  Warm season forage-type crops
  1. Red proso millet @ 22 lbs/acre
  2. White proso millet @ 22 lbs/acre
  3. German millet @ 22 lbs/acre
  4. Siberian millet @ 22 lbs/acre
  5. Teff @ 10 lbs/acre
  6. Sorghum-sudangrass @ 26 lbs/acre
- Seeding Date & Rate: Seeding was done on May 30
- Seeding method: 6-row Fabro plot drill with 9" row spacing
- Fertility (actual lbs/acre): 89 N + 50 P + 29 K + 24 S
- Plot size: 11.04 m^2 (118.8 ft^2)
- Spraying: In-crop spraying was done once with 2,4-D-700
- Measurements taken were plant height, lodging, forage yield & forage quality.


German millet

Barley was harvested at soft-dough stage, oats at milk stage and triticale at late milk stage. The millets were harvested at the early heading and teff was at flowering. Sorghum-sudangrass was harvested at heading out stage.

Results and Interpretation

Plant Height, Flowering & Lodging

For both cool and warm season cereals tested, sorghum-sudangrass grew tallest (142 cm). Teff, on the other hand, was the shortest crop.

No lodging was observed for any of the tested crops.

All crops flowered or headed out, but German millet and sorghum-sudangrass headed out much later than any of the other crops tested. For the warm season cereals, both proso millets flowered first, followed by teff, then Siberian millet, German millet, and later on sorghum-sudangrass.

Forage Dry Matter (DM) Yield

Generally, forage DM yield was higher for cool season forage-type cereal crops than warm season crops. The forage DM yield for cool season crops was higher for CDC Maverick barley and Bunker triticale than CDC Haymaker oats. For the warm season crops, forage DM yield in order of highest to lowest was: red proso millet > white proso millet > sorghum-sudangrass > teff. Overall, cool season crops yielded 1342-5358 lbs DM/acre more forage than warm season crops.

Though warm season crops did not yield as much as cool season crops, it is evident that the warm season crops tested here (except for teff) can provide a high-yielding alternative to barley, oats and triticale. Warm season can be utilized for greenfeed, swath grazing and cocktail mixtures. It is important to note that warm season plants require higher soil temperatures for germination in spring, they grow well under high temperatures, and they cannot tolerate frost.

Forage Quality

Crude Protein (CP): The forage CP was lower for cool season than warm season crops. For the cool season crops, the forage CP was highest for CDC Haymaker oats (12.4% CP). For the warm season crops, the forage CP was as high as 19.3% (teff). All warm season crops had >14.0% CP.

Table 1. Forage DM yields and forage quality of 6 warm season cereals and 3 cool season cereals (oats, barley & triticale) *NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

	Cool season cereals			Warm season cereals									
Parameters	**CDC Maverick barley**	**Bunker triticale**	**CDC Haymaker oats**	**Red proso millet**	**White proso millet**	**German millet**	**Siberian millet**	**Teff**	**Sorghum-sudangrass**	***Mean***	***Significance***	***$LSD_{0.05}$***	***CV, %***
Moisture, %	63.3	58.4	70.4	78.0	77.6	78.5	74.0	73.2	81.6	*72.8*	*	*1.51*	*1.20*
DMY, lb/acre	8478	8453	7764	6422	6046	5010	4161	3120	5889	*6038*	*	*1117*	*11.2*
Height	105	124	111	108	106	91.6	96.6	68.6	141.6	*106*	*	*6.35*	*3.46*
CP, %	10.0	10.5	12.4	14.7	15.5	16.1	14.7	19.3	16.9	*14.0*	*	*2.55*	*8.02*
ADF, %	25.7	32.7	37.2	32.2	34.1	32.5	33.7	27.8	29.2	*31.4*	*	*2.85*	*4*
NDF, %	46.2	52.6	57.6	57.5	57.8	56.3	55.8	58.3	53.9	*54.5*	*	*4.45*	*3.60*
TDN, %	68.8	63.3	59.8	63.8	62.3	63.5	62.6	67.1	66.1	*64.3*	*	*2.22*	*1.52*
NE_L, Mcal/kg	1.57	1.44	1.35	1.44	1.41	1.44	1.41	1.53	1.50	*1.46*	*	*0.05*	*1.66*
NE_G, Mcal/kg	0.99	0.83	0.72	0.84	0.80	0.83	0.80	0.94	0.91	*0.85*	*	*0.06*	*3.47*
NE_M, Mcal/kg	1.71	1.55	1.44	1.56	1.52	1.55	1.53	1.66	1.63	*1.58*	*	*0.06*	*1.91*
Ca, %	0.35	0.24	0.35	0.32	0.31	0.39	0.33	0.64	0.59	*0.38*	*	*0.13*	*15.4*
P, %	0.18	0.17	0.18	0.15	0.18	0.16	0.16	0.17	0.15	*0.17*	*NS*	*0.04*	*10.7*
K, %	1.30	1.57	1.48	1.91	1.79	2.79	1.82	1.62	2.34	*1.80*	*	*0.62*	*15.2*
Mg, %	0.18	0.20	0.19	0.45	0.45	0.44	0.46	0.29	0.33	*0.31*	*	*0.05*	*6.96*
Na, %	0.08	0.03	0.56	0.01	0.01	0.01	0.01	0.04	0.01	*0.08*	*	*0.03*	*19.8*
S, %	0.14	0.18	0.21	0.18	0.19	0.15	0.18	0.29	0.16	*0.18*	*	*0.03*	*8.19*
Cu, ppm	6.09	4.39	4.92	10.2	8.55	10.8	8.36	11.9	9.80	*8.04*	*NS*	*5.41*	*29.7*
Fe, ppm	50.4	55.1	92.5	80.5	110	100	92.7	81.5	139	*85.5*	*	*32.9*	*17.0*
Zn, ppm	42.6	41.5	40.4	41.8	65.1	44.2	54.2	82.9	128	*58.3*	*	*26.4*	*20*
Mn, ppm	31.5	68.6	80.4	42.3	50.8	42.9	50.9	80.7	50.1	*54.8*	*NS*	*37.9*	*30.6*
NFC, %	32.2	25.6	18.4	16.1	15.1	15.9	17.9	10.8	17.5	*19.8*	*	*5.63*	*12.5*
RFV	139	112	96	103	100	104	104	107	113	*110*	*	*12.7*	*5.09*

Of the 3 cool season crops tested, only CDC Haymaker oats had sufficient CP for mature beef cattle. The other 2 cool season cereals (barley and triticale) were only able to meet the protein requirements of dry gestating beef cows. All warm season crops however, far exceeded the protein requirements of all categories of both young and mature beef cattle.

Energy: The forage total digestible nutrients (TDN) varied from 60% TDN for CDC Haymaker oats to 69% TDN for CDC Maverick barley. The forage TDN of warm season crops compared well with cool season crops. All crops tested were adequate for the amount of TDN needed by a pregnant beef cow (55% TDN at mid-pregnancy & 60% TDN at late-pregnancy). For mature lactating beef cows, only 3 (CDC Maverick barley, teff and sorghum-sudangrass) of the 9 crops tested had sufficient TDN for this category of mature beef cattle.

Minerals
The forage Ca was highest for teff (0.64% Ca), followed by sorghum-sudangrass with 0.59% Ca. The other crops tested varied from 0.24 to 0.39% Ca.

All crops had similar forage P content, only varying from 0.15 to 0.18% P.

The forage K, S and Cu was higher for sorghum-sudangrass than all other crops tested. The warm season crops generally had more forage K and Cu than the cool season crops.

In terms of whether or not the crops have been able to meet measured mineral requirements, all crops did meet the Ca, P (except for red proso millet and sorghum-sudangrass) and S (except CDC Maverick barley) requirements of dry gestating beef cows. For a lactating beef cow, only teff had sufficient forage Ca. None of the crops tested had adequate P for lactating beef cows. Only CDC Maverick slightly fell short of the S requirement for lactating beef cows, while other crops had enough S for a nursing beef cow.

All crops were able to meet the requirements of K, Mg, Fe, Zn and Mn (except for CDC Maverick barley) of mature beef cattle.

Most of the warm season crops were able to meet the requirements of Cu for young and mature beef cattle.

Conclusion

Though generally forage DM yield was higher for cool season forage-type cereal crops than warm season crops, the present study shows that warm season cereal crops (except Siberian millet and teff) would be able to produce substantial forage DM yield which could be of immense benefit as alternatives to cool season crops. The forage DM yield for cool season crops was higher for CDC Maverick barley and Bunker triticale than CDC Haymaker oats. For the warm season crops, forage DM yield in order from highest to lowest was: red proso millet > white proso millet > sorgum-sudangrass > teff. The forage CP was lower for the cool season than warm season crops. All warm season crops had >14.0% CP, indicating that warm season crops would have enough CP for young and mature beef cattle. The forage TDN of warm season crops compared well with cool season crops. All crops tested were adequate for the TDN required by a pregnant beef cow (55% TDN at mid-pregnancy & 60% TDN at late-pregnancy). For mature lactating beef cows, only 3 (CDC Maverick barley, teff and sorghum-sudangrass) of the 9 crops tested had sufficient TDN for this category of mature beef cattle.


Teff

Cocktail Mixtures Versus Forage-Type Cereal Monocrops

By Akim Omokanye, PCBFA

There is growing interest in the potential for a multispecies cover crop mixture (cocktail) for forage-based livestock production. The idea of cocktails is still new in the Peace. Cover crops can be grown as a monoculture or in mixtures with other cover crops. A cocktail mixture is a number of cover crop species mixed together to take advantage of each of its species' unique offering to the producer's soil. Mixtures of cover crop species can be planted to optimize the benefits associated with cover crop use. The three major categories of commonly grown cover crops are grasses, legumes, and brassicas. Legumes in the mixtures can contribute N through symbiotic dinitrogen (N_2) fixation, which can benefit non-legumes growing in the mixtures through transfer of N by the roots. Better forage quality, building soil organic matter and improving overall soil health are some of the reasons given by producers who have seeded cover crops.

Objective

To evaluate cocktail cover crops using multi-species cover crop mixtures versus cool season forage-type cereals for forage production.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Chemical fallow in 2016, barley in 2015.
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 7.0%.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications in small plots (118.8 ft^2)
- Treatments (18 treatments in total as shown below in Table 1): 14 mixtures, 4 monocrops as checks (CDC Haymaker oats, CDC Maverick barley, Bunker triticale & AC Andrew soft white wheat).
- The cocktails were pre-mixed before seeding.
- Except for cocktail #7, the legumes were inoculated at seeding.
- Seeding Date: Seeding was done on May 31.
- Seeding method: 6-row Fabro plot drill with 9" row spacing.
- Fertility: No fertilizer applied to cocktails as well as the monocrop cereals (checks).
- Spraying: No pre-seed, pre-emergent or in-crop spraying was done.


Table 1. Cocktail mixtures and monocrop cereals, and their seeding rates (lbs/acre)

Cocktail #1	**Cocktail #5**	**Cocktail #11 (Union Forage Relay Mix)**
Peas 60 lbs	Barley 48 lbs	60% Italian ryegrass
Oats 45 lbs	CDC Horizon peas 8 lbs	20% Hairy vetch
Hairy vetch 4 lbs	Hairy vetch 4 lbs	10% Hunter forage brassica (turnip/Asiatic leaf veg)
Radish 0.5 lb	Crimson clover 1 lb	10% Winfred forage brassica (kale/turnip cross)
Turnips 0.5 lb	Winfred forage brassica 1 lb	Seeding rate: 12 lbs/acre
Crimson clover 1 lb	GreenSpirit annual ryegrass 1 lb	+ CDC Haymaker oats 34 lbs
Cocktail #2	Sunflower 1 lb	
Annual Ryegrass - 2 lbs	**Cocktail #6**	**Cocktail #12 (PGG Annual mix)**
Proso millet- 2 lbs	Barley 50 lbs	29.8% Hairy vetch
Barley- 20 lbs	Hairy vetch 6 lbs - inoculated	24.7% GreenSpirit Italian ryegrass
Peas- 20 lbs	**Cocktail #7**	14.95% Sorghum Sudan
Purple top turnip- 1 lb	Barley 50 lbs	9.85% Crimson clover
Kale- 1 lb	Hairy vetch 6 lbs - not inoculated	9.98% Winfred rape
Crimson Clover- 1 lb	**Cocktail #8**	5.0% Goliath Rape
Cocktail #3	Barley 36 lbs	4.98% Graza radish
Annual Ryegrass- 2 lbs	CDC Horizon peas 36 lbs	Seeding rate: 12 lbs/acre
Oats- 35 lbs	Triticale 36 lbs	CDC Haymaker oats 34 lbs
Peas- 25 lbs	**Cocktail #9**	CDC Horizon peas 10 lbs
Purple top turnip- 1 lb	25% Peas	
Forage rape- 1 lb	25% Hairy vetch	**Cocktail #13 (Pinpoint from Barenbrug)**
Persian clover- 2 lbs	25% Crimson clover	45% GreenSpirit Italian ryegrass
Cocktail #4	25% Faba bean	20% BMR hybrid sorghum
Proso millet- 2 lbs	**Cocktail #10 (Union Ultimate mix)**	10% Berseem clover
Oats- 15 lbs	30% Hairy vetch	8% Barsica forage rape
Barley- 15 lbs	25% Italian ryegrass	7% T raptor forage turnip x Rape
Peas- 15 lbs	15% Sorghum 10% Crimson clover	5% CW0604 teff grass 5% Laser Persian clover Seeding rate: 12 lbs/acre
Tillage radish- 0.5 lb	10% Winfred forage brassica	**Cockktail #14**
Hairy vetch- 5 lbs	5% Hunter forage brassica	Peas 40 lbs
Kale- 0.5 lb	5% Graza forage brassica	Oats 34 lbs
Crimson - 1 lb	Seeding rate: 12 lbs/acre +	Hairy vetch 6 lbs
Persian Clover – 1 lb	CDC Haymaker oats 34 lbs	**Mono Haymaker** oat (check) @27.8 plants/ft^2
	CDC Horizon peas 10 lbs	**Mono AC Andrew** (check) @34.3 plants/ft^2
		Mono Bunker triticale (check) @34.3 plants/ft^2
		Mono CDC Maverick barley @27.8 plants/ft^2

- Forage yield was determined on August 14, corresponding to 75 days after seeding.

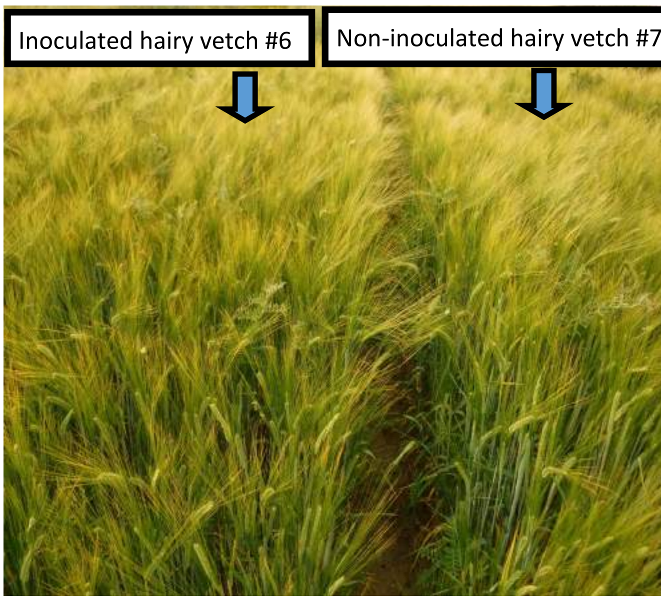
Prior to harvest, efforts were made to identify the crop varieties in each cocktail mixture and we compared these crop varieties to the supposed list of seeded crop varieties in the mixtures. This was done to ensure that the final result of a particular cocktail mixture reflects the intended crop composition. A day before forage harvest, the plots were scanned with a GreenSeeker Technology instrument to obtain NDVI values. Forage quality was also determined.

Results & Implications

Forage Dry Matter (DM) Yield (Table 2)

The forage DM yield was highest for AC Andrew soft white wheat (8925 lbs DM/acre), closely followed by Bunker triticale (8832 lbs DM/acre) and then cocktail #5 (8644 lbs DM/acre). Only one (cocktail #5) of the 14 cocktails had >8000 lbs DM/acre. Other cocktails had <8000 lbs DM/acre. Three of the monocrop cereals (wheat, barley and triticale) had >8000 lbs DM/acre, and the fourth monocrop cereal (oats) had <8000 lbs DM/acre. Cocktails #4, 9, 12 and 13 had far less forage DM yield than other cocktails as well as monocrop cereals.

Cocktails #6 & #7 contained only barley and hairy vetch. The hairy vetch in Cocktail #6 was inoculated, while that of cocktail #7 was not. The differences between the two, which was in favour of cocktail #6 (inoculated) was high, resulting in a yield advantage of 791 lbs DM/acre over cocktail #7. This confirms the need to inoculate legumes before seeding. Visual observation just before forage harvest showed that the barley in cocktail #6 seemed to grow slightly taller than barley in cocktail #7 (see Picture below).



Forage Quality (Table 2)

Meeting the basic nutrient requirements of beef cows is a key component of meeting cow herd production and profitability goals for the beef cattle enterprise. Adequate nutrition is vital for adequate cow reproduction, cow and calf health, and growth of all classes of cattle. Nutrient requirements of cattle change throughout the year based upon stage of the production cycle, age, sex, breed, level of activity, pest load, and weather conditions.

Crude Protein (CP): The forage CP was highest for cocktail #12 (23.9% CP), followed closely by cocktail #13 (22.7% CP) and then cocktail #10 (19.8% CP). Other cocktails had 11.1– 16.0% CP. The improvement in forage CP content from cocktails #10, 12 and 13 over other cocktails was probably due to the presence and higher rates of annual/Italian ryegrass (particularly Italian and Green spirt) and brassicas (up to 20% in the premixed seeded cocktails).

Brassicas and annual ryegrasses are usually high in forage CP and are highly digestible as well. However, caution may need to be taken when feeding brassicas. Introduce stock slowly to the brassica crop and never with an empty rumen to minimize problems. All cocktails seemed to fare better in terms of forage CP than the 4 monocrop cereals tested (barley, wheat, oats and triticale).

Protein is a building block. The beef cow's protein requirements change throughout the year. The requirement for protein is dependent upon the age of the cow, stage of production, and level of production. Protein requirements are additive during any point in the cow's production cycle. The general beef cow rule of thumb with protein is 7-9-11, which means an average mature beef cow requires a ration with crude protein of 7 per cent in mid pregnancy, 9 per cent in late pregnancy and 11 per cent after calving.

Lactation is the most stressful time in the cow's production cycle. Milk contains a large concentration of protein. The source of the protein in milk comes either from dietary sources or mobilization of body lean tissue. Mobilization of lean tissue decreases the overall body condition score of the cow. Research indicates that maintenance of body condition score from calving to rebreeding is imperative to ensure acceptable conception rates. Therefore adequate protein from the diet is an important nutritional consideration.

All cocktails tested in this study were able to meet and in most cases, exceed the CP requirements of mature beef cattle. For the monocrop cereals, both soft white wheat and barley conveniently met the CP requirements of mature beef cattle than oats and barley. Both oats and barley slightly fell short of meeting the 11% CP needed by lactating beef cows.

Energy *(Table 2)*
Energy gives the ability to use the building blocks for growth and other productive purposes. Energy requirements are expressed in the tables in terms of total digestible nutrients (TDN) and net energy for maintenance (NE_M). Three of the cocktails (#5, 12 and 13) had >70% total digestible nutrients (TDN). Other cocktails had 61.6 - 68.7% TDN. Barley had higher TDN (69.4% TDN) than other monocrop cereals. The 3 other cereals had similar TDN. Most cocktails had higher TDN than monocrop soft white wheat, oats and triticale.

Cow energy requirements change throughout the year. The requirement for energy by the mature cow is a dynamic situation because the production cycle is not static. At no point in a yearly production cycle does a cow experience only maintenance energy requirements. The energy requirement for lactation is a function of milk yield, milk fat %, and milk protein %.

For TDN, the rule of thumb is 55-60-65. This rule says that for a mature beef cow to maintain her body condition score (BCS) through the winter, the ration must have a TDN energy reading of 55% in mid pregnancy, 60% in late pregnancy and 65% after calving. Nine of the cocktails conveniently met and in most cases exceeded the TDN requirements of mature beef cattle, while the remaining 5 cocktails fell slightly short of meeting the 65% TDN needed by lactating beef cows.

In terms of net energy requirements for maintenance (NE_M), all cocktails and the 4 monocrop cereals exceeded the 1.08-2.29 Mcal/kg NE_M for growing and finishing calves, 0.97-1.10 Mcal/kg NE_M for dry gestating cows and 1.19-1.28 Mcal/kg NE_M for lactating beef cows. Also, all cocktails and the 4 monocrop cereals were within 0.53-1.37 Mcal/kg net energy for gain (NE_G) requirements by growing and finishing beef calves.

Young beef cattle (growing and finishing calves) require 65-70% TDN. Nine of the cocktails tested here and CDC Austenson barley monocrop were either within or exceeded this range for young beef cattle.

Minerals *(Table 2)*
Most cocktails had higher forage Ca than monocrop cereals. All cocktails and the 4 monocrop cereals had enough forage Ca for a dry gestating beef cow, but only 6 cocktails had the required Ca (0.58% Ca) for a lactating beef cow. The other cocktails and the 4 monocrop cereals all fell short of meeting the Ca requirements of a lactating beef cow.

Table 2. Forage DM yield and quality (DM basis) of 14 cocktail mixtures and 4 monocrop cereals (oats, barley, triticale and soft white wheat) tested in Fairview in 2017. *NS - not significant; *- significant at P<0.05; CV- coefficient of variation*

Parameters	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	Soft white wheat	CDC Haymaker	CDC Auestenson	Bunker Triticale	*Mean*	*Significance*	*$LSD_{0.05}$*	*CV %*
Moisture, %	70.0	69.4	72.4	76.8	62.6	66.9	64.6	65.2	75.2	100	68.8	88.7	87.7	70.7	68.8	67.6	66.8	60.3	*72.4*	*	*4.24*	*3.53*
DM Yield, lb/acre	7203	7067	7664	5141	8644	7583	6792	6639	5648	6887	7035	3944	2941	6227	8925	7574	8015	8633	*6831*	*	*1738*	*16.5*
CP, %	13.6	15.0	11.5	15.2	12.2	12.0	11.8	12.5	16.0	19.8	11.1	23.9	22.7	13.3	11.1	10.0	11.0	10.5	*13.9*	*	*2.84*	*9.72*
Soluble protein, %	61.8	58.1	61.6	57.7	54.9	49.8	50.3	54.5	56.3	51.9	67.4	68.2	53.6	65.7	53.9	63.8	50.6	63.2	*57.9*	*	*7.49*	*6.15*
ADF-CP, %	0.73	0.78	0.63	0.63	0.57	0.83	0.68	0.78	1.22	1.37	0.66	0.57	0.80	0.72	0.86	0.78	1.17	1.06	*0.84*	*	*0.35*	*19.7*
NDF-CP, %	1.97	2.48	2.24	2.50	2.62	3.11	2.61	2.37	2.03	4.93	2.11	1.33	2.50	3.79	3.02	1.96	1.44	2.35	*2.49*	*	*1.59*	*30.5*
UIP, %	19.1	20.9	19.1	21.1	22.5	25.0	24.8	22.7	21.8	24.0	16.2	15.8	23.1	17.1	23.0	18.0	24.5	18.3	*21.0*	*	*3.71*	*8.41*
ADF, %	31.4	26.1	33.1	25.8	22.7	29.4	26.5	26.7	32.6	28.6	35.0	20.4	21.7	31.8	33.6	34.3	25.0	33.8	*28.8*	*	*5.92*	*9.76*
NDF, %	49.6	40.2	54.6	44.6	41.5	49.9	45.5	43.8	38.4	36.1	58.5	24.2	31.6	52.7	53.8	57.3	47.8	55.9	*46.2*	*	*8.23*	*8.47*
TDN, %	64.4	68.5	63.1	68.7	71.1	65.9	68.2	68.0	63.4	66.6	61.6	73.0	71.9	64.0	62.6	62.1	69.4	62.5	*66.4*	*	*4.63*	*3.32*
NE_L, Mcal/kg	1.46	1.56	1.43	1.57	1.63	1.50	1.55	1.55	1.44	1.51	1.39	1.67	1.65	1.45	1.42	1.41	1.58	1.41	*1.51*	*	*0.11*	*3.57*
NE_G, Mcal/kg	0.86	0.98	0.82	0.99	1.06	0.90	0.97	0.96	0.83	0.92	0.78	1.11	1.07	0.85	0.80	0.79	1.00	0.80	*0.91*	*	*0.13*	*6.96*
NE_M, Mcal/kg	1.58	1.70	1.54	1.71	1.78	1.62	1.69	1.68	1.55	1.64	1.50	1.83	1.79	1.57	1.53	1.51	1.73	1.52	*1.63*	*	*0.13*	*3.89*
Ca, %	0.56	0.67	0.47	0.47	0.42	0.24	0.23	0.40	1.33	1.55	0.28	1.67	1.81	0.47	0.22	0.30	0.24	0.26	*10.2*	*	*1.03*	*3.07*
P, %	0.19	0.21	0.18	0.24	0.20	0.17	0.15	0.18	0.17	0.26	0.15	0.29	0.18	0.22	0.19	0.18	0.15	0.17	*0.19*	*	*0.07*	*17.5*
K, %	1.54	1.17	1.69	1.51	1.28	1.23	1.02	1.07	1.14	2.97	1.29	3.17	3.10	1.26	1.53	1.28	1.43	1.69	*1.63*	*	*0.96*	*28.1*
Mg, %	0.23	0.30	0.23	0.27	0.20	0.17	0.18	0.20	0.45	0.33	0.17	0.56	0.48	0.20	0.18	0.16	0.18	0.20	*0.25*	*	*0.09*	*17.8*
Na, %	0.29	0.12	0.39	0.42	0.08	0.19	0.19	0.09	0.19	0.27	0.56	1.39	0.66	0.16	0.01	0.29	0.12	0.19	*0.30*	*	*0.49*	*77.4*
S, %	0.21	0.21	0.26	0.30	0.16	0.18	0.18	0.17	0.11	0.39	0.18	1.05	0.42	0.16	0.17	0.16	0.18	0.18	*0.25*	*	*0.17*	*33.2*
Cu, ppm	5.15	7.34	4.71	6.26	6.44	6.59	5.57	5.70	7.19	5.62	4.70	4.94	4.96	5.49	5.43	4.25	5.29	4.32	*5.52*	*NS*	*2.21*	*19.1*
Fe, ppm	63.6	56.7	69.3	62.7	58.0	48.9	40.5	50.7	75.3	141	86.9	70.9	170	85.8	54.2	95.1	60.8	70.7	*75.2*	*	*24.8*	*15.7*
Zn, ppm	38.1	48.8	33.7	43.4	45.2	37.6	35.5	42.9	65.3	74.6	33.2	47.5	44.5	37.7	37.0	32.2	39.2	39.2	*42.9*	*	*10.8*	*12.0*
Mn, ppm	60	25.7	78.9	38.1	28.5	21.9	23.4	41.0	72.07	44.3	87.9	48.8	54.2	72.0	56.7	82.9	28.8	73.5	*55.4*	*NS*	*77.1*	*66.2*
NFC, %	25.2	33.2	22.3	28.5	32.0	26.5	31.0	32.0	33.9	32.5	18.8	40.2	34.7	22.4	23.4	21.1	29.6	22.0	*28.3*	*	*7.38*	*12.4*
RFV	120	158	108	144	159	122	140	144	153	172	98	280	213	114	108	100	138	104	*142*	*	*31.0*	*10.3*

Only 2 of the cocktails (#7 & 11) and CDC Austenson barley did not have the required 0.16% P needed by dry gestating beef cows. For the P requirements of lactating beef cows (0.26% P), only cocktails #10 and #12 had adequate forage P.

The requirements of K, S (except cocktail #9), Fe (except cocktails #6 and #7) and Zn were met by all cocktails and monocrop cereals tested.

Dry gestating beef cows require 0.06-0.08% Na and 0.10% Na during lactation. Except for cocktails #5 and #8 and soft white wheat, the Na requirements of mature beef cattle were met by cocktails and monocrop cereals tested.

None of the cocktails or monocrop cereals were able to meet the complete macro and trace minerals measured here, so a supplemental mineral program may still be required for mature beef cattle when some of the cocktails and any of the monocrop cereals are being used.

Conclusion

The forage DM yield was highest for AC Andrew soft white wheat (8925 lbs DM/acre), closely followed by Bunker triticale (8832 lbs DM/acre) and then cocktail #5 (8644 lbs DM/acre). Only one (cocktail #5) of the 14 cocktails had >8000 lbs DM/acre, while other cocktails had <8000 lbs DM/acre. Cocktails #4, 9, 12 and 13 had far less forage DM yield than the other cocktails as well as monocrop cereals. Visual observation just before forage harvest showed that the barley in cocktail #6 (with inoculated hairy vetch) seemed to grow slightly taller than barley in cocktail #7 (with non-inoculated hairy vetch) and had a yield advantage of 791 lbs DM/acre over cocktail #7, further confirming the need to inoculate legumes before seeding. All cocktails tested in this study were able to meet and in most cases, exceed the CP requirements of mature beef cattle. None of the cocktails or monocrop cereals were able to meet the complete macro and trace mineral requirements of mature beef cattle, so a supplemental mineral program may still be required when feeding beef cattle.

Some Notes on Tillage Radish

The tillage radish has been bred/developed to produce a large taproot and penetrate compacted soil layers in an effort to increase soil aeration and water infiltration, decrease compaction and provide increased rooting depth opportunities to successive crops. Although tillage radish may not penetrate and grow as deeply in some of our "gumbo" type soils as we might hope, they can serve another useful purpose that can be of great value to producers - nutrient retention. The large taproot that is developed by tillage radish can absorb and retain a significant amount of macro- and micronutrients that might otherwise be prone to leaching or other loss mechanisms. Think of the tillage radish taproot as a giant sponge that will absorb residual nutrients from the soil and hold them until termination in the fall. The other nice thing is that the nutrients which are absorbed by the taproot are readily available to the following crop as the taproot is mostly water and desiccates and decays, quickly releasing those nutrients for uptake and utilization by the following crop. However, care needs to be taken on the amount of tillage radish used in cocktails because of its competitive nature, which results from its deep tap root sucking up nutrients from the soil at the expense of nearby or surrounding crops.

Sources:

http://www.deltafarmpress.com/management/tillage-radish-cover-crop-tips-maximize-its-benefits

https://www.albertafarmexpress.ca/2015/09/25/tapping-into-nutrients-and-tackling-compaction-with-tillage-radishes/

Testing of Forage-Type Legumes for Inclusion in Cocktail Mixtures

By Akim Omokanye, PCBFA

Because of the interest in cocktail mixtures, there is a need to regularly test new annual crops as they are introduced to the Peace for their adaptation, potential for forage yield, and suitability for soil health improvement and inclusion in cocktail mixtures. Forage-type legumes for cocktail mixtures include those of cool and warm season types. Cool season legumes include peas, faba beans and hairy vetch and warm-season legumes include crops like cowpeas and soybeans. These crops produce N and provide ground cover for weed and erosion control, in addition to the many other benefits of growing cover crops. Legumes are generally lower in carbon and higher in nitrogen than grasses. This lower C:N ratio results in faster breakdown of legume residues. Therefore, the N and other nutrients contained in legume residues are usually released faster than from grasses. Mixtures of legume and grass cover crops combine the benefits of both, including biomass production, N scavenging and additions to the system, as well as weed and erosion control.

Objective

To identify forage-type legumes that can be recommended for inclusion in cocktail mixtures.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: oats for greenfeed in 2016, forage grasses from 2010-2015
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.6 and soil organic matter = 8.0%.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications.
- Treatments: 12 forage-type legume cover crops were tested:
    1. Hairy vetch @ 18 lbs/acre
    2. Chickling vetch @ 70 lbs/acre
    3. Wolly pod vetch@ 27 lbs/acre
    4. Fenugreek @ 27 lbs/acre
    5. 40-10 Peas @ 8.8 seeds/ft^2
    6. Horizon peas @ 8.8 seeds/ft^2
    7. Meadow peas @ 8.8 seeds/ft^2
    8. CDC Leroy @ 8.8 seeds/ft^2
    9. Tabasco Fababean @ 5.2 seeds/ft^2
    10. Fabelle Fababean @ 5.2 seeds/ft^2
    11. Snowbird Fababean @ 5.2 seeds/ft^2
    12. Iron & Clay Cowpeas @ 100 lbs/acre

Hairy vetch

- Seeding date was June 1.
- Seeding Date & Rate: Seeding was done on June 1 and seed was inoculated.
- Seeding method: 6-row Fabro plot drill with 9” row spacing
- Fertility (actual lbs/acre): 50 lbs/acre of 11-52-0.
- Plot size: 11.04 m^2 (118.8 ft^2)
- Sprayings: Pre-emergent with Roundup Weathermax
  In-crop spraying was done with Basagran Forte once

The crops were harvested from August 12-22, corresponding to 76-82 days after seeding. Forage samples were analyzed for quality.

Notes were taken on soil cover, flowering and pod maturation, and lodging in peas. The legumes were assessed for their N fixation potential by digging the roots out of the soil and looking at their nodules.

Results and Interpretation

Forage Dry Matter (DM) Yield (Table 1)

The forage DM yield was highest for CDC Horizon peas (8660 lbs DM/acre). All peas had similar forage DM yield. The peas had more forage DM than other legumes tested.

Of the 3 vetches tested, woolly pod vetch produced a higher forage DM yield than chickling and hairy vetches. Woolly pod vetch had 1543-1648 lbs DM/acre more forage yield than chickling and hairy vetches. Our observation over 4 years has shown that hairy vetch does have an initial slow growth or establishment here in the Peace, but once established it grows vigorously and has excellent soil cover particularly into late summer. Once established, hairy vetch provides enough cover to suppress weeds and protect soil, and it does provides a longer window of protection than other cover crops. It is important to note that hairy vetch does have the potential to yield higher forage DM than what was obtained this year.

The 3 faba bean varieties produced similar forage DM yield. Iron & Clay cowpea (a warm season legume) and Fenu Greek produced far lower forage DM yield than other legumes.

With the exception of Iron & Clay cowpea, which did not have any nodules, all tested legumes produced nodules on their roots, indicating that the legumes could be fixing N. Reports elsewhere have shown that some of the legumes tested here, such as hairy vetch and faba beans, can add enough nitrogen to provide almost all of the needs of the subsequent crop. Reports have also indicated that hairy vetch can make K more accessible to subsequent crops. Other attributes of hairy vetch include overwintering ability and cold tolerance, as well as early spring growth in the second year following seeding.

Forage Quality (Table 1)

Crude Protein (CP): The forage legumes tested here had high forage CP, which was generally >17% CP. The forage CP was highest for Iron & Clay cowpea (26.3% CP). The 40-10 variety of forage-type peas had the highest forage CP among the 4 peas tested. The faba beans had similar forage CP.

All forage-type legumes tested here far exceeded the CP requirements of young and mature beef cattle.

Energy: The total digestible nutrients (TDN) varied from 60.1% TDN for chickling vetch to 74.7% TDN for fenugreek. The forage net energy for lactation (NE_L), net energy for gain (NE_G) and net energy for maintenance (NE_M) seemed to be higher for fenugreek than other legumes, though some legumes had very close values to that of fenugreek.

Table 1. Forage DM yield and quality (DM basis) of 12 forage-type legumes tested in Fairview in 2017. **- Significant at $P<0.05$; CV- coefficient of variation*

Parameters	Horizon Peas	40-10 peas	CDC Leroy	Meadow peas	Iron & Clay	Fenugreek	Woolly pod vetch	Chickling vetch	Hairy vetch	Fabelle fababean	Snowbird fababean	Tabasco fababean	*Mean*	*Significance*	*$LSD_{0.05}$*	*CV %*
Forage DM Yield, lb/acre	8660	8307	7842	7761	2409	1807	6110	4567	4462	5786	5635	5367	*5731*	*	*1007*	*10.3*
CP, %	18.1	24.8	19.0	19.1	26.3	23.3	23.0	17.1	25.5	21.9	22.2	22.7	*22.3*	*	*2.30*	*4.67*
Soluble protein, %	74.3	69.4	74.4	75.1	58.7	59.7	60.8	54.1	57.1	61.2	65.2	55.6	*63.3*	*	*3.58*	*2.57*
ADF-CP, %	1.57	1.51	0.23	0.29	0.78	0.57	2.27	0.85	1.55	1.50	0.82	2.16	*1.17*	*	*0.38*	*14.7*
NDF-CP, %	1.49	2.19	1.53	0.65	3.77	0.91	2.89	2.55	2.64	4.68	3.89	4.07	*2.75*	*	*0.53*	*8.74*
UIP, %	12.8	15.2	12.8	12.4	20.6	20.1	19.5	22.9	21.4	19.3	17.3	22.1	*18.3*	*	*1.79*	*4.44*
ADF, %	30.9	23.6	20.6	19.2	23.7	18.1	34.2	36.8	26.4	33.4	26.6	29.0	*26.5*	*	*5.68*	*9.72*
NDF, %	32.7	27.0	26.3	26.9	29.5	23.3	39.9	43.9	32.6	36.7	30.6	31.6	*31.5*	*	*3.50*	*5.04*
TDN, %	64.7	70.4	72.7	73.9	70.4	74.7	62.2	60.1	68.3	62.8	68.1	66.2	*68.2*	*	*4.42*	*2.94*
NE_L, Mcal/kg	1.47	1.61	1.67	1.70	1.61	1.72	1.41	1.35	1.56	1.43	1.55	1.51	*1.55*	*	*0.10*	*3.20*
NE_G, Mcal/kg	0.87	1.04	1.10	1.14	1.04	1.16	0.8	0.73	0.97	0.81	0.97	0.91	*0.97*	*	*0.12*	*5.98*
NE_M, Mcal/kg	1.59	1.76	1.82	1.86	1.76	1.88	1.52	1.46	1.69	1.54	1.69	1.64	*1.69*	*	*0.12*	*3.45*
Ca, %	1.07	1.13	0.73	0.77	2.41	1.43	1.46	0.98	0.94	0.85	0.85	1.02	*1.14*	*	*0.11*	*4.47*
P, %	0.24	0.36	0.38	0.23	0.32	0.29	0.30	0.27	0.40	0.35	0.24	0.32	*0.30*	*	*0.08*	*11.8*
K, %	1.60	1.64	1.55	1.17	2.40	2.02	2.96	2.24	4.82	2.65	1.91	1.90	*2.22*	*	*0.33*	*6.85*
Mg, %	0.50	0.44	0.42	0.39	1.12	0.51	0.52	0.47	0.39	0.50	0.45	0.56	*0.54*	*	*0.08*	*6.69*
Na, %	0.12	0.02	0.02	0.02	0.02	0.77	0.11	0.06	0.01	0.75	0.47	0.87	*0.27*	*	*0.01*	*2.44*
S, %	0.26	0.29	0.26	0.21	0.34	0.35	0.33	0.17	0.28	0.17	0.15	0.20	*0.25*	*	*0.05*	*10.7*
Cu, ppm	5.22	7.55	5.91	5.79	7.47	4.60	8.12	4.77	9.10	5.54	4.45	4.69	*6.09*	*	*1.14*	*8.53*
Fe, ppm	76.0	87.5	94.4	89.3	429	220	240	201	176	245	215	247	*181*	*	*65.6*	*16.4*
Zn, ppm	79.0	65.9	65.4	59.4	118	69.5	133	115	162	99.2	94.0	152	*99.7*	*	*30.6*	*13.9*
Mn, ppm	35.3	47.1	33.2	22.3	248	50.2	45.3	88.8	94.9	92.9	65.3	95.0	*74.2*	*	*13.8*	*8.48*
NFC, %	37.6	36.5	43.1	42.4	32.7	41.8	25.4	27.4	30.3	29.8	35.6	34.1	*34.5*	*	*1.25*	*1.64*
RFV	184	242	257	255	225	298	147	127	194	159	206	194	*210*	*	*23.1*	*4.99*

Only 3 (woolly pod vetch, chickling vetch and fabelle fababean) of the tested forage-type legumes did not have enough TDN for mature beef cattle. Woolly pod vetch, chickling vetch and fabelle fababean were only able to meet the TDN requirements of dry gestating beef cattle and not that of a lactating beef cow.

In terms of net energy requirements for maintenance (NE_M), all forage-type legumes tested here fell within the recommended 1.08-2.29 Mcal/kg NE_M for growing and finishing calves. All legumes exceeded the 0.97-1.10 Mcal/kg NE_M for dry gestating cows, and the 1.19-1.28 Mcal/kg NE_M for lactating beef cows.

Minerals: All the macro minerals (Ca, P, K, Mg, Na & S) and trace minerals (Cu, Fe, Zn & Mn) measured here were significantly affected by forage-type legume crops tested. Iron & Clay had the highest forage Ca, Mg, Fe and Mn. Hairy vetch had the most forage P, K, Cu and Zn. Tabasco faba bean had the highest forage Na content. Iron & Clay, fenugreek, and woolly pod vetch all had similar, high levels of forage S.

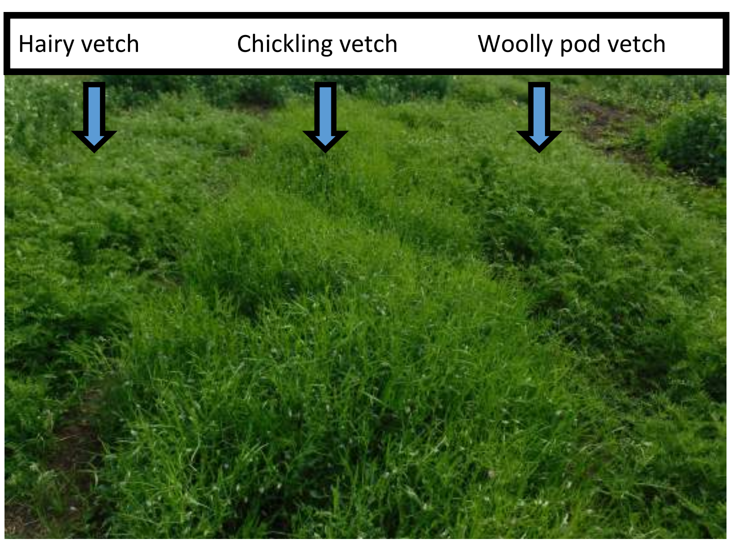
The mineral requirements of Ca, K, Mg, S, Fe and Zn were all met by all forage-type legumes tested here.

All forage-type legumes were able to meet the amount of P needed by a dry gestating beef cow, but only 3 (CDC Horizon peas, Meadow peas and snowbird fababean) fell short of meeting the P requirements of a lactating beef cow, which needs 0.26% P after calving.

A few of the legumes did not have enough forage Na and Mn for mature beef cattle. All legumes fell short of meeting the 10 ppm Cu needed by mature beef cattle.

Overall, fenugreek, chickling vetch, hairy vetch, woolly pod vetch, snowbird faba bean and tabasco faba bean were all able to meet most of the mineral requirements of mature beef cattle.

Estimated N Fertilizer Value (see Table 2 below)
When the forage-type legumes were assessed for their potential N fertilizer value based on their forage biomass and forage N content at harvest, all peas seemed to have higher N fertilizer value than other legumes. Please note that except for the peas, which were at an advanced stage of growth, other legumes (particularly Iron & Clay cowpea, hairy vetch and fenugreek) would have been able to produce more forage DM than what we obtained had they been harvested later. It is also important to note that Iron & Clay cowpea, hairy vetch and fenugreek were still actively growing (mostly vegetative stage) at harvest, so the estimated N fertilizer value reported here could still be higher if they were harvested later.



Should any of the forage materials from the legumes be used for green manure or rolled down, it is evident that at the time when the legumes were harvested here in this study, most legumes had enough N for a subsequent cereal crop production.

Conclusion

With the exception of Iron & Clay cowpea and Fenugreek, all the forage-type legumes tested here showed great potential for inclusion in cocktail mixtures for forage production for beef cattle. The vetches and the peas did provide very good to excellent soil cover. Iron & Clay cowpea and Fenugreek are not recommended for the area. Except for Iron & Clay cowpea, all legumes had nodules. Chickling and woolly pod vetches flowered earlier than hairy vetch and they both also produced mature pods, and therefore they have the potential to be grown for seed in Fairview and area.

Table 2. Estimated potential N fertilizer value of forage legume cover crops in 2017

Crop	Forage DM yield (lbs/acre)	Forage N Content (%)	N Yield (lbs/acre)	Estimated N Fertilizer Value (lbs/acre)*
Horizon Peas	8660	2.89	250	125
40-10 peas	8307	3.96	329	165
CDC Leroy	7842	3.04	238	119
Meadow peas	7761	3.05	237	118
Iron & Clay cowpea	2409	4.21	101	51
Fenugreek	1807	3.72	67	34
Woolly pod vetch	6110	3.67	224	112
Chickling vetch	4567	2.73	125	62
Hairy vetch	4462	4.07	182	91
Fabelle faba bean	5786	3.50	202	101
Snowbird faba bean	5635	3.55	200	100
Tabasco faba bean	5367	3.63	195	97
*Estimated based on 50 percent availability of legume N				

Forage-Type Brassica Crops for Inclusion in Cocktail Mixtures

By Akim Omokanye, PCBFA

Brassicas are a group of closely related plants, which include cabbage, cauliflower, kale, rape, radish, turnip, rutabaga and swede. Grazing of forage brassicas requires careful management. Brassica crops can cause health disorders in grazing animals if not managed properly. The main disorders are bloat, atypical pneumonia, nitrate poisoning, hemolytic anemia (mainly with kale), hypothyroidism, and polioencephalomalacia. Although there are many management factors to consider, forage brassicas do provide producers with a high yielding, quality forage option at a time when most cool season grasses are not available. Annual forage brassicas can provide livestock producers with fast-growing, high yielding, quality fall pasture.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Oats for greenfeed in 2016 and 2015.
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.6 and soil organic matter = 8.0 %.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications in small plots (118.8 ft^2)
- Brassica crops tested (treatments): 11 forage-type brassicas were seeded at recommended seeding rates as listed below:
    1. Kale @ 4lbs
    2. Bayou kale cross @ 4 lbs
    3. Winfred forage brassica @ 4lbs
    4. Dwarf Essex rape @ 4lbs
    5. Fodder radish @ 4lbs
    6. Tillage radish @ 6 lbs
    7. Daikon radish @ 13 lbs
    8. Hunter forage turnips @ 4lbs
    9. Graza forage turnips @ 4lbs
    10. Purple top turnips @ 3 lbs
    11. Barkant turnips @ 4lbs
- Seeding Date: Seeding was done on June 1
- Seeding method: 6-row Fabro plot drill with 9" row spacing
- Fertility (actual lbs/acre): 44 N + 100 P + 123K + 7 S
- Spraying: In-crop spraying with Lontreal 360
- Forage yield was determined on August 03 for tillage radish, fodder radish and daikon radish. For the remainder of the crops, harvest was done on August 21.

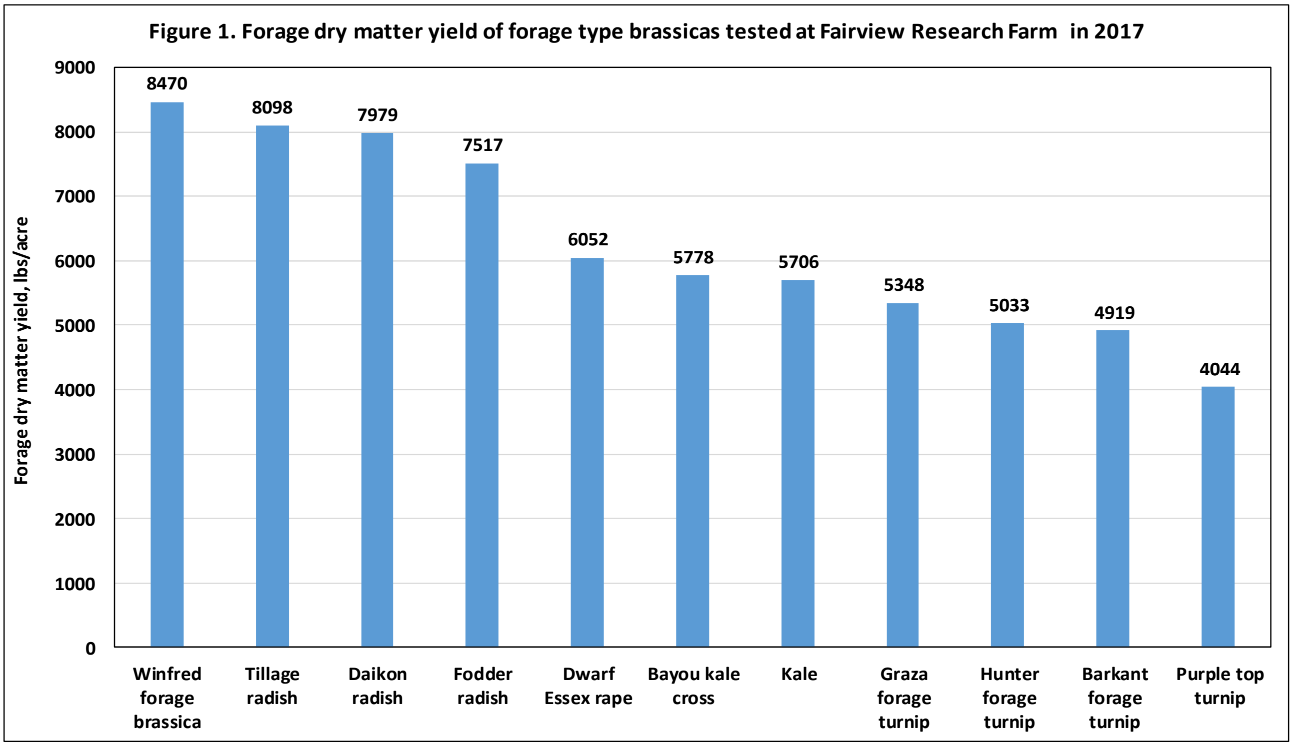
Results and Interpretation

Forage Dry Matter (DM) Yield (Figure 1)

Winfred forage brassica had the highest forage DM yield (8470 lbs/acre), followed by tillage radish (8098 lbs/acre), daikon radish (7979 lbs/acre) and then fodder radish (7517 lbs/acre) (Figure 1). The 3 radishes produced higher forage yields than the rape, kale and turnips.

Forage Crude Protein (CP) (Table 1)

The forage CP was highest for Hunter forage turnip (30.8% CP). The 4 turnip varieties had higher forage CP than other forage-type brassicas tested, while the radishes had lower forage CP than other brassicas. Generally, the forage CP from all brassicas was above the 11% CP requirements by mature beef cattle.



Energy (Table 1)

The forage total digestible nutrients (TDN) were generally above 60% TDN. With the exception of fodder radish and tillage radish, all brassicas met and far exceeded the TDN requirements of young and mature beef cattle.

Minerals (Table 1)

The forage macro and trace minerals were generally high for the brassicas.

All brassicas exceeded the Ca, K, Mg, Na, S, Fe (except daikon radish) and Zn requirements of young and mature beef cattle.

Only 4 forage-type brassicas (hunter forage turnip, dwarf Essex rape, graza forage turnip and daikon radish) had enough forage P for mature beef cattle.

Half of the brassicas tested did not meet the Mn requirements of mature beef cattle.

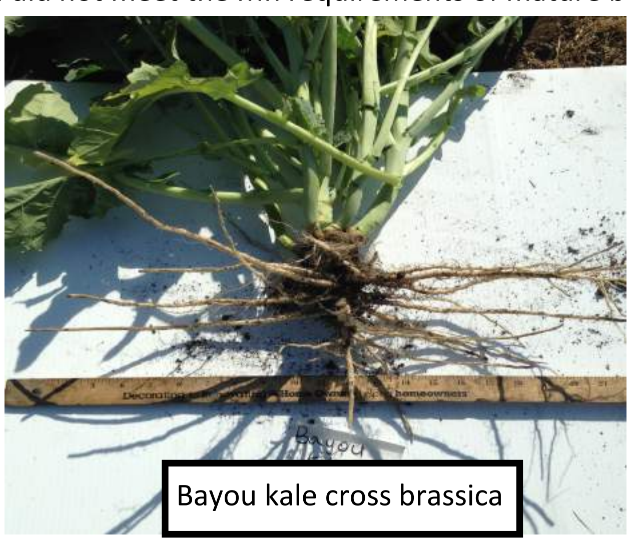


Table 1. Forage quality indicators of 11 forage brassica crops tested in Fairview in 2017.

	CP	ADF	NDF	TDN	NE_L	NE_G	NE_M	Ca	P	K	Mg	Na	S	Cu	Fe	Zn	Mn	NFC	RFV
Crop	%	%	%	%	——	Mcal/	Kg——	%	%	%	%	%	%	%	%	%	%	%	
Kale	23.7	13.2	17.6	78.6	1.81	1.27	1.99	2.47	0.24	2.59	0.68	0.83	1.15	2.76	132	36.0	29.1	47.2	416
Bayou kale cross	24.9	15.7	20.9	76.7	1.76	1.22	1.94	2.05	0.23	2.96	0.71	0.66	1.14	2.88	121	35.2	43.2	42.7	341
Winfred brassica	18.3	12.3	16.9	79.3	1.83	1.29	2.01	2.54	0.24	2.93	0.52	0.40	0.99	2.74	102	84.4	87.7	53.3	437
Dwarf Essex rape	28.3	11.1	14.8	80.3	1.85	1.32	2.04	1.47	0.28	3.23	0.60	0.53	1.28	3.55	55	42.3	35.1	45.4	503
Fodder radish	13.4	38.4	49.5	62.3	1.33	0.70	1.42	1.86	0.24	2.84	0.34	0.47	0.91	1.89	95	30.2	34.4	27.6	111
Tillage radish	14.3	32.0	42.9	64.4	1.45	0.85	1.57	0.70	0.22	1.82	0.55	1.13	1.37	2.18	163	31.8	22.6	32.3	139
Daikon radish	18.1	26.6	35.4	68.2	1.56	0.97	1.69	1.32	0.28	2.39	0.55	1.11	1.46	2.17	49	41.8	35.8	35.0	179
Purple top turnips	28.9	11.4	15.0	79.5	1.85	1.31	2.03	1.63	0.17	2.64	0.91	2.18	0.99	3.10	270	53.0	40.2	43.4	498
Graza forage turnip	26.5	16.1	21.7	76.4	1.76	1.21	1.93	3.20	0.31	2.52	1.10	3.40	1.41	4.76	336	58.6	68.2	40.3	327
Hunter forage turnip	30.8	14.0	19.6	78.0	1.80	1.25	1.98	1.59	0.43	4.27	0.53	0.88	1.00	5.8	172	56.5	34.2	38.1	370
Barkant forage turnip	28.0	12.1	16.2	80.2	1.83	1.30	2.02	3.52	0.23	2.86	0.72	1.11	1.09	4.33	174	61.2	52.0	44.4	458

Feeding Concerns of Brassicas

Brassica crops can cause health disorders in grazing animals if not managed properly. Livestock health problems from grazing brassicas are relatively rare, but elsewhere brassica crops have been associated with some animal health problems. Here are some excerpts from a publication (from https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/146730/forage-brassicas-quality-crops-for-livestock-production.pdf) on mono-crop brassicas or where large amounts of brassicas are included in cocktails:

The grazing of brassica crops for protracted periods can sometimes result in rumen stasis (rumen stops moving) and constipation. Affected stock will appear depressed and lack appetite.

Goitre (enlarged thyroid) - This is sometimes a problem in young lambs, where pregnant ewes have been grazing leafy brassica crops. Contact your veterinarian for advice on iodine supplements for lambs or supplements for the pregnant ewes.

Blindness - Occasional outbreaks of the condition that involves blindness, aimless wandering and unpredictable hyperexcitability are observed in cattle grazing brassica crops.

Kale Anaemia - This disorder (sometimes referred to as red water) can occur with all brassica crops, but is more common with kale crops. Anaemia is caused by excess levels of the amino acid compound S-methyl Cysteine Sulphoxide (SMCO) in the plant. SMCO causes a decrease in haemoglobin concentration and a depression of appetite. This condition tends to be worse when soil phosphorous is low and soil nitrogen and sulphur levels are high. Stock should be removed from the crop if they develop this disease.

Respiratory Problems - Grazing brassicas has sometimes been associated with cases of pulmonary oedema (fluid in lungs). Affected animals display respiratory distress.

Pulpy Kidney - Pulpy kidney is most common in young stock. Stock are most at risk when they have been on low quality feed for a period of time, and are then placed onto a highly digestible brassica crop. Vaccination is the best way to guard against this disease.

Researchers have discovered that these disorders can be avoided by adhering to two management rules:
Introduce grazing animals to brassica pastures slowly. Avoid abrupt changes from dry summer pastures to lush brassica pastures. Don't turn hungry animals that are not adapted to brassicas into a brassica pasture. Secondly brassica crops should not constitute more than 20-30% of beef cattle's diet.

Corn Intercropping Systems to Improve Corn Forage Quality

By Akim Omokanye, PCBFA

Corn is good for extending the grazing season. Corn would normally meet the energy requirements of mature beef cattle, but occasionally the protein content of corn may fall short of what is needed by cows at the late-pregnancy stage. For producers wanting to use corn silage for backgrounding calves, the 12-14% protein required by these calves can hardly be met by a sole corn crop. To improve corn forage protein, we tested tillage radish, peas, faba bean, soybean, hairy vetch, crimson clover and a cocktail mixture as companion crops with corn.

Objective

To assess the effectiveness of a variety of crops for corn intercropping systems in improving corn forage quality for young and mature beef cattle

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: Oats for greenfeed in 2016 and 2015
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.6 and organic matter = 8.0%.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications.
- Treatments: The following crops and cocktail mixture were seeded as companion crops with corn.
    1. Tillage radish
    2. Crimson clover
    3. Hairy vetch
    4. Soybean (variety TH 33003)
    5. Peas (CDC Horizon peas)
    6. Faba bean (variety Tabasco)
    7. Cocktail mixture containing:
        - Barley 48 lbs
        - CDC Horizon peas 8 lbs
        - Hairy vetch 4 lbs
        - Crimson clover 1 lb
        - Winfred forage brassica 1 lb
        - GreenSpirit annual ryegrass 1 lb
        - Sunflower 1 lb
    8. Monocrop corn (check)
- Seeding date was June 1 for both corn and the companion crops; Plot size: 11.04 m^2(118.8 ft^2)
- Seeding method: 6-row Fabro plot drill with 9" row spacing. Corn was seeded in rows 27 inches apart. The companion crops were seeded between 2 rows of corn. All companion crops were seeded at 50% of their recommended seeding rates. The cocktail mixture was seeded at 7 lbs/acre. Corn was seeded at 30,000 kernels per acre.
- Fertility (actual lbs/acre): We applied half of the recommended rates for corn following soil tests- 50 lbs N /acre + 14 lbs P /acre + 15 lbs K /acre + 10 lbs S /acre.
- Sprayings: Pre-emergent with Roundup Weathermax
  In-crop spraying was done with Basagran Forte on corn with crimson clover, soybeans, hairy vetch & peas.
- Measurements: Corn plant height measurements and harvesting of the crops (corn & companion crops) were done on September 05. Forage yield and quality were determined.

Results and Interpretation

Corn Plant (Table 1)

The monocrop corn had the highest corn height value (189 cm) followed closely by the corn plant from the corn/faba bean intercrop (184 cm). Overall, the order of corn height in the intercrops only was: faba bean > crimson clover >hairy vetch > cocktail mixture > soybean > peas > tillage radish.

The slower growth of corn in both peas and tillage radish intercrops could be due to the early vigorous growth of peas and tillage radish following seeding, compared to the rate at which the corn was growing earlier in the spring. As a warm season crop, corn requires higher soil temperatures for germination in spring and it grows well under high temperatures.

Forage Dry Matter (DM) Yield (Table 1)

For the corn intercrops, the corn forage DM yield value was highest for corn/crimson clover intercrop (9627 lbs/acre), followed by corn/faba bean intercrop (8763 lbs/acre) and then corn/hairy vetch intercrop (7264 lbs/acre). Only the corn/crimson clover and corn/faba bean intercrops appeared to produce slightly higher forage DM yield than the corn monocrop. The corn/crimson clover and corn/faba bean intercrops had forage yield advantages of 134% and 122%, respectively, over the monocrop corn.

Looking at the forage DM yield of the individual companion crop, hairy vetch had the highest forage DM yield (5107 lbs/acre) as a companion crop with corn. The forage DM yield of the other companion crops did not vary much.

The combinations of corn & crimson clover, corn & hairy vetch and corn & faba bean produced higher total forage DM yield (11698 - 12944 lbs DM/acre) than the combinations of corn & other companion crops (9140-9749 lbs DM/acre). All corn intercrops produced far higher forage DM yield than the monocrop corn. The total forage DM yield of intercrops as % of monocrop corn in order from highest to lowest was: corn/crimson clover (180%) > corn/hairy vetch (172%) > corn/faba bean (163%) > corn/soybean (136%) > corn/tillage radish & corn cocktail mixture (132%) > peas (127%).

Table 1. Corn plant height and forage DM yield of monocrop corn, companion crops and intercrops.
**- significant at P<0.05; CV- coefficient of variation*

Crop	Corn height (cm)	Forage DM yield			Forage DM yield of corn as % of monocrop corn	Forage DM yield of intercrops as % of monocrop corn
		Corn (lbs/acre)	Companion (lbs/acre)	Total (lbs/acre)		
Tillage radish	145	5670	3820	9490	79	132
Crimson clover	170	9627	3317	12944	134	180
Hairy vetch	166	7264	5107	12371	101	172
Soybean	159	6424	3325	9749	89	136
Peas	149	5283	3857	9140	73	127
Faba bean	184	8763	2935	11698	122	163
Cocktail mixture	162	6143	3351	9494	85	132
Corn mono crop	189	7193		7193	100	100
Mean	*166*	*7046*	*3673*	*10260*		
Significance	*	*	*			
$LSD_{0.05}$	*22.7*	*2764*	*1829*			
CV, %	*8.35*	*18.7*	*24.7*			

Forage Quality (Table 2)
Meeting the basic nutrient requirements of beef cows is a key component of meeting cow herd production and profitability goals for the beef cattle enterprise. Adequate nutrition is vital for adequate cow reproduction, cow and calf health, and growth of all classes of cattle. Nutrient requirements of cattle change throughout the year based upon stage of the production cycle, age, sex, breed, level of activity, pest load, and environment.

Forage Crude Protein (CP): The forage CP of the intercrops (corn + companion crops) was highest for the corn/hairy vetch intercrop (14.8% CP), followed closely by the corn/cocktail intercrop (14.2% CP). Generally, the forage CP for the intercrops and monocrop corn was >10% CP. Hairy vetch has an initial slow growth in this area, but growth quickens in later summer/early fall when it becomes very lush with excellent soil cover. The impressive growth of hairy vetch later in the season coupled with continual growth of corn before the killing frost was thought to be responsible for the higher forage CP (14.2-14.8% CP) of corn/hairy vetch and corn/cocktail mixture intercrops.

All intercrops tested had sufficient CP for mature beef cattle. For backgrounding and finishing calves, which require 12-14% CP, both corn/hairy vetch and corn/cocktail mixture appeared to be outstanding combinations for these categories of calves. On the other hand, monocrop corn and soybean/corn intercrop were only able to meet the 9% CP needed by a dry gestating beef cow.

Energy: Energy gives the ability to use the building blocks for growth and other productive purposes. The forage TDN of intercrops varied from about 63% TDN for corn/crimson clover and corn/peas intercrops to 67% TDN for both corn/hairy vetch and corn/soybean intercrops.

The beef cattle rule of thumb for TDN is 55-60-65. This rule says that for a mature beef cow to maintain her body condition score (BCS) through the winter, the ration must have a TDN energy reading of 55% in mid pregnancy, 60% in late pregnancy and 65% after calving. The TDN requirements of backgrounding and finishing calves is 65-70% TDN. Looking at Table 2 below, all intercrops and monocrop corn exceeded the TDN requirements of a dry gestating beef cow, but only corn/tillage radish, corn/hairy vetch and corn/soybean intercrops were able to meet the TDN requirements of lactating beef cows. The corn/tillage radish, corn/hairy vetch and corn/soybean intercrops were also within the 65-70% TDN needed by young calves.

Minerals: The forage macro and trace minerals measured here were higher for the following intercrops than other intercrops or corn monocrop:
Forage Ca: corn/peas and corn/cocktail mixture, each with 0.84% Ca
Forage P: corn/hairy vetch and corn/cocktail mixture, each with 0.18% P
Forage K: corn/hairy vetch (1.37% K)
Forage S: corn/tillage radish (0.40% S)
Forage Mg: corn/soybean (0.45% Mg)
Forage Na: corn/tillage radish (0.37% Na)
Forage Cu: corn/hairy vetch (6.18 ppm Cu)
Forage Zn: corn/hairy vetch (48.3 ppm Zn)
Forage Fe: corn/hairy vetch (216 ppm Fe)
Forage Mn: corn/hairy vetch (45 ppm Mn)

Generally, corn/hairy vetch intercrops seemed to fare better than other intercrops and monocrop corn for most of the minerals measured here. Surprisingly, monocrop corn had higher levels of some minerals than some of the intercrops.

Except for forage P and Cu, of the 7 intercrops and monocrop corn tested here, only corn/crimson clover and corn/cocktail mixture intercrops were able to meet most of the mineral requirements of young and mature beef cattle.

Table 2. Forage quality indicators of corn intercrop systems and corn monocrop.

**- significant; NS-significant at P<0.05; CV- coefficient of variation*

Crop	CP %	ADF %	NDF %	TDN %	NE_L Mcal/kg	NE_G Mcal/kg	NE_M Mcal/kg	Ca %	P %	K %	S %	Mg %	Na %	Cu ppm	Zn ppm	Fe ppm	Mn ppm	NFC %	RFV
Tillage radish	12.0	29.2	44.2	66.1	1.51	0.91	1.63	0.77	0.14	0.89	0.4	0.32	0.37	3.07	24.4	134	22.9	32.2	139
Crimson clover	11.4	33.8	56.1	62.5	1.42	0.81	1.53	0.67	0.17	0.94	0.16	0.42	0.14	5.18	35.9	167	42.9	20.9	104
Hairy vetch	14.8	27.7	42.2	67.3	1.54	0.95	1.67	0.58	0.18	1.37	0.22	0.42	0.02	6.18	48.3	216	45	31.4	148
Soybean	10.5	27.5	46.7	67.4	1.54	0.95	1.67	0.67	0.16	1.06	0.16	0.45	0.01	4.61	30.9	143	38.2	31.2	134
Peas	12.0	33.7	50.4	62.6	1.42	0.81	1.53	0.84	0.15	0.92	0.18	0.35	0.10	4.39	42	141	36.1	26.1	115
Faba bean	11.8	31.6	54.8	64.2	1.46	0.86	1.58	0.39	0.16	0.85	0.14	0.38	0.11	4.85	36.9	122	40.4	21.9	109
Cocktail mixture	14.2	32.2	45.5	63.8	1.45	0.84	1.57	0.84	0.18	1.32	0.37	0.42	0.20	4.41	31.9	103	42.1	33.4	131
Corn monocrop	10.2	31.9	56.5	64.0	1.45	0.85	1.57	0.50	0.13	0.88	0.13	0.38	0.07	4.29	26.6	92	32.4	19.7	105
Mean	12.4	30.9	49.6	64.7	1.47	0.87	1.59	0.66	0.16	1.03	0.21	0.39	0.13	4.62	34.6	140	37.5	27.1	123
Significance	*	NS	*	NS	NS	NS	NS	*	NS	NS	*	NS	*	NS	NS	NS	NS	*	*
LSD0.05	1.94	5.89	4.73	4.69	0.11	0.13	0.13	0.23	0.03	0.39	0.16	0.14	0.12	1.71	14.7	71.6	16.5	4.62	19.3
CV, %	6.75	7.79	3.9	2.96	3.32	6.56	3.47	14.6	10.2	15.6	30.6	14.7	40	15.1	17.3	20.9	17.9	6.97	6.42

Conclusion

The corn/crimson clover and corn/faba bean intercrops had forage yield advantages of 134% and 122% respectively, over monocrop corn. The combinations of corn & crimson clover, corn & hairy vetch and corn & faba bean produced higher total forage DM yield (11698 - 12944 lbs DM/acre) than the combinations of corn & other companion crops (9140-9749 lbs DM/acre). All intercrops tested had sufficient CP for mature beef cattle. For backgrounding and finishing calves, which require 12-14% CP, both corn/hairy vetch and corn/cocktail mixture appeared to be outstanding combinations for these categories of calves. On the other hand, corn monocrop and soybean/corn intercrop were only able to meet the 9% CP needed by a dry gestating beef cow. All intercrops and monocrop corn exceeded the TDN requirements of a dry gestating beef cow, but only corn/tillage radish, corn/hairy vetch and corn/soybean intercrops were able to meet the TDN requirements of lactating beef cows as well as those of growing and finishing calves that require 65-70% TDN.

Progress Report on Reducing Fertility Costs for Cereals

By Akim Omokanye, PCBFA

Proper nutrition is essential for crop growth and production. Nitrogen is the most common limiting nutrient for crop production systems. In Alberta, the recent direct input expense reports showed that fertilizer costs constitute up to 25% of the total variable costs in cereal production, and up to about 30% for canola. Fertilizer alone had the highest of any single input cost. High fertilizer costs and the price volatility of cattle and grains are causing producers to look for alternate ways to manage farming systems that will improve soil health without sacrificing yields. Options to cut production costs could possibly include use of cocktail cover crops (CCC) in cropping systems, and the use of foliar fertilizer to nurture the soil food web, stimulate the activity of soil micro-organisms and improve nutrient cycling. CCC mixtures can cut fertilizer costs by contributing N to the next crop, and by scavenging and mining soil nutrients. Inorganic fertilizer use contributes to a rise in atmospheric nitrous oxide (N_2O), a major greenhouse gas contributing to global climate change.

This year, PCBFA started a short-term rotation project that will examine the agronomic and economic benefits of including cocktail mixtures, legumes (hairy vetch, peas and crimson clover) and tillage radish in rotation with a cereal crop (barley or oats) for grain and silage production. The goal is to test the effectiveness of cereal-legume rotation systems or fertilizer based cereal crop production compared to inclusion of annual cover crop mixtures and tillage radish on soil health improvement, fertility savings & C-sequestration. Redmond salt, Penergetic K & P, and CHI Liquid Carbon 9-5-3 are being used as nutrient supplements.

The full report for this project will be available after the 2018 growing season. A continuous barley crop will be used as a check in both years (2017 & 2018). The barley crop treatments will be used to compare other systems in both an overall cost-benefit analysis, as well as soil health analysis.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: Oats for greenfeed in 2016 and 2015
- Site soil information(0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.6 and soil organic matter = 8.0%.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 4 replications.
- Treatments: Table 1 below shows the planned short rotation systems from 2017 to 2018.

Table 1. Crops & foliar fertilizer treatments for 2017 & 2018 growing seasons

Year 1 (2017)	Year 2 (2018)
Tillage radish	Barley
Hairy vetch	Barley
CDC Horizon peas (forage peas)	Barley
Cocktail mixture	Barley
All legume cocktail mixture	Barley
Crimson clover	Barley
Barley + Redmond salt	Barley + Redmond salt
Barley (Check): Zero fertility	Barley (Check)
Barley + Penergetic K & P	Barley + Penergetic K & P
Barley + Canada Humalite International (CHI) Inc.	Barley + CHI
Barley: 50% Fertility	Barley: 50% Fertility
Barley: 100% Fertility	Barley: 100% Fertility

Cocktail mixture seeded in 2017 consisted of:

- Annual Ryegrass - 2 lbs
- Proso millet- 2 lbs
- Barley- 20 lbs
- Peas- 20 lbs
- Purple top turnip- 1 lb
- Kale- 1 lb
- Crimson Clover- 1 lb

The legume cocktail mixture seed in 2017 consisted of:

- 25% Hairy vetch
- 25% Crimson clover
- 25% CDC Horizon peas
- 25% Faba beans

- ♦ Seeding Date: Seeding of the crops in Table 1 in 2017 was done on June 1
- ♦ Seeding method: 6-row Fabro plot drill with 9" row spacing
- ♦ Forage yield and forage quality were measured. All crops were harvested and removed from the plots.

Future Plan

Soil tests will be done in spring 2018 to determine nutrient credits from the treatments in 2017.

Barley will be seeded for grain and silage in 2018.

Cost-benefit analysis and soil health analysis will be carried out on emanating field data.

Purple top turnips

CDC Horizon peas

Crimson clover

Progress Report on Soil pH and Nutrient Improvement with Forage Brassicas and Buckwheat

By Akim Omokanye, PCBFA

Soil acidity is identified by the measurement of soil reaction (pH). The reaction is alkaline when the pH value is above 7.0; neutral at 7.0; and acidic below 7.0. In practical terms, soils between pH 6.5 and 7.5 are considered neutral. Soils in the range of 5.6 to 6.0 are moderately acidic and below 5.5 are strongly acidic. The distribution of acidic soils in Alberta according to Alberta Agriculture & Forestry (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex3684/$file/534-1.pdf?OpenElement), indicates that acidic soils occur most frequently in central Alberta and in the Peace River region. Recent data from PCBFA's on-farm studies seems to show the potential for pH in the sub-surface soil (6-24") to be slightly higher than in the surface soil. If this holds true, then we may be able to use some cover crops with deep rooting systems, and those with potential to scavenge nutrients (such as purple top turnip, tillage radish, daikon radish & barkant turnip) as options to improve surface soil pH, instead of liming.

Objectives

1. To examine the potential of a variety of annual cover crops for improving surface soil nutrients and pH
2. To determine forage dry matter and quality for beef cattle production

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: Oats for greenfeed in 2016 and 2015
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.6 and soil organic matter = 7.8%.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 4 replications.
- Treatments: 4 forage-type brassica crops and buckwheat were tested:
    1. Purple top turnip (brassica) @ 3 lbs
    2. Tillage radish (brassica) @ 6 lbs
    3. Daikon radish (brassica) @ 13 lbs
    5. Barkant turnip (brassica) @ 3 lbs
    6. Buckwheat @ 50 lbs
- Seeding Date & Rate: Seeding was done on June 1
- Seeding method: 6-row Fabro plot drill with 9" row spacing
- Fertility: No fertility was applied.
- Spraying: In-crop spraying was done once with Lontreal 360 (except for buckwheat)
- Forage yield & quality, and crop root nutrients were determined.

Results and Interpretation

Forage Dry Matter (DM) Yield

For the purpose of livestock production, the above ground forage DM yield of the crops tested was highest for tillage radish (7353 lbs DM/acre), followed closely by daikon radish (7128 lbs DM/acre) and then buckwheat (6037 lbs DM/acre). Generally, the 2 turnips had lower forage DM yield than radishes and buckwheat.

Forage Quality

Generally, both purple top turnips and barkant turnips had higher forage crude protein (CP), total digestible nutrients (TDN), net energy for lactation (NE_L), gain (NE_G) & maintenance (NE_M), Ca, K, Fe and RFV than other crops tested.

The requirements of CP, TDN, Ca, K, Mg, S and Zn by mature beef cattle were all met by all brassicas and buckwheat tested.

All crops had enough forage P for a dry gestating beef cow, but only buckwheat and daikon radish seemed to have sufficient forage P for a lactating beef cow.

Except for buckwheat, all crops tested had enough forage Na for young and mature beef cattle.

None of the crops had adequate forage Cu for young and mature beef cattle, which is 10ppm Cu.

Root Quality

The root CP was highest for purple top turnips (14.5% CP), followed by barkant turnips (12.8% CP).

Both purple top turnips and barkant turnips generally had higher root TDN, NE_L, NE_G, NE_M and P than other crops.

Buckwheat generally had far less root CP, TDN, NE_L, NE_G, NE_M, P, K, Na and S than other crops.

Future Plan

Soil tests will be done in spring 2018 to determine nutrient credits and soil pH changes from the treatments in 2017.

The same set of crops will be seeded again in the same plots in 2018.

Cost-benefit and soil health analysis will be carried out on emanating field data.

Table 1. Forage dry matter yield (DMY) and forage quality (on DM basis) of 4 brassica crops and buckwheat

Crop	DMY (lb/acre)	CP (%)	ADF (%)	NDF (%)	TDN (%)	NE_L	NE_G Mcal/kg	NE_M	Ca (%)	P (%)	K (%)	Mg (%)	Na (%)	S (%)	Cu (ug/g)	Fe (ug/g)	Zn (ug/g)	Mn (ug/g)	NFC (%)	RFV
Purple top turnip	3694	30.1	11.4	15.0	80.0	1.88	1.31	2.02	1.62	0.19	2.62	0.91	2.19	1.00	3.10	270	53	40	43	498
Tillage radish	7353	13.3	32.0	42.9	64.0	1.45	0.85	1.57	0.70	0.22	1.82	0.55	1.13	1.37	2.18	163	32	23	32	139
Buckwheat	6037	17.9	27.3	35.5	67.7	1.52	0.98	1.69	1.29	0.28	2.50	1.60	0.01	0.22	4.78	109	50	165	35	177
Daikon radish	7128	18.1	26.6	35.4	68.2	1.56	0.97	1.69	1.32	0.28	2.39	0.55	1.11	1.46	2.17	49	42	36	35	179
Barkant turnip	3431	28.0	12.0	16.1	79.2	1.92	1.15	2.01	3.76	0.22	2.93	0.86	1.06	1.05	4.17	174	61	52	44	458

Table 2. Nutrients in roots (on DM basis) of 4 brassica crops and buckwheat

Crop	CP (%)	ADF (%)	NDF (%)	TDN (%)	NE_L	NE_G Mcal/kg	NE_M	Ca (%)	P (%)	K (%)	Mg (%)	Na (%)	S (%)	Cu (ug/g)	Fe (ug/g)	Zn (ug/g)	Mn (ug/g)	NFC (%)	RFV
Buckwheat	3.61	59.4	72.0	42.6	0.93	0.23	0.95	0.42	0.07	0.62	0.33	0.03	0.08	9.70	5266	37.5	168	12.9	55
Tillage radish	9.05	29.4	32.1	66.0	1.50	0.91	1.63	0.48	0.13	2.08	0.19	0.88	0.85	2.42	279	39.8	22	47.4	191
Daikon radish	11.5	35.7	43.0	61.1	1.38	0.76	1.48	0.54	0.21	2.86	0.25	0.96	0.75	2.11	168	24.9	14	34.0	132
Purple top turnip	14.5	10.6	13.3	80.7	1.86	1.33	2.05	0.34	0.19	1.82	0.14	1.46	0.64	2.68	67	28.8	11	60.7	564
Barkant turnip	12.8	9.93	12.2	81.2	1.87	1.35	2.07	0.27	0.30	2.18	0.13	0.83	0.48	2.68	43	28.9	10	63.6	621

Demonstration of Sunflower, Phacelia and Sugar Beet for Forage Quality

By *Akim Omokanye, PCBFA*

Many annual crops are suitable for inclusion in cocktail mixtures for forage production (grazing, silage or greenfeed) and to improve soil health. Some of the broadleaf cover crops are still relatively new to us in the Peace, and questions have been asked about the forage quality of some of these broadleaf crops in order to determine their suitability for livestock production. This year, we seeded sunflower, phacelia and sugar beet for demonstration purposes and to determine what the forage quality of these crops would be in this area. The crops were seeded at the recommended seeding rates in small plots replicated twice.

Results

Forage Crude Protein (CP)

The 3 broadleaf crops had impressive forage CP, with sunflower having the highest value (19.8% CP). Both phacelia and sugar beet had similar forage CP (about 18% CP). With these forage CP values, the 3 crops had far more protein than is required by both young and mature beef cattle.

Forage Detergent Fibres

The forage ADF and NDF were both lower for sugar beet forage than sunflower and phacelia. For both ADF and NDF, lower values are preferred for livestock production. The ADF values are important because they relate to the ability of an animal to digest the forage. As ADF increases, digestibility of forage usually decreases. The NDF values are important in ration formulation because they reflect the amount of forage the animal can consume. As NDF percentage increases, forage DM intake will generally decrease. Comparing the 3 broadleaf crops, the lower ADF and NDF values for sugar beet would suggest that when all the broadleaves are presented side by side to cows in a preference study, sunflower and phacelia would likely be less preferred and consumed less than sugar beet.

Generally, NFC is more rapidly digested than fibre. It is a significant source of energy for the rumen microbes. The microbes also use NFC to make microbial protein. From the 3 broadleaves tested, sugar beet also had higher NFC than sunflower and phacelia.

Minerals

Phacelia had the highest forage Ca. Sunflower had the highest forage P and Cu. Sugar beet had higher forage K, Mg, S, Fe, Zn and Mn.

It is very important to note that the Ca requirements of both young and mature beef cattle were far exceeded by the 3 broadleaves tested, indicating that including any of these crops in a cocktail mixture would probably help improve forage Ca of the cocktail. Only sugar beet fell short of meeting the P requirements of young and mature beef cattle. Both sunflower and phacelia had more than what calves and mature beef cattle need for P.

The requirements of K, Mg, S, Fe, Zn and Mn have all been met by the 3 broadleaves.

Sunflower and phacelia did not have enough Na for mature beef cattle, while sugar beet far exceeded the Na needed by mature beef cattle.

The Cu requirement of young and mature beef cattle is 10 ppm. Looking at the 3 broadleaves, only sunflower was able to meet the required amount of Cu. Both phacelia and sugar beet did not have enough Cu for beef cattle.

Energy

Energy is probably the most important nutritional consideration in beef cattle production. The forage energy (%TDN) was generally >60% TDN for all broadleaves tested. Sugar beet had the highest forage TDN (80% TDN), followed by sunflower (77% TDN) and then phacelia (61% TDN). All broadleaves tested here were therefore able to meet the TDN requirements of a gestating cow. For a lactating cow, which requires 65% TDN, all broadleaves (except for phacelia), met the requirement.

Other forms of energy measured (NE_L, NE_M & NE_G) all appeared to be higher for sugar beet than sunflower and phacelia. A range of 0.97-1.10 Mcal kg^{-1} NE_M (net energy for maintenance) has been recommended for a dry gestating beef cow and a range of 1.19-1.28 Mcal kg^{-1} for a lactating beef cow. The NE_M is an estimate of the energy value of a feed used to keep an animal in energy equilibrium, i.e., neither gaining nor losing weight. Generally, the 3 broadleaves tested here exceeded the NE_M requirements of mature beef cattle during pregnancy and even after calving.

Table 1. Forage quality of sunflower, phacelia and sugar beet

Quality Indicator	Unit	Sunflower	Phacelia	Sugar beet	Sugar beet roots
Moisture	%	83.7	81.7	86.1	78.4
Crude Protein	%	19.8	18.3	18.4	6.2
ADF	%	14.9	35.3	12.1	7
NDF	%	21.3	36.1	18.8	9.5
TDN	%	77.3	61.4	79.5	83.5
NE_L	Mcal/kg	1.78	1.39	1.83	1.93
NE_G	Mcal/kg	1.23	0.77	1.3	1.41
NE_M	Mcal/kg	1.96	1.49	2.02	2.14
Ca	%	2.13	3.42	1.22	0.1
P	%	0.29	0.3	0.14	0.11
K	%	2.44	2.61	4.76	1.39
Mg	%	1.52	0.56	1.57	0.16
Na	%	0.02	0.02	3.26	0.23
S	%	0.45	0.35	0.58	0.08
Cu	ppm	10.6	5.13	4.7	4.6
Fe	ppm	113	256	280	32
Zn	ppm	92	49	179	19
Mn	ppm	296	106	487	39
NFC	%	47.4	34.2	51.3	72.9
RFV		338	158	394	821

Conclusion

From the forage CP, energy and minerals measured here for the 3 broad leaves, one can say that the nutrient requirements of both young and mature beef cattle have been met by these 3 broadleaves (except for sugar beet for P, and both phacelia and sugar beet for Cu). It therefore shows that including any of the 3 broadleaves tested in cocktail mixtures should help improve the forage quality of the cocktails for beef cattle. It is however important to note that both sunflower and phacelia seem to have better growth in the area than sugar beet.

Soybean Varieties for Forage Production

By *Akim Omokanye, PCBFA*

Soybeans are a warm season annual legume that is grown mainly for the oil and protein value of their seed. Forage soybeans may be an option to consider. Forage soybeans are high in protein and highly palatable, and can be harvested for hay or silage. Seed varieties of soybeans can be used as forage. Harvesting soybeans for silage is preferred over baling as dry hay, because more dry matter is retained during harvest and storage. Soybeans may also be included in cocktail mixtures (with appropriate varieties). Agronomically, soybeans have the advantage of fixing nitrogen when properly inoculated, and do not require a lot of specialized equipment to grow. Crop species and variety choice for silage or greenfeed is one of the most important decisions any beef cattle producer makes.

Objective

To test and select soybean varieties for forage yield and quality for livestock production.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: Oats for greenfeed in 2016 and 2015.
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.6 and soil organic matter = 8.0 %.
- Experimental Design: Randomized complete block design in 3 replications in small plots (118.8 ft^2)
- Nine Roundup Ready soybean varieties (see Table 1 below) were seeded on June 1, 2017 with a 6-row Fabro plot drill at 9" row spacing. Inoculated soybean seeds were used.
- The field was cultivated (disked and harrowed) before seeding soybeans.
- Fertility was 50 lbs/acre of 11-52-0.
- Seeding rate was 222,672 seeds/acre (5.1 seeds/ft^2).
- Roundup was used for in-crop weed control twice.
- Harvest for forage yield estimation and feed quality testing was done on September 11.

Results & Interpretation

Forage DM Yield

The forage DM yield was highest for Reson RR2Y2 with 7138 lbs/acre. Generally, all the soybeans tested had >5000 lbs/acre (2.5 tons DM/acre). The forage DM yields obtained for soybeans tested were generally lower than the forage DM yields obtained for the 4 forage-type peas tested this year (see report on forage type-legumes in this Annual Report). The soybean varieties tested here yielded 623-3602 lbs DM/acre less than the forage-type peas tested this year.

Forage Quality

The forage Crude Protein (CP) content varied from about 12% CP for Akris R2 to 16.8% CP for TH 35002. The forage CP met and in most cases far exceeded the protein requirements of growing and finishing calves (12-14% CP) as well as mature beef cattle (11%).

The forage Ca content was generally high for all soybean varieties tested and in all cases, the Ca requirements of young and mature beef cattle were exceeded.

Table 1. Forage dry matter (DM) yield & quality (DM basis) of 9 soybean varieties tested in Fairview in 2017

Quality Indicators	Units	Watson RR2Y	Starcity RR2X	Belmont RR2X	Reson RR2Y	Leroy RR2Y	Currie R2	TH 33003	TH 35002	Akris R2
Moisture	%	70.3	73.3	73.1	70.1	72.2	74.0	71.9	72.4	73.0
Forage DM yield	lbs/acre	6625	6074	6296	7138	5561	5058	6416	6177	6802
Crude Protein	%	13.4	15.4	16.2	13.4	13.4	15.0	16.2	16.8	11.9
Soluble Crude Protein (CP)	% of CP	66.3	58.0	64.0	64.2	60.4	56.0	57.6	56.9	58.2
ADF-CP	%	0.61	0.68	0.75	0.88	0.56	0.64	0.57	0.64	0.64
NDF-CP	%	0.81	1.06	1.28	0.98	1.15	1.38	0.97	1.24	1.41
UIP (Bypass Protein)	Est % CP	16.8	21.0	18.0	17.9	19.8	22.0	21.2	21.6	20.9
Acid Detergent Fibre	%	25.6	29.7	27.2	29.6	27.2	27.1	28.1	23.7	31.9
Neutral Detergent Fibre	%	33.9	37.2	34.7	38.9	35.4	33.4	37.0	29.7	40.1
Total Digestible Nutrients	%	68.9	65.7	67.7	65.8	67.7	67.8	67.0	70.4	64.1
Net energy for lactation (NE_L)	MCal/Kg	1.57	1.50	1.54	1.50	1.54	1.55	1.53	1.61	1.45
Net energy for gain (NE_G)	MCal/Kg	0.99	0.90	0.96	0.90	0.95	0.96	0.94	1.04	0.85
Net energy for maintenance (NE_M)	MCal/Kg	1.71	1.62	1.68	1.62	1.68	1.68	1.66	1.76	1.57
Calcium	%	0.96	1.42	1.59	1.23	1.25	1.73	1.50	1.88	1.15
Phosphorus	%	0.20	0.28	0.28	0.21	0.24	0.25	0.22	0.22	0.17
Potassium	%	1.32	1.68	1.73	1.46	1.43	1.59	1.96	1.62	1.32
Sulphur	%	0.14	0.17	0.19	0.17	0.14	0.17	0.16	0.18	0.14
Magnesium	%	0.48	0.74	0.65	0.57	0.72	0.68	0.56	0.62	0.59
Sodium	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Zinc	ppm	34.3	43.9	57.0	42.6	38.8	65.9	49.1	70.5	46.1
Iron	ppm	117	167	191	129	117	173	140	196	146
Manganese	ppm	33.2	50.7	68.2	50.0	43.3	81.7	77.9	96.9	56.6
Copper	ppm	3.45	4.12	3.78	3.75	4.07	4.70	2.66	3.57	3.69
NFC	%	41.2	35.9	37.7	36.2	39.7	40.1	35.4	42.0	36.5
Relative Feed Value		189	164	182	158	178	189	169	220	149

Forage P varied from 0.17% P for Akris R2 to 0.28% P for both Starcity RR2X and Belmont RR2X. All varieties had enough P for a dry gestating beef cow, but only Starcity RR2X and Belmont RR2X were able to meet the P requirement of a lactating beef cow.

The S (except for Watson RR2Y and Leroy RR2Y), K, Mg, Zn, Mn (except Watson RR2Y) and Fe requirements of mature beef cattle were all met by the soybean varieties tested.

None of the varieties had adequate forage Cu or Na for mature beef cattle.

Forage energy content (total digestible nutrients, TDN) was mostly >65% for soybean varieties tested. All varieties conveniently met the TDN requirements of mature beef cattle, except for Akris R2, which just barely met this requirement.

Conclusion

Soybeans can be harvested as a hay or silage crop. The forage yield potential of soybeans can be as high as 3.6 tons DM per acre with the right variety for the area. Soybeans also appear to have high forage quality.

Demonstration of Annual Forage-Type Cover Crops and Perennial Forages

By *Akim Omokanye, PCBFA*

Collaborator: Performance Seed

In collaboration with Performance Seed (Lethbridge), 4 perennial mixes, 3 alfalfas, 3 grasses, 2 annual clovers, 2 forage-type brassicas, 2 annual ryegrasses and an annual cocktail cover crop mixture were seeded for demonstration purposes at the Fairview Research Farm. This was to see how these annuals and perennials perform in the area.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- 2-3 plots were seeded for each variety in small plots (118.8 ft^2)
- Seeding was done on May 31 - June 1, 2017 with a 6-row Fabro plot drill at 9" row spacing.
- Fertility was 50 lbs/acre of 11-52-0 for alfalfa and clovers. Annual ryegrasses received (lbs/acre) 89 N + 50 P + 29 K + 24 S.
- Spraying: In-crop spraying – 2,4-D-700 for annual ryegrasses, Lontrel 360 for brassicas, Basagran Forte for alfalfas, and Curtail M for perennial grasses. The mixtures were not sprayed.
- Seeding rates are shown in Table 1 below.

Table 1. Crop & forage varieties, seeding rates and notes on germination, flowering, height and soil cover

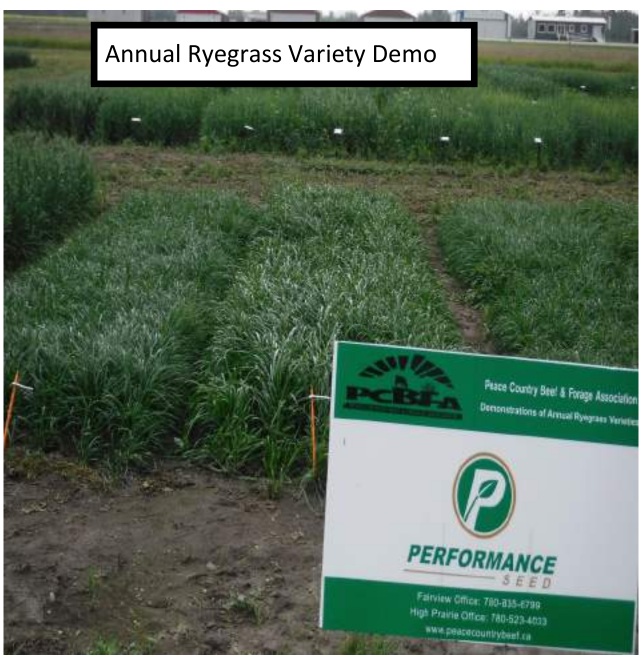
Crop/Forage Variety	Seeding rate (lbs/acre)	Germination	Flowering Flowering date (50% bloom)	Stand height (cm)	Soil cover (%)
Perennial Mixes					
VersaMax	15	Scanty	Some flowers in late August	50.0	<50
Performa HQ	15	Scanty	Some flowers in late August	46.7	<50
LeguMax	15	Scanty	Some flowers in late August	52.5	<50
Pollinator Mix	15	Very Good	50% flowers by July 10 Radish & phacelia flowered early Crimson & hairy vetch flowered later	76.3	100
Alfalfa					
Compass	6.25	Fair	50% flowers by August 11th	56.1	50
Fusion (coated)	6.25	Fair	50% flowers by August 11th	56.5	50
Megan	6.25	Fair	50% flowers by August 11th	57.0	50
Perennial Grasses					
Cowgirl Tall Fescue	7.13	Good	-	47.0	60
HQL Orchard Grass	8.03	Very Good	-	36.3	75
York Smooth Brome Grass	7.13	Fair	-	55.0	50
Clovers					
Frosty – annual clover	7.84	Very Good	-	63.7	85
Fixation – annual clover	7.84	Poor	50% flowers by July 31th	25.6	<50
Brassicas					
Impact	4	Good	-	43.0	90
Premiere	4	Fair	-	39.0	75
Annual rye					
Meroa	10	Very Good	50% flowers by August 16th	65.4	100
Spring Green	10	Very Good	-	54.7	100
Annual mix					
Performa Annual	15	Very Good	-	57.0	100

Table 2. Summary field notes on tested crops and forages

Crop/Forage Variety	Field notes/observations
Perennial Mixes	
VersaMax	
Performa HQ	
LeguMax	
Pollinator Mix	Very impressive growth, good soil cover and attracted a lot of bees
Alfalfa	
Compass	
Fusion (coated)	
Megan	
Perennial Grasses	
Cowgirl Tall Fescue	
HQL Orchard Grass	
York Smooth Brome Grass	
Clovers	
Frosty	Very impressive growth, recommended for the area. Plant structure is very similar to that of alfalfa.
Fixation	Has some potential, but needs further testing in the area
Brassicas	
Impact	Very impressive growth, excellent soil cover, recommended for the area
Premiere	Very impressive growth, excellent soil cover, recommended for the area
Annual rye	
Meroa	Very impressive growth, excellent soil cover, recommended for the area
Spring Green	Very impressive growth, excellent soil cover, recommended for the area
Annual mix	
Performa Annual	Very impressive growth, excellent soil cover, recommended for the area

Table 3. Forage DM yield and quality of annual crops seeded

Quality Indicator	Unit	Annual rye		Brassicas		Annual clovers		Annual mix
		Spring Green	Meroa	Impact	Premiere	Frosty	Fixation	Performa Annual
Moisture	%	81.1	77.5	80.7	82.6	78.9	80.0	86.4
Forage DM yield	lbs/acre	4872	4636	9913	4237	4892	2305	3897
Crude Protein	%	27.7	21.0	29.8	25.0	15.2	14.9	22.6
Soluble Crude Protein	% of CP	64.4	56.5	69.5	69.0	32.9	52.6	67.6
ADF-CP	%	1.46	1.68	0.15	0.45	0.84	0.18	0.61
NDF-CP	%	5.38	5.78	0.15	0.39	7.41	2.19	1.28
UIP (Bypass Protein)	Est % CP	17.8	21.8	15.3	15.5	33.6	23.7	16.2
Acid Detergent Fibre	%	25.3	25.8	10.2	10.0	26.1	21.0	12.5
Neutral Detergent Fibre	%	43.4	44.8	14.5	14.2	37.0	25.4	16.9
Total Digestible Nutrients	%	69.2	68.8	81.0	81.1	68.6	72.5	79.1
NE Lactation	MCal/Kg	1.58	1.57	1.87	1.87	1.57	1.66	1.82
NE Gain	MCal/Kg	1.00	0.99	1.34	1.34	0.98	1.10	1.29
NE Maintenance	MCal/Kg	1.72	1.71	2.06	2.07	1.70	1.82	2.01
Calcium	%	0.65	0.49	0.52	0.99	1.74	1.22	1.61
Copper	ug/g	7.62	6.95	4.52	4.17	6.16	3.15	5.21
Phosphorus	%	0.27	0.21	0.38	0.26	0.21	0.12	0.29
Potassium	%	3.68	3.30	2.18	3.13	1.12	0.73	3.33
Sulphur	%	0.35	0.28	1.19	1.49	0.20	0.14	1.26
Magnesium	%	0.47	0.36	0.46	0.81	0.38	0.31	0.64
Zinc	ppm	68.3	52.4	40.5	39.2	63.9	38.1	42.1
Iron	ppm	141.2	184.5	86.0	103.7	132.9	261.9	84.9
Manganese	ppm	73.4	64.8	40.9	44.0	59.2	44.1	73.5
Sodium	%	0.91	0.89	0.61	0.78	0.94	0.17	1.20
NFC	%	17.4	22.7	44.3	49.3	36.3	48.3	49.0
Relative Feed Value		148	143	520	530	172	266	436



Annual Ryegrass Variety Demo


Frosty Clover

Annual Clover Variety Trial

By *Akim Omokanye, PCBFA*

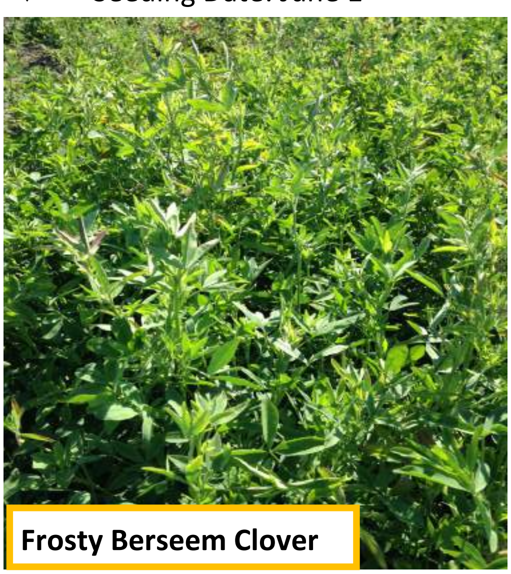
There is growing interest in using annual clover varieties for inclusion in cocktail mixtures and cereal intercropping systems in the Peace. The performance of some annual clovers in the area is well known, but it is important to test new clover varieties as they are introduced to the Peace. In the last 2-3 years, questions have been asked about the right type of clover with a good number of nodules, N fixing ability, good soil cover to control weeds in intercrops, and low growing/dwarf type for grain intercrops. Crimson clover is new to us in the Peace. PCBFA's studies, and producers with experience growing crimson clover, have shown that it does well here.

Objective

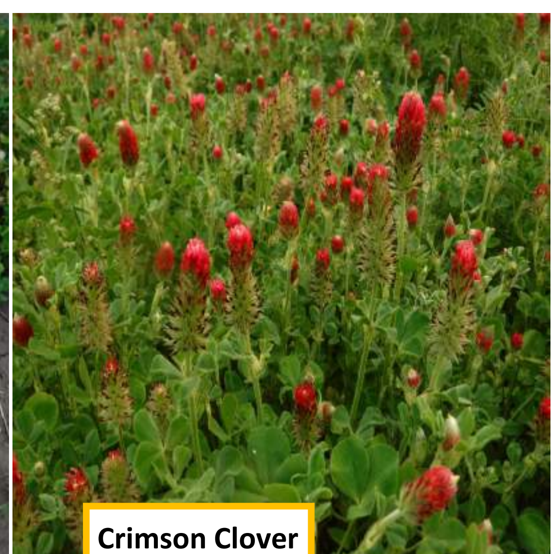
To test the suitability of annual clover varieties for forage and crop production systems

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: Oats for greenfeed in 2016 and 2015
- Site soil information (0-6" depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.8 and soil organic matter = 8.0%. The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications.
- Treatments: The following 10 annual clover varieties were tested:
  1. Crimson clover (no variety name available)
  2. Subterranean clover (no variety name available)
  3. Balansa clover (Frontier)
  4. Persian clover (Laser)
  5. Sweet clover (Yellow blossom)
  6. Balansa clover (Fixation)
  7. White clover (CW 204)
  8. White clover (CW 190)
  9. Berseem clover (Frosty)
  10. Berseem clover (no variety name available)
- Seeding Date: June 1


Frosty Berseem Clover


Fixation Berseem Clover


Crimson Clover

- Recommended seeding rates for each clover type were used. Pre-inoculated seed was used.
- Fertility (actual lbs/acre): 50 lbs/acre of 11-52-0
- Spraying: In-crop spraying was done with Basagran Forte

Forage Dry Matter Yield and Field Notes on Varieties Tested

Most of the varieties tested did not do well, so forage dry matter yield was far less than 1000 lbs DM/acre for some clover varieties.

Forage DM yield was highest for crimson clover, followed by yellow blossom sweet clover and then Frosty berseem clover (Table 1).

Table 1 below also shows annual clover varieties which may have potential for inclusion in the cropping systems or forage-based production systems in the area.

Crimson clover, Frosty berseem clover and yellow blossom sweet clover did far better than other clover varieties in terms of seed emergence, early spring growth and nodulation.

Frosty berseem clover's maturity is late when compared to other annual clovers and bloom period is similar to that of red clover. As an annual clover, Frosty produces an abundance of flowers and is favored by pollinators over red clover.

Crimson clover, like most other clovers that are new to us, needs to be inoculated at seeding with appropriate inoculants.

Table 1. Summary of field notes taken in 2017 on 10 annual clover varieties tested in Fairview

Variety	Establishment/ Stand density	Flowering	Soil cover (%)	Forage DM yield lbs/acre	Recommendation for this area
Crimson clover	Excellent	100%	85-90	4953	Highly Recommended
Yellow blossom sweet clover	Very good	Some	70-80	3994	Recommended
Berseem clover (Frosty)	Very good	None	85-90	3649	Recommended
White clover (CW 204)	Fair	Some	20-30	1945	Not at the moment
Balansa clover (Fixation)	Fair	None	25-30	1845	Not at the moment
White clover (CW 190)	Fair	Some	25-30	1678	Not at the moment
Subterranean clover	Poor	None	10	<1000	Not at the moment
Persian clover (Laser)	Poor	None	10	<1000	Not at the moment
Balansa clover (Frontier)	Poor	100%	10	<1000	Not recommended
Berseem clover	Poor	None	5-10	<1000	Not recommended

Poor Performers

The following clovers did not do well in our tests : White clover(CW 204), Fixation Balansa clover, White clover (CW 190), Subterranean clover, Persian clover (Laser), Balansa clover (Frontier) and Berseem clover. Emergence was poor, and for those that emerged, the seedling counts were very low relative to the seeding rates. These clovers wouldn't be recommended for inclusion in cocktails for now. Persian clover may however have some potential, further tests on clovers at Fairview Research Farm would include Persian clover.

Testing of Perennial Forages: Forage Yields of 11 Grasses, 15 Legumes and 9 Mixtures

By *Akim Omokanye (PCBFA) & Khalil Ahmed (SARDA)*

Funder: Alberta Beef Producers
Collaborators: Chinook Applied Research Association (CARA) & SARDA

Perennial forages consisting of different grasses, legumes and grass/legume mixtures were seeded in 2016 in a province-wide project. Forages consisted of varieties which have been developed in recent years along with some older varieties. The project is intended to address the following ABP priority areas: (1) improved grazing, management and forage mixture strategies that optimize hay yields and beef production from native range and tame pastures, (2) quantification of varietal and species differences in the ability of grasses, legumes and annual forages to maintain nutritional quality throughout the grazing season and in extended stockpiled or swath grazing systems and (3) evaluation of yield, nutrient profile and animal performance of new forage varieties in geographical regions beyond the development region. This project will provide farmers and ranchers in Alberta with performance information on a number of perennial forages.

Measurements Taken in 2017

Project Site: High Prairie

The following field data collection was done: a) plant height (cm) (June 30) & stage of maturity (June 30), b) botanical composition for grass/legume mixes only (June 30) and c) forage dry matter yield (determined by hand using quadrats) and forage quality

Table 1. Precipitation in High Prairie in 2017

Month	Precipitation (mm)
May	61.8
June	66.6
July	82.2
Aug	50.3
Total	260.9 mm

Results and Interpretation

<u>Grasses</u>

Plant Height (Table 2): The plant height for grasses varied from 100.8 cm for Kirk crested wheatgrass to 149.8 cm for Fleet meadow brome. Fleet meadow brome, Success hybrid brome, Greenleaf pubescent wheatgrass, Killarney orchardgrass, Knowles hybrid brome and Admiral hybrid brome grew taller than other grasses.

Forage DM yield (Table 2): Greenleaf pubescent wheatgrass had the highest forage DM value (7597 lbs/acre), followed closely by Killarney orchardgrass (7103 lbs/acre). Fojtan festulolium and Courtney tall fescue seemed to have lower forage DM yields than other grasses.

Forage Quality (Table 3): The forage CP was highest for Success hybrid brome (13.1%) and lowest for Greenleaf pubescent wheatgrass (8.71%). Only 4 of the 11 grasses had 11% CP or more. Others had <11% CP. Except for Greenleaf pubescent wheatgrass, which had 58% forage TDN, the forage TDN was mostly >60%. AC Admiral hybrid brome, Success hybrid brome and Knowles hybrid brome had higher forage TDN than other grasses. The forage NE_M varied from 1.33-1.44 Mcal/kg for the grasses tested.

Table 2. Plant height and forage dry matter (DM) yield of 11 forage grasses at High Prairie.
** indicates significance at $P<0.05$; CV indicates coefficient of variation*

Variety	Stage of maturity	Plant height (cm)	Moisture (%)	Forage DM yield (lb/acre)
Fleet Meadow Brome	R1	149.8	67.2	5781
AC Admiral Hybrid Brome	R2	136.5	66	6693
Knowles Hybrid Brome	R2	138.5	62.1	6169
Success Hybrid Brome	R2	145	65.8	6334
Greenleaf Pubescent Wheatgrass	R2	141.5	69.3	7597
Kirk Crested Wheatgrass	R2	100.8	56.8	5363
AC Saltlander Green Wheatgrass	R2	120.5	56.7	5976
Fojtan Festulolium	R1	104.5	68.1	4840
Courtney Tall Fescue	R1	117.8	77.9	4781
Kilarney Orchardgrass	R2	140.3	65.7	7103
Grinstad Timothy	R1	116.8	62.9	6306
Mean		*128.3*	*65.5*	*6077*
Significance		*	*	*NS*
$LSD_{0.05}$		*11.2*	*6.73*	*2134*
CV, %		*6.09*	*13.4*	*24.1*

Legumes

Plant Height (Table 4): Nova sainfoin and 44-44 alfalfa appeared to have higher plant height values than other legumes. Veldt cicer milkvetch did not grow as tall as other legumes.

Forage DM yield (Table 4): PV Ultima produced higher forage DM yield values than other legumes.

Forage Quality (Table 5): The forage CP was highest for Assalt ST Alfalfa (19.6% CP), followed by Halo (17.2%) and then PV Ultima and Rangelander (with 16.6% CP each). Nine of the 15 legumes had 15% CP or more, while others had <15% CP. The 2 sainfoins and the 2 cicer milkvetches had lower forage CP than other legumes.

The forage TDN was higher for Assalt ST alfalfa, Halo alfalfa, PV Ultima alfalfa, Oxley 2 cicer milkvetch, Veldt cicer milkvetch and Rangelander with about 60% or more TDN. Other forage legumes had <60% TDN. The forage NE_M varied from 1.26-1.49 Mcal/kg for the legumes tested.

Field Observations - Fojtan festulolium was not as good as other grasses in terms of establishment/stands and soil coverage in 2017. Forage DM was not determined from some Fojtan Festulolium plots due to lack of uniform stands.

Table 3. Forage quality of 11 grasses harvested on June 30 in High Prairie

** indicates significance at P<0.05; CV indicates coefficient of variation*

Forage quality parameter		Fleet Meadow Brome	AC Admiral Hybrid Brome	Knowles Hybrid Brome	Success Hybrid Brome	Greenleaf Pubescent Wheatgrass	Kirk Crested Wheatgrass	Saltlander Green Wheatgrass	Fojtan Festulolium	Courtney Tall Fescue	Killarney Orchardgrass	Grinstad Timothy	*Mean*	*Significance*	*$LSD_{0.05}$*	*CV, %*
NFC	%	17.4	14.2	12.7	13.9	12.3	16.8	13.8	15.7	13.8	19.1	16.6	*15.1*	***	*3.50*	*10.4*
Crude Protein	%	9.87	11.1	13.1	11.1	8.71	10.5	10.4	10.6	10.2	11.5	9.52	*10.6*	*NS*	*2.47*	*10.4*
Soluble Crude Protein	% of CP	36.5	36.4	36.2	36.4	36.3	36.5	36.5	36.4	36.4	36.2	36.5	*36.4*	*NS*	*0.37*	*0.46*
ADF-CP	%	0.57	0.62	0.98	0.75	0.48	0.59	0.55	0.55	0.51	0.46	0.66	*0.61*	***	*0.17*	*13.0*
NDF-CP	%	2.53	2.69	3.09	2.90	1.75	1.92	2.20	2.03	2.55	2.68	2.31	*2.42*	***	*0.55*	*10.2*
UIP (Bypass Protein)	Est % CP	30.9	31.4	32.6	32.2	32.4	32.1	32.5	31.1	30.1	30.0	31.9	*31.6*	*NS*	*1.69*	*2.40*
Acid Detergent Fibre	%	41.1	40.2	37.9	37.7	42.7	37.6	38.4	40.1	40.4	39.6	39.7	*39.6*	*NS*	*3.15*	*3.58*
Neutral Detergent Fibre	%	60.9	62.5	61.8	62.8	67.9	61.6	64.3	62.0	64.1	56.9	62.6	*62.5*	***	*3.88*	*2.79*
Total Digestible Nutrients	%	63.7	65.2	64.8	65.3	58.0	62.0	61.8	63.3	62.4	64.2	62.9	*63.0*	***	*2.00*	*1.42*
Lignin	%	4.36	4.56	4.26	4.42	5.10	5.39	4.73	4.16	4.48	3.86	5.14	*4.58*	*NS*	*1.92*	*19.3*
NE Lactation	MCal/Kg	1.28	1.30	1.34	1.34	1.25	1.35	1.33	1.30	1.29	1.31	1.31	*1.31*	*NS*	*0.05*	*1.93*
NE Gain	MCal/Kg	0.64	0.66	0.71	0.72	0.61	0.72	0.70	0.66	0.66	0.68	0.68	*0.67*	*NS*	*0.07*	*4.82*
NE Maintenance	MCal/Kg	1.36	1.38	1.44	1.44	1.33	1.44	1.43	1.39	1.38	1.40	1.40	*1.40*	*NS*	*0.07*	*2.49*
Calcium	%	0.32	0.37	0.38	0.35	0.29	0.32	0.30	0.27	0.27	0.38	0.24	*0.32*	*NS*	*0.09*	*13.4*
Phosphorus	%	0.12	0.16	0.16	0.14	0.11	0.12	0.12	0.15	0.14	0.18	0.19	*0.14*	*NS*	*0.05*	*16.7*
Potassium	%	2.91	2.76	2.52	2.18	1.95	1.53	2.09	2.07	2.37	2.06	1.97	*2.22*	***	*0.57*	*11.5*
Sulphur	%	0.10	0.12	0.16	0.14	0.11	0.17	0.13	0.18	0.16	0.21	0.11	*0.14*	*NS*	*0.06*	*21.0*
Magnesium	%	0.14	0.15	0.15	0.12	0.10	0.11	0.12	0.17	0.17	0.19	0.11	*0.14*	***	*0.03*	*13.2*
Sodium	%	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.07	0.02	0.03	0.01	*0.02*	***	*0.01*	*35.7*
Chloride	%	0.77	0.77	0.72	0.67	0.70	0.67	0.70	0.70	0.69	0.70	0.61	*0.70*	***	*0.07*	*4.51*
Copper	ppm	4.09	4.45	6.10	6.17	3.46	4.53	4.76	4.15	4.94	4.10	4.44	*4.65*	*NS*	*2.24*	*21.9*
Zinc	ppm	33.2	40.7	45.0	47.9	38.7	41.2	34.4	58.6	46.7	32.0	46.3	*42.2*	*NS*	*19.4*	*21.2*
Iron	ppm	53.6	49.3	46.5	54.9	54.4	39.3	53.8	65.2	70.4	81.0	74.3	*58.4*	***	*17.0*	*12.9*
Manganese	ppm	47.5	42.1	37.2	38.7	28.5	18.7	19.4	33.6	77.0	30.4	44.0	*37.9*	*NS*	*33.7*	*41.2*
Relative Feed Value		86.8	85.7	89.6	88.1	76.3	90.0	85.4	86.6	83.4	94.8	86.2	*86.6*	***	*8.41*	*4.38*
Starch	%	5.04	4.65	3.73	4.35	5.03	4.80	4.46	4.76	4.65	4.79	4.68	*4.63*	***	*0.52*	*5.10*
Total Ash	%	9.41	9.46	9.28	8.99	8.58	8.55	8.62	8.94	9.15	9.68	8.39	*9.00*	*NS*	*1.05*	*5.24*
Crude Fat	%	2.42	2.76	3.03	3.12	2.52	2.59	2.88	2.79	2.80	2.77	2.85	*2.77*	***	*0.26*	*4.24*

Table 4. Plant height and forage dry matter (DM) yield of 15 forage legumes at High Prairie. ** indicates significance at P<0.05; CV indicates coefficient of variation*

Variety	Stage of maturity (flowering)	Plant height (cm)	Moisture (%)	Forage DM yield (lb/acre)
Spreador 4 Alfalfa	Mid	104.3	75.5	5433
44-44 Alfalfa	Mid	106.0	77.3	6005
Dalton Alfalfa	Mid	100.5	75.8	5532
PV Ultima Alfalfa	Mid	98.5	75.5	7031
Rangelander Alfalfa	Mid	101.0	76.7	6123
20-10 Alfalfa	Mid	99.8	76.2	6026
Rugged Alfalfa	Mid	98.5	76.1	6094
Halo Alfalfa	Mid	97.3	75.8	6218
Assalt ST Alfalfa	Mid	102.0	77.0	6086
Yellowhead Alfalfa	Early	97.8	77.9	6692
Spreador 5 Alfalfa	Mid	99.5	76.3	6364
Nova Sainfoin	Full	106.5	75.9	6027
AC Mountainview Sainfoin	Full	101.5	73.4	5827
Oxley 2 Cicer Milk Vetch	Full	98.5	76.3	5829
Veldt Cicer Milk Vetch	Full	92.5	77.7	4492
Mean		*100*	*76.2*	*5985*
Significance		*NS*	*NS*	*NS*
$LSD_{0.05}$		*9.07*	*4.17*	*1904*
CV, %		*6.34*	*12.3*	*22.3*

Table 5. Forage quality of 15 legumes harvested on June 30 in High Prairie.

** indicates significance at P<0.05; CV indicates coefficient of variation*

Parameter	Unit	Aassalt ST Alfalfa	Dalton Alfalfa	20-10 Alfalfa	Halo Alfalfa	Rugged Alfalfa	SPREDOR 4 Alfalfa	SPREDOR 5 Alfalfa	Yellowhead Alfalfa	PV ULTIMA Alfalfa	44-44 Alfalfa	RANGELANDER Alfalfa	Nova Sainfoin	Mountainview Sainfoin	Oxley 2 Cicer Milkvetch	VELDT Cicer Milkvetch	Mean	Significance	$LSD_{0.05}$	CV, %
NFC	%	23.2	23.8	23.4	24.0	23.0	24.0	24.6	25.0	25.4	23.5	22.8	23.7	27.1	31.7	33.9	25.3	*	4.35	8.04
Crude Protein	%	19.6	15.5	14.9	17.2	16.5	13.4	15.8	14.1	16.6	15.1	16.6	11.6	11.4	12.0	11.3	14.8	*	2.62	8.32
Soluble CP	% of CP	35.9	36.1	36.2	36.0	36.0	36.2	36.0	36.2	36.0	36.2	36.0	36.3	36.4	36.5	36.6	36.2	*	0.24	0.31
ADF-CP	%	1.19	1.03	1.01	1.02	0.90	0.96	1.10	1.15	0.98	0.97	1.07	1.21	1.18	1.02	0.93	1.04	NS	0.21	9.46
NDF-CP	%	3.85	3.29	3.14	3.36	3.15	3.09	3.83	3.46	3.44	3.30	3.67	2.74	2.86	3.35	3.00	3.30	NS	0.70	10.0
UIP	Est % CP	29.0	26.2	29.8	27.1	28.4	29.6	28.1	29.6	27.0	26.7	26.6	34.5	34.0	30.4	30.0	29.1	*	3.80	6.10
ADF	%	35.7	43.1	42.5	39.1	39.0	45.1	41.3	45.8	40.5	41.8	40.1	42.2	41.5	43.0	41.2	41.5	*	3.62	4.07
NDF	%	45.9	49.7	51.1	47.3	49.4	52.2	48.2	49.8	46.6	50.6	49.2	54.0	50.9	45.6	44.3	49.0	*	3.84	3.66
TDN	%	62.9	58.3	57.8	60.3	59.3	55.2	59.4	58.2	59.9	58.2	59.7	54.4	58.1	61.8	62.7	59.1	*	2.90	2.29
Lignin	%	6.30	7.54	8.18	6.95	7.86	8.75	6.49	8.00	7.30	8.01	7.43	8.16	7.48	7.57	7.47	7.56	NS	1.28	7.90
NE_L	MCal/Kg	1.38	1.24	1.26	1.32	1.32	1.21	1.28	1.19	1.29	1.27	1.30	1.26	1.27	1.24	1.28	1.27	*	0.06	2.50
NE_G	MCal/Kg	0.77	0.60	0.61	0.69	0.69	0.55	0.64	0.54	0.65	0.63	0.67	0.62	0.63	0.60	0.64	0.63	*	0.08	6.06
NE_M	MCal/Kg	1.49	1.32	1.33	1.41	1.41	1.27	1.36	1.26	1.38	1.35	1.39	1.34	1.35	1.32	1.36	1.35	*	0.08	2.83
Calcium	%	1.85	1.32	1.23	1.79	1.62	1.40	1.83	1.06	2.01	1.46	1.62	0.93	1.29	0.91	0.93	1.41	*	0.34	11.4
Phosphorus	%	0.18	0.22	0.15	0.22	0.16	0.20	0.18	0.18	0.21	0.19	0.24	0.20	0.18	0.20	0.17	0.19	NS	0.06	16.1
Potassium	%	1.99	2.21	1.95	1.94	2.01	1.90	2.33	2.28	1.74	2.17	2.31	1.58	1.73	2.76	2.26	2.08	NS	0.61	13.7
Sulphur	%	0.32	0.23	0.19	0.28	0.24	0.21	0.28	0.17	0.34	0.24	0.24	0.18	0.19	0.21	0.21	0.23	NS	0.10	21.7
Magnesium	%	0.23	0.23	0.21	0.27	0.23	0.21	0.24	0.21	0.27	0.21	0.24	0.22	0.31	0.27	0.31	0.24	*	0.05	10.7
Sodium	%	0.09	0.09	0.06	0.10	0.07	0.08	0.08	0.04	0.13	0.06	0.05	0.02	0.03	0.02	0.02	0.06	*	0.04	36.5
Chloride	%	0.76	0.64	0.61	0.51	0.57	0.63	0.53	0.59	0.52	0.57	0.57	0.43	0.48	0.45	0.35	0.54	*	0.14	12.2
Copper	ppm	9.77	9.37	8.84	10.3	8.96	9.22	10.6	9.04	11.0	10.4	9.45	6.32	8.17	6.24	6.24	8.92	*	2.27	11.9
Zinc	ppm	44.3	27.4	21.7	37.6	40.0	35.0	29.6	37.5	26.1	30.3	40.7	13.5	28.7	25.7	38.8	31.8	NS	18.9	27.7
Iron	ppm	79.2	55.5	79.8	54.8	47.4	50.9	82.5	42.5	56.8	52.4	51.7	36.4	46.3	48.2	41.6	55.1	NS	49.7	42.1
Manganese	ppm	18.3	14.9	15.6	19.9	14.0	14.1	20.0	13.9	14.7	14.7	18.2	17.9	20.5	17.3	18.4	16.8	NS	5.72	15.9
RFV		124	104	102	115	110	96	110	100	115	104	109	97	103	113	120	108	*	11.8	5.13
Starch	%	2.19	3.67	3.46	3.02	3.25	3.98	3.50	4.23	3.50	3.51	3.35	3.76	3.85	4.15	4.26	3.58	*	0.74	9.77
Total Ash	%	9.32	9.06	8.59	9.39	9.10	8.54	9.56	9.14	9.42	8.80	9.35	8.50	8.45	8.65	8.38	8.95	*	0.74	3.85
Crude Fat	%	1.95	1.99	1.96	2.03	2.03	1.91	1.92	2.04	2.03	2.04	2.05	2.21	2.16	2.08	2.16	2.03	*	0.11	2.54

Forage Mixtures

Plant Height (Table 6): The grasses in the mixtures all had similar plant height, varying from 141.5 to 148.3 cm. The legumes in the mixtures also had similar plant heights, varying from 88.3 to 95.0 cm. Generally, the grasses in the mixtures grew taller than the companion legumes.

Botanical Composition (Table 6): The grass component of the mixtures was mostly higher than the legume component. The percent composition of grasses was highest for Success hybrid brome (82.0%) in the Success HB/AC Mountainview mixture. Seven of the 9 mixtures had >50% grasses in the mixtures. Only 2 mixtures had more legumes than grasses in the mixtures. Spredor 5 was higher than AC Knowles MB in the AC Knowles MB/Spreador 5 as well as in Success HB/Spreador 5.

Forage Dry Matter (DM) (Table 6): Fleet MB/Yellowhead had the highest forage DM (7490 lb/acre) and this was followed by AC Knowles MB/Spreador 5 with 6759 lb/acre. The mixtures that included AC Mountainview sainfoin mostly seemed to have lower total forage DM yield than other mixtures.

Table 6. Plant height, forage dry matter (DM) yield and composition of grasses and legumes of 9 forage mixtures in High Prairie. ** indicates significance at P<0.05; CV indicates coefficient of variation*

	Plant height (cm)		Forage DM yield (lb/acre)			Composition (%)	
Variety	**Grass**	**Legume**	**Grass**	**Legume**	**Total**	**Grass**	**Legume**
Fleet MB/Yellowhead	147.0	92.8	3972	3518	7490	52.9	47.1
Fleet MB/AC Mountainview	145.8	92.3	3946	1257	5433	77.4	22.6
Fleet MB/Speador 5	142.5	90.5	2859	2452	5311	51.6	48.4
AC Knowles/Yellowhead	143.0	93.3	3412	2191	5602	61.4	38.6
AC Knowles MB/Spreador 5	143.0	88.3	1905	4855	6759	27.1	72.9
AC Knowles MB/AC Mountainview	145.3	95.0	2867	975	3842	64.4	35.6
Success HB/Yellowhead	148.3	93.3	3268	2125	5394	59.8	40.2
Success HB/Spreador 5	145.3	92.0	1928	3421	5349	31.8	68.2
Success HB/AC Mountainview	141.5	94.3	3613	771	4384	82.0	18.0
Mean	*145*	*92.4*	*3081*	*2429*	*5509*	*55.8*	*44.1*
Significance	*NS*	*NS*	*NS*	*	*	*	*
$LSD_{0.05}$	*8.46*	*7.21*	*2350*	*1579*	*2327*	*30.2*	*30.2*
CV, %	*4.1*	*5.35*	*45.2*	*38.5*	*25*	*32*	*40.6*

Forage Quality (Table 7): The forage CP was highest for Fleet meadow brome/Spredor 5 mixture with about 20% CP. Six of the 9 mixtures had 17% CP or more. AC Knowles MB/Spreador 5, Fleet MB/AC Mountainview and Success HB/AC Mountainview had <14.0% CP.

The forage TDN was 60% or more for 6 of the 9 mixtures. AC Knowles MB/Spreador 5, Fleet MB/AC Mountainview and Success HB/AC Mountainview had <56% TDN. The forage NE_M varied from 1.45-1.53 Mcal/kg for the mixtures tested.

Future Plan

Further evaluation (including forage yield, botanical composition of the mixtures, and field notes on winter kill) will continue in 2018. The project will conclude in 2018, so comprehensive information on the performance of the forages and forage mixtures will be available to producers in early 2019.

Table 7. Forage quality of 9 grass/legume mixtures harvested on June 30 in High Prairie.

** indicates significance at P<0.05; CV indicates coefficient of variation*

Parameter	Unit	FLEET MB/YELLOWHEAD	SUCCESS/YELLOWHEAD	KNOWLES/YELLOWHEAD	FLEET/SPREDOR 5	SUCCESS/SPREDOR 5	KNOWLES/SPREADOR 5	FLEET/MOUNTAINVIEW	SUCCESS/MOUNTAINVIEW	KNOWLES/	*Mean*	*Significance*	*LSD*	*CV, %*
NFC	%	22.9	21.3	22.5	24.1	23.1	23.9	23.9	21.6	18.9	*22.5*	*NS*	*4.22*	*8.16*
Crude Protein	%	17.7	17.0	18.0	19.8	18.1	11.8	11.9	13.1	18.6	*16.2*	*	*4.88*	*13.1*
Soluble CP	% of CP	35.7	35.8	35.8	35.6	35.9	36.4	36.3	36.2	35.6	*35.9*	*	*0.37*	*0.45*
ADF-CP	%	0.98	1.03	0.93	1.09	1.04	0.92	0.97	1.05	1.15	*1.02*	*NS*	*0.14*	*6.34*
NDF-CP	%	3.81	4.09	3.62	4.21	3.84	2.56	2.64	2.65	4.17	*3.51*	*	*0.67*	*8.34*
UIP	Est % CP	31.0	31.3	27.5	28.3	30.0	32.5	32.2	31.9	30.8	*30.6*	*	*2.11*	*2.99*
ADF	%	35.1	35.5	34.7	33.8	33.6	37.1	37.2	36.7	34.6	*35.4*	*NS*	*8.06*	*9.90*
NDF	%	47.5	49.9	47.6	43.7	47.1	53.7	53.3	54.5	50.8	*49.8*	*NS*	*9.44*	*8.23*
TDN	%	63.9	65.1	61.4	63.9	65.5	55.3	54.4	54.4	61.0	*60.5*	*	*7.68*	*5.50*
Lignin	%	4.71	4.90	5.78	5.00	5.09	5.92	5.81	5.75	5.11	*5.34*	*NS*	*1.61*	*13.1*
NE Lactation	MCal/Kg	1.39	1.39	1.40	1.42	1.42	1.36	1.36	1.37	1.40	*1.39*	*NS*	*0.15*	*4.79*
NE Gain	MCal/Kg	0.78	0.77	0.79	0.81	0.81	0.73	0.73	0.74	0.79	*0.77*	*NS*	*0.18*	*10.1*
NE Maintenance	MCal/Kg	1.50	1.49	1.51	1.53	1.53	1.46	1.45	1.47	1.51	*1.49*	*NS*	*0.18*	*5.34*
Calcium	%	1.38	1.38	1.54	2.11	1.46	1.18	1.33	1.18	1.66	*1.47*	*NS*	*0.94*	*27.9*
Phosphorus	%	0.21	0.22	0.24	0.24	0.22	0.16	0.24	0.20	0.23	*0.22*	*NS*	*0.10*	*20.4*
Potassium	%	2.50	2.18	2.12	2.16	2.07	1.51	1.62	1.61	2.11	*1.98*	*	*0.30*	*6.70*
Sulphur	%	0.22	0.24	0.23	0.29	0.25	0.17	0.21	0.18	0.25	*0.22*	*NS*	*0.12*	*23.2*
Magnesium	%	0.25	0.27	0.25	0.27	0.22	0.26	0.27	0.27	0.29	*0.26*	*NS*	*0.11*	*18.8*
Sodium	%	0.02	0.02	0.03	0.05	0.03	0.01	0.01	0.01	0.02	*0.02*	*	*0.01*	*39.9*
Chloride	%	0.55	0.54	0.55	0.55	0.51	0.43	0.45	0.43	0.49	*0.50*	*	*0.06*	*5.99*
Copper	ppm	7.69	8.19	6.98	8.49	7.68	5.27	6.38	6.25	9.43	*7.37*	*	*1.66*	*9.76*
Zinc	ppm	19.1	15.0	14.4	29.7	21.3	13.0	9.9	17.2	15.0	*17.2*	*NS*	*26.2*	*66.3*
Iron	ppm	115.1	92.5	93.8	80.2	76.7	68.0	54.6	50.2	568.8	*133.3*	*NS*	*481.2*	*156.5*
Manganese	ppm	33.6	30.1	26.0	24.8	30.5	28.0	22.7	19.0	33.8	*27.6*	*NS*	*13.0*	*20.5*
RFV		121	115	124	133	124	104	105	103	114	*115.9*	*NS*	*34.1*	*12.8*
Starch	%	2.98	3.11	3.18	2.65	2.71	3.74	3.77	3.25	2.50	*3.10*	*NS*	*1.15*	*16.1*
Total Ash	%	10.0	9.7	9.9	10.4	9.6	8.4	8.6	8.5	9.8	*9.44*	*	*0.96*	*4.41*
Crude Fat	%	1.96	2.07	2.00	2.08	2.10	2.23	2.25	2.24	1.79	*2.08*	*NS*	*0.33*	*6.94*

Progress Report on Fall or Spring Management Options for Pastures: Renovate or Rejuvenate?

By Akim Omokanye, PCBFA

Funding Received from: Alberta Beef Producers (ABP)

Collaborators: Wanham Provincial Grazing Reserve (PGR)/Wanham Grazing Association
Chinook Applied Research Association (CARA)

Background

Over time, the productivity and livestock carrying capacity of seeded hay fields and pastures on beef cattle operations may decline. This is largely a result of reduced stand vigor, consequence of drought, pests, weeds, the invasion of unpalatable or less productive species, overgrazing and poor soil fertility. Rejuvenation is a complex and costly challenge for producers. With the high cost and time associated with forage stand termination and re-establishment, farmers are anxious to identify all options for sustaining a forage stand. Local on-farm research is needed to compare all or at least most of the practicable methods of rejuvenation, in order to determine the most effective and profitable methods for producers in comparison to a complete break and reseed scenario. It was thought that comparing a break and reseed scenario to other minimal soil disturbance methods will show the advantages and disadvantages of these practices as well as identify the most cost effective methods/options that may exist for beef cattle producers.

Objectives

1. To test a variety of methods for rejuvenating the productivity of low producing forage stands and improving soil conditions under a grazing system.
2. To examine the effect of herbicide application on brush control in pasture and forage stand rejuvenation.
3. To demonstrate practical and sustainable forage production with minimal costs under farm conditions.
4. To provide a guide for the producer or manager when alternatives to breaking need to be considered.

Methods

Site: Provincial Grazing Reserve (PGR) in Wanham (Birch Hills County, Alberta).

Treatments: The following treatments are being examined in 3 replications:

1. Check
2. Plow– This was supposed to be break & re-seed, but after plowing in 2016, we couldn't seed because of the wet soil conditions, which persisted for a long period. We decided to leave it as a Plow only treatment after we noticed the impressive forage growth from the seed bank in the field after plowing. A seed bank is a reserve of dormant seeds in the soil that enables some types of plants to re-establish themselves after a drastic disturbance of the established vegetation.
3. Fertilizer application (broadcast)- Fertility was 77 lb N + 37 lb P + 0 lb K +13 lb S.
4. Grazon® herbicide application to kill brush
5. Aerate in spring
6. Aerate in fall
7. Roundup WeatherMAX® herbicide application
8. Roundup WeatherMAX® herbicide application/re-seeding in spring– Roundup was sprayed and a forage seed mixture (grasses and legumes) was seeded with a no-till drill. Fertility at seeding was 77 lb N + 37 lb P + 0 lb K +13 lb S.
9. Broadcast forage seed mixture (grasses and legumes)/aerate in fall
10. Broadcast forage seed mixture (grasses and legumes) /aerate in spring
11. Broadcast forage seed mixture (grasses and legumes) only in spring

Last year (2016), we collected all of the necessary baseline data in June. The treatments listed above were implemented in 2016.

On June 21-22, 2017, soil water infiltration, soil compaction, forage yield, botanical composition of the forage, forage quality and soil nutrients (0-6" and 6-12") were measured.

Results

Soil Component

The soil organic matter (SOM), pH and nutrients (N, P, K and S) are shown in Table 1.

The SOM in 2017 (Y17) did not show any significant improvement over the 2016 (Y16) baseline data for most treatments. However, in 2017, five methods of rejuvenation ('Roundup/seed in spring', 'Plow', 'Aerate in spring', 'Broadcast seed/aerate in fall' and 'Roundup') seemed to have higher SOM (8.1-9.4%) than the others tested here. The SOM was higher for surface soil than subsurface soil for all treatments.

The soil pH for the different methods of rejuvenation was mostly similar for both years (2016 and 2017). The pH was also similar for both soil depths (0-6" and 6-12").

Soil N was particularly higher in 2017 than 2016 for the treatments 'Plow', 'Roundup/seed in spring', and 'Fertilizer application'. The soil N in the surface soil (0-6") was significantly higher than the sub-surface soil (6-12") for 'Roundup/seed in spring', 'Fertilizer application' and 'Roundup application'.

For some reason, the soil P was generally higher in 2017 than 2016 for all methods of rejuvenation tested. 'Roundup/seed in spring' and 'Plow' treatments had far more soil P than other methods of rejuvenation at both depths (0-6" & 6-12").

In 2017, soil K was particularly higher for the treatments 'Roundup/seed in spring' and 'Plow' than other methods at both depths.

Soil S did not change much for most treatments from 2016 to 2017.

Soil infiltration and permeability describe the manner by which water moves into and through soil. Generally, infiltration rate was low, varying 0.18 to 1.08 inches/hour. Going by the permeability class (Table 3) and as expected, only the 'Plow' treatment improved infiltration significantly. Infiltration was moderate for 'Plow', while it was slow to moderately slow for other treatments methods.

In 2017, the mean soil compaction from 0-12" soil depth was far lower for the treatment 'Plow' (166 PSI) than other methods, which had 393 to 653 PSI. Readings of 400 to 500 PSI would indicate potential soil compaction. In 2017, only 'Plow' showed great improvement over 2016. Except for treatment 'Plow' in 2017, looking at Figure 1, it is evident that soil compaction was generally high in both the surface soil (0-6") and subsurface soil (6-12") in both years (2016 & 2017) for all treatments.

Forage Yield and Botanical Composition

The forage dry matter (DM) yield was generally higher in 2017 than 2016. In 2017, the treatments 'Plow', 'Roundup/seed in spring' and 'Fertilizer application' had significantly higher forage DM yields than other treatments. The treatment 'Plow' had the highest forage DM yield (3792 lbs/acre), followed closely by 'Roundup/seed in spring' (3644 lbs/acre) and then 'Fertilizer application' (2528 lbs/acre).

With the exception of the treatment 'Roundup', which was dominated by mostly dandelions and brush, the forage stand was mostly dominated by grasses in both years (2016 & 2017) for all treatments. Forage legumes were very minimal in the stands of the treatments.

Table 1. Soil organic matter (SOM), pH, electrical conductivity (EC) and soil nutrients from surface soil (0-6") and subsurface soil (6-12") in 2016 (Y16) & 2017 (Y17) for different methods of forage stand rejuvenation

Rejuvenation method	Depth (")	SOM		pH		EC		N		P		K		S	
		Y16	Y17	Y16	Y17	Y16	Y17	Y16	Y17	Y16	Y17	Y16	Y17	Y16	Y17
Check	0-6"	4.1	5.7	7.3	7	0.32	0.36	4	6	10	44	566	594	11	10
	6-12"	6.8	4.9	6.9	7	0.55	0.43	4	6	9	38	902	444	10	22
Roundup/seed in spring	0-6"	6.9	9.4	7.4	6.6	0.49	0.37	8	18	12	120	644	1200	10	14
	6-12"	3.8	4.2	6.8	6.5	0.42	0.48	4	4	11	120	804	1198	8	12
Plow	0-6"	7.2	8.1	7.1	6.7	0.37	0.46	5	24	14	120	498	1200	22	14
	6-12"	4.9	3.2	6.8	7	0.37	0.31	6	22	12	120	639	1200	22	16
Fertilizer	0-6"	5.5	5.7	6.8	6.5	0.34	0.32	7	26	11	44	562	516	8	24
	6-12"	5.5	3.1	6.4	6.8	0.46	0.54	4	8	13	10	350	340	4	16
Grazon	0-6"	7.5	7	7.3	6.8	0.2	0.27	5	8	12	58	460	854	10	10
	6-12"	6.6	3.9	6.9	6.8	0.27	0.23	8	4	11	12	646	836	6	8
Aerate in spring	0-6"	3.5	8.8	6.7	6.4	0.22	0.27	5	6	14	18	444	1058	12	12
	6-12"	5	4.6	6.8	6.2	0.31	0.28	6	4	13	22	728	602	8	20
Broadcast seed/aerate in fall	0-6"	6.1	8.2	6.8	6.4	0.21	0.26	6	8	13	16	572	912	12	10
	6-12"	4.9	5.9	7	6.4	0.29	0.26	4	4	11	10	590	770	16	16
Broadcast seed/aerate in spring	0-6"	6.2	5.7	6.4	7.2	0.44	0.58	7	6	9	20	796	464	10	12
	6-12"	4.6	4.3	6.6	6.7	0.3	0.3	6	14	11	12	876	642	12	10
Roundup	0-6"	6.2	8.6	6.6	7	0.25	0.28	8	16	13	40	522	922	14	10
	6-12"	5.8	5.6	6.8	7.3	0.24	0.25	6	4	13	18	570	594	6	10
Aerate in fall	0-6"	5	5.7	6.8	7.1	0.2	0.28	8	14	12	52	496	556	10	16
	6-12"	5.4	3.8	6.9	6.8	0.63	0.96	6	12	9	14	599	486	8	14
Broadcast seed in spring	0-6"	6	5.4	7	7.1	0.37	0.37	4	4	16	30	406	552	12	10
	6-12"	5.5	3.1	7	6.5	0.44	0.54	5	8	19	10	460	340	10	10

Table 2. The mean soil compaction readings and surface soil water infiltration in 2016 and 2017

Rejuvenation method	Mean soil compaction readings (0-12" soil depth), PSI		Surface soil infiltration rate, Inches/hour	
	2016	2017	2016	2017
Grazon	542	526	0.22	0.18
Fertilizer	603	497	0.18	0.36
Plow	528	166	0.19	1.08
Roundup/seed in spring	584	399	0.11	0.31
Roundup	535	514	0.20	0.39
Aerate in fall	627	477	0.20	0.22
Aerate in spring	622	445	0.16	0.24
Broadcast seed/aerate in fall	491	393	0.24	0.55
Broadcast seed/aerate in spring	522	583	0.15	0.23
Broadcast seed only in spring	465	653	0.16	0.31
Check	584	578	0.15	0.20

Table 3. Permeability classification system

Permeability Class	Rate (inches/hour)
Very rapid	Greater than 10
Rapid	5 to 10
Moderately rapid	2.5 to 5
Moderate	0.8 to 2.5
Moderately slow	0.2 to 0.8
Slow	0.05 to 0.2
Very slow	Less than 0.05

Adapted from: Plant & Soil Sciences elibrary, University of Nebraska

Forage Nutritive Value

The forage CP seemed to be slightly improved in 2017 over 2016 for the treatments 'Plow', 'Roundup/re-seeding in spring' and 'Roundup'.

Forage energy appeared to be increased by the treatment 'Plow' in 2017 over 2016. Also, 'Plow' had the highest TDN (62% TDN) of all other treatments.

Forage Ca and P did not seem to improve from 2016 to 2017 for any of the methods of rejuvenation tested here.

Figure 1. Soil compaction readings from 1-12 inches soil depth for different methods of rejuvenation in 2016 (Y16) and 2017 (Y17)

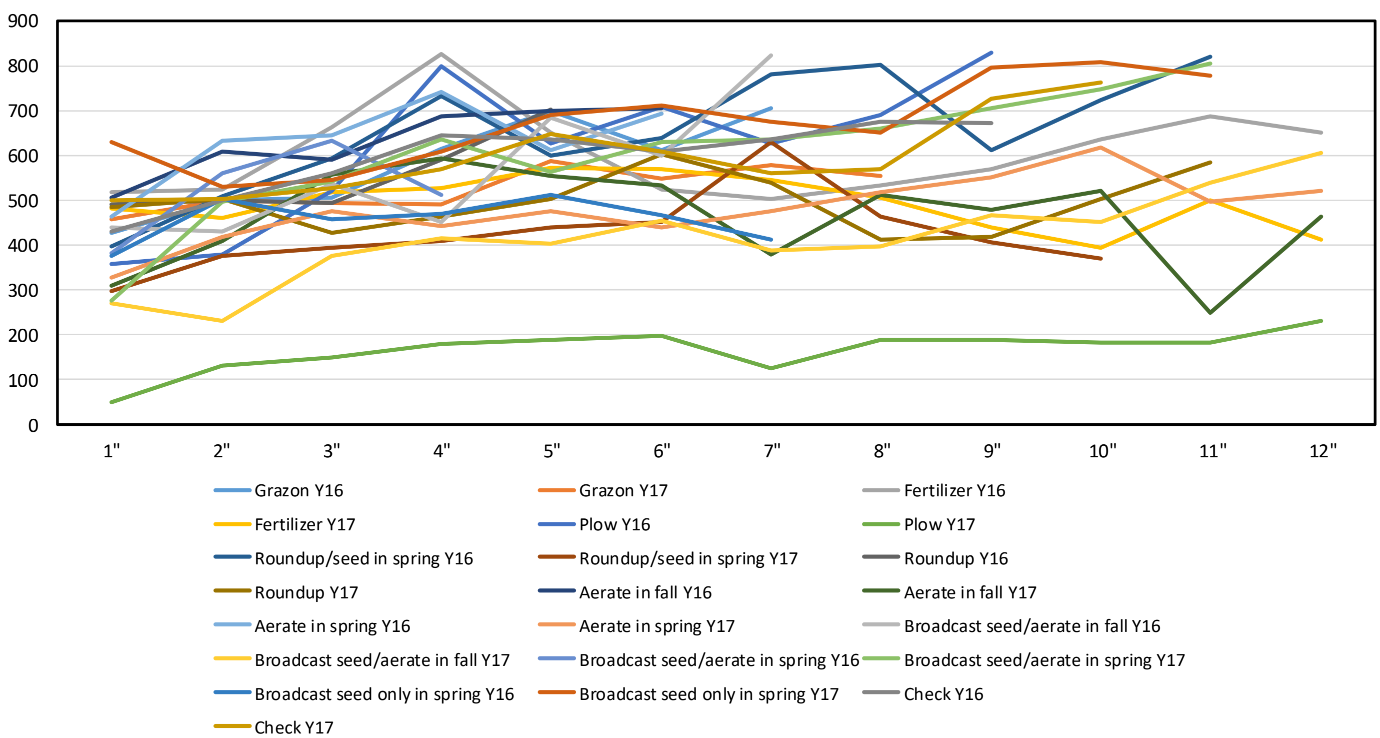


Table 4. Forage dry matter (DM) yield, forage composition and forage nutritive values of methods of rejuvenation in 2016 (Y16) and 2017 (Y17)

	Yield, % grasses, legumes & other plants								Forage Nutritive Value									
	Forage DM (lb/acre)		% Grass		% Legume		% Others		CP		TDN (%)		Ca (%)		P (%)		NE_M (Mcal/kg)	
Rejuvenation method	**Y16**	**Y17**	**Y16**	**Y17**	**Y16**	**Y17**	**Y16**	**Y17**	**Y16**	**Y17**	**Y16**	**Y17**	**Y16**	**Y17**	**Y16**	**Y17**	**Y16**	**Y17**
Plow	877	3792	80	100	14		7		9.18	11	58	62	0.65	0.22	0.26	0.19	1.37	1.39
Roundup/seed in spring	763	3644	74	72	6	19	19	8	10.4	13	58	59	0.45	0.25	0.29	0.2	1.28	1.33
Fertilizer	820	2528	59	91	9	4	32	4	10.5	10.5	57	57	0.62	0.5	0.18	0.18	1.22	1.3
Broadcast seed/aerate in spring	729	1875	69	90	14	4	18	5	10.9	9.43	59	59	0.57	0.26	0.24	0.19	1.29	1.31
Aerate in spring	856	2083	62	89	16	5	22	5	11	8.08	58	59	0.54	0.27	0.23	0.19	1.22	1.28
Aerate in fall	812	1777	77	93	16	5	7	1	10	8.21	58	58	0.43	0.3	0.25	0.19	1.29	1.28
Broadcast seed only in spring	815	1702	82	70	4	2	15	28	9.71	10	59	60	0.35	0.29	0.21	0.18	1.26	1.32
Broadcast seed/aerate in fall	951	1239	44	89	24	5	32	6	10.3	10.6	58	59	0.24	0.29	0.21	0.23	1.27	1.29
Grazon	672	1462	74	93	4	7	21		10.9	8.19	57	56	0.3	0.23	0.2	0.16	1.21	1.2
Check	924	1382	61	96	20	4	19		10.8	9.25	58	58	0.33	0.29	0.2	0.19	1.31	1.33
Roundup	838	169	55	27	16		29	73	9.45	12.1	58	60	0.49	0.34	0.18	0.22	1.29	1.35

Persistency of Sainfoin in Alfalfa Pasture Mixtures: A Research Update

By Akim Omokanye

Sainfoin is a perennial forage legume that does not cause bloat because of its condensed tannin concentration. Condensed tannins are very effective at preventing deadly pasture bloat in ruminants. Studies have shown that 15% or more sainfoin in alfalfa mixture can significantly lower, and in certain cases eliminate, the risk of pasture bloat. However, until recently, available sainfoin varieties have not survived well in mixed stands with alfalfa, or have not regrown at the same rate after the first cut or grazing and so cannot be used with alfalfa for reducing pasture bloat. Studies have shown that new experimental sainfoin lines are more competitive and have improved regrowth rates compared to older sainfoin varieties. Sainfoin is said to be as nutritious and palatable as alfalfa, and more tolerant of both cold and drought.

Methods

Three experimental sainfoin lines (LRC05-3900, LRC05-3901, LRC05-3902) along with an older sainfoin variety called Nova (check) were each seeded in mixtures with AC Grazeland alfalfa on May 23, 2013 at the Fairview Research Farm (NW5-82-3W6) on RR #35. Both sainfoin and alfalfa were seeded in the same row (same row mixtures). *AC Grazeland alfalfa is a low-bloat potential alfalfa, because this variety results in a slower initial rate of digestion, which helps prevent the onset of bloat*. The soil at the test site had a pH of 5.4 and 8.8% organic matter before seeding. Each mixture was seeded with 15 lbs/acre of sainfoin and 6 lbs/acre of AC Grazeland alfalfa, indicating that half of the usual recommended seeding rates were used for both legumes.

The 4 treatment mixtures were replicated 4 times in small plots, which had been arranged in a randomized complete block design. Seeding was 0.5-0.7" deep, and the seed was inoculated. We applied 40 lbs/acre of 11-52-0 at seeding in 2013. Assure II and Basagran Forte were used to control volunteer oats & canola and other broad leaf weeds in the seeding/establishment year (2013).

Cutting was done twice yearly in 2014 and 2016, while in 2015 and 2017, only one cut was made. The first cut was when sainfoin was at 40-50 % bloom (alfalfa was at 20-30% bloom) and mostly from June 20-23 every year. The second cut was 6 weeks after the first cut. *Please note that the highest risk of bloat occurs when legumes are in the pre-bud or vegetative stage.* In 2015 and 2017, only one cut was possible because deer had selectively grazed down all sainfoin stands in the mixtures just before the second cut was to be taken. In addition to deer selectively grazing down the sainfoin, Fairview was also dry in 2015. From 2014 to 2017, forage dry matter (DM) yield and percent composition (proportion) of sainfoin and alfalfa in the mixtures was determined.

Results Obtained and Implications

Total Forage Dry Matter Yield (Figure 1)

In general, total DM yield at any particular cut was statistically similar for the sainfoin - alfalfa mixtures in each year (2014, 2015, 2016 & 2017). In 2014 (one year after seeding), total DM yield was generally lower for the 2nd cut (1143-1495 lbs DM/acre) than 1st cut (3114-3685 lbs DM/acre). The lower total DM yield obtained for the 2nd cut in 2014 was due to low moisture.

Proportion of Sainfoin and Alfalfa in the Mixtures

The proportions of sainfoin in alfalfa mixtures at every cut are shown in Table 1. During the first 3 years after seeding (2014, 2015 and 2016), with the exception of Nova sainfoin in 2016 (which had 5-6% sainfoin in the mixtures), the proportion of sainfoin in alfalfa mixtures was generally >18%. But in 2017, all sainfoin lines have had great reduction in population, varying from 0-13% in the alfalfa mixture. The check (Nova sainfoin) had completely disappeared in the mixtures.

Figure 1. Forage dry matter yields of sainfoin-alfalfa pasture mixtures tested in Fairview from 2014 to 2017 (only 1 cut in 2015 & 2017)

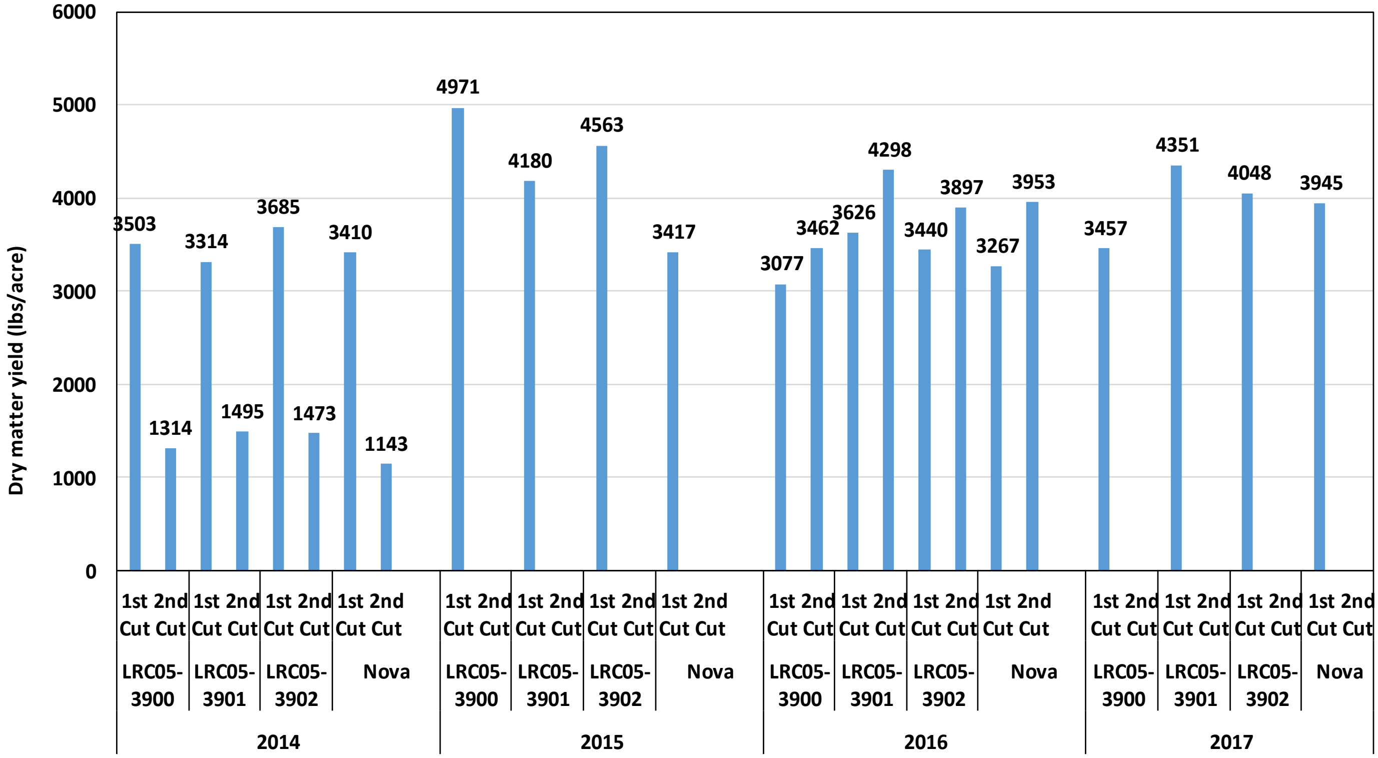


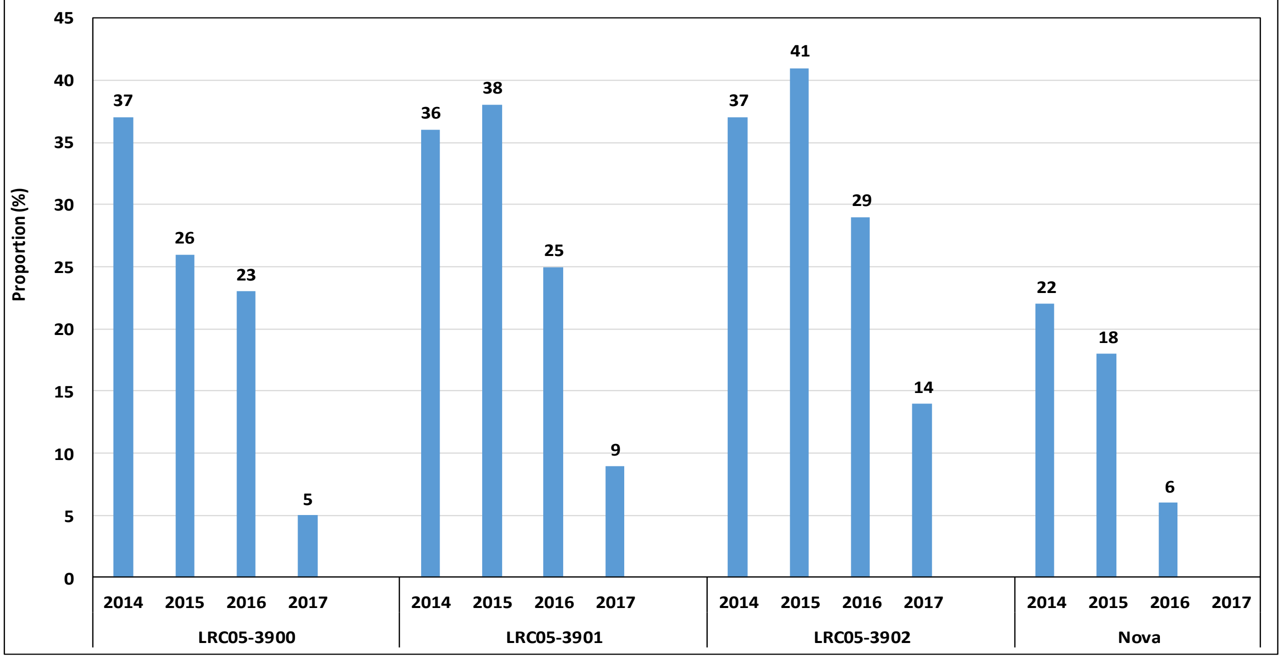
Table 1. Proportion (%) of sainfoin and alfalfa in the mixtures from 2014-2017														
		2014 Cuts (%)			2015 Cut* (%)			2016 Cuts (%)			2017 Cut* (%)		
Sainfoin- Alfalfa Mixture	Forage	1st	2nd	Mean	1st	2nd	Mean	1st	2nd	Mean	1st	2nd	Mean
LRC-3900 + alfalfa	LRC-3900 sainfoin	39	34	37	26	-	26	22	24	23	5		5
	AC Grazeland alfalfa	61	66	63	74	-	74	78	76	77	95		95
LRC-3901 + alfalfa	LRC-3901 sainfoin	31	40	36	38	-	38	26	23	25	9		9
	AC Grazeland alfalfa	69	60	64	63	-	63	74	77	76	91		91
LRC-3902a + alfalfa	[a]LRC-3902 sainfoin	36	38	37	41	-	41	28	29	29	14		13
	AC Grazeland alfalfa	64	62	63	59	-	59	72	71	72	86		87
Nova Sainfoin + alfalfa	Nova sainfoin	20	24	22	18	-	18	5	6	6			
	AC Grazeland alfalfa	80	77	78	82	-	82	95	94	95	100		100

*Only was cut was done in 2015 and 2017. [a] Recently released as AC Mountainview sainfoin.

It is important to note that the 3 experimental sainfoins consistently formed 20% or more in the mixtures from 2014 to 2016. This is important because at least 15% sainfoin needs to be present in the alfalfa stand to avoid bloat. Though there was still some sainfoin stands in the mixtures in 2017 for LRC-3900, LRC-3901, LRC-3902 (AC Mountainview), this was not enough to reduce or eliminate the incidence of alfalfa bloat, as they all fell short of the required 15% or more sainfoin in alfalfa mixtures (Table 1 and Figure 2).

Compared to the 3 experimental lines, the drastic drop in the proportion of sainfoin for Nova from a mean of 22% in 2014 to a mean of 6% in 2016 and to a complete disappearance by 2017, probably confirms that an older sainfoin variety such as Nova wouldn't be as competitive as the new sainfoin in alfalfa pasture mixtures. Our study further shows that when seeded with alfalfa, the experimental sainfoins should be able to provide bloat protection for more growing seasons than Nova (which only lasted for 2 years after seeding) or other older sainfoin varieties.

Figure 2. The yearly mean proportion of sainfoins in alfalfa pasture mixtures tested in Fairview



Summary

Over a period of 4 years of cutting, our results show that Nova sainfoin may not be good competitor with alfalfa in pasture mixtures, compared to any of the 3 experimental lines. As indicated earlier, studies have shown that 15% or more of sainfoin in an alfalfa pasture mixture would significantly lower, and in certain cases eliminate, the risk of bloat. Our study here at the Fairview Research Farm indicates that Nova sainfoin, which was reduced to just 6% in the alfalfa pasture mixtures by 2016, may not have the potential to lower bloat a few years after seeding. The newer lines, however, still had a few more productive years. Our thought is that the selective grazing down of the new sainfoin lines a few times may have contributed to lower stands of sainfoin recorded in 2017. One (LRC05-3902) of the 3 experimental sainfoin lines used in this study has been released as AC Mountainview sainfoin. The use of AC Mountainview sainfoin variety in alfalfa pasture mixtures is recommended.

2017 Peace Country Feed Tests Summary

By Akim Omokanye, PCBFA

Nutrient concentration can vary considerably in feeds, especially forages. Use feed tests to target specific feeds to different livestock. Feed high quality forage to the most productive livestock or when nutrient needs are highest. Feed lower quality forage to animals with lower nutrient needs. Feed tests can help establish the dollar value of a forage, in the cash market or in personal use inventories. Use these tests to establish the value of your forage and to help determine what forages to feed, buy, or sell. Livestock are most productive when fed a ration balanced according to their nutrient needs. CowBytes is an easy-to-use beef ration balancing software package that you can use once you have your feed tests done. Using SheepBytes (for sheep) you can also formulate rations for sheep for different animal types (mature ewes and rams, replacement ewe lambs and ram lambs, early weaned lambs, growing lambs and finishing lambs). PCBFA's services to producers include feed testing, analysis and interpretation of results. This report looks at the 2017 feed test results in the Peace. The results are discussed in relation to the nutrient requirements of mature beef cattle.

Methods

From July 2017 to January 2018, 145 feed samples from producers in the Peace were analyzed for quality. The feed samples were analyzed by Central Testing Laboratory (Winnipeg) using standard laboratory procedures for wet chemistry or Near-Infrared Reflectance (NIR) spectroscopy. This year, samples were grouped by forage/feed type into 11 groups (Table 1).

Results and Interpretation

Crude Protein (CP) (Table 1)

Turnip root had the highest mean protein content, with 15.5% CP, followed by wheat grain, mixed grain and alsike clover with about 14% CP. The lowest mean CP was from grass aftermath with 5.57% CP. Except for haylage, aftermath and pea straw, other feed types had a mean CP of 10% or more. For the individual samples submitted, CP was as high as 17.0% for hay, 16.4% for silage and 15.9% for mixed grain.

Minerals (Table 1)

All the grain samples (oats, barley, wheat and mixed grain) and aftermath had much lower Ca than other feed types.

Turnip root and all the grain samples (oats, barley, wheat & mixed grain) were higher in P than other feed types.

Alsike and turnip roots had higher Mg content than other feed types.

Also, turnip roots had more K and Na content than other feed types tested.

As expected, aftermath had lower mineral values than other feed types in most cases.

Only turnip roots was able to meet the Ca, P, Mg, K and Na requirements of young and mature beef cattle. Other feed types were not able to meet the complete macro mineral requirements of beef cattle, so a supplemental mineral program may still be required when some of the feed types tested here are being used.

The mineral content of forages is influenced by the corresponding mineral levels in the soil and by excess levels of some minerals that reduce the availability of others. Mature forages also may be lower in mineral content, especially phosphorus. Normally, supplemental minerals are supplied in a free-choice mineral mix or force-fed in the total mixed ration.

Energy (Table 1).

The mean total digestible nutrients (TDN) was generally higher for the grain samples (oats, barley, wheat and mixed grain) and turnip roots than other feed types. Hay samples varied from 45.1 to 68.6% TDN, with a mean of 57.4% TDN. Silage varied from 54.9 to 76.6% TDN, while haylage had 53.6 to 68.5% TDN. Both pea straw and alsike clover appeared to have far lower TDN than other feed types.

General Consideration

Beef cattle production, whether on range, improved pasture, or in the feedlot, is most economic when feedstuffs are used effectively. Young growing grass or other high-quality pasture crops usually supply ample nutrients, such that mature and young growing cattle can consume sufficient good-quality mixed pasture (grasses and legumes) for normal growth and maintenance. However, mature pasture, crop residues, or forage crops harvested in a manner that results in shattering, leaching, or spoilage may be so reduced in nutritive value (particularly energy, protein, phosphorus, and provitamin A or β-carotene) that they are suitable only in a maintenance ration for adult cattle (Hilton, 2016). Such feedstuffs should be tested and should be supplemented if used for any other purposes.

Table 1. Summary (by feed type) of feed tests carried out for producers in parts of the Peace in 2017

		CP	Ca	P	Mg	K	Na	ADF	NDF	NFC	TDN	ME	NE_L	DE	NE_M	NE_G
Feed type	Number	%	%	%	%	%	%	%	%	%	%	Mcal /kg				
Hay	93	10 (4.40-17.0)	0.97	0.15	0.21	1.51	0.02	38.5	59.8	19.6	57.4 (45.1-68.6)	2.1	1.29	2.51	1.25	0.68
Silage	18	11 (6.89-16.4)	0.6	0.22	0.19	1.56	0.07	31.5			64.8 (54.9-76.6)	2.37	1.56	2.78	1.46	0.89
Haylage	4	9.7 (7.69-10.9)	0.59	0.19	0.19	1.6	0.04	36	61.2	17.4	60.1 (53.6-68.5)	2.2	1.36	2.65	1.34	0.76
Greenfeed	8	10.8 (8.10-13.4)	0.5	0.21	0.15	1.7	0.11	38.4	60.2	17.7	57.6 (51.7-66.9)	2.11	1.3	2.54	1.25	0.68
Aftermath	10	5.57 (3.21-9.30)	0.29	0.09	0.09	1.21	0.01	37.8	63.8	19.7	58.1 (52.7-63.5)	2.13	1.31	2.56	1.27	0.7
Turnip tuber	1	15.5	1	0.45	0.24	5.82	0.32	24			70.1	2.57	1.6	3.09	1.67	1.06
Oat Grain	3	12.2 (9.78-14.5)	0.11	0.35	0.14	0.69	0.01	17.9			75.3 68.6-82.3)	2.75	1.73	3.32	1.83	1.19
Barley grain	3	11.6 (10.2-13.1)	0.07	0.32	0.12	0.49	0.02	10.2			82.8 (81.7-84.5)	3.03	1.92	3.65	2.06	1.4
Wheat grain	1	13.9	0.05	0.42	0.14	0.42	0	3.2			85.8	3.14	1.99	3.78	2.15	1.47
Mixed grain	2	13.7 11.4-15.9)	0.09	0.36	0.13	0.67	0.02	10.3			87.6 (84.5-90.7)	3.21	2.04	3.87	2.2	1.52
Pea straw	1	7.12	1.41	0.08	0.19	1.55	0.02	45.6	63.7	18.3	49.9	1.83	1.1	2.2	0.99	0.44
Alsike clover	1	13.6	1.11	0.17	0.3	1.88	0.01	46.5			48.9	1.79	1.08	2.16	0.95	0.4

High Legume Pasture Project

By Lekshmi Sreekumar, PCBFA
Collaborator: Conrad Dolen, Fourth Creek
Funder: Alberta Agriculture & Forestry; Growing Forward 2

Sainfoin (*Onobrychis viciifolia*), an introduced legume that can be used as hay, or grazed by livestock possesses polyphenolics including condensed tannins (CT) that contribute to some of its superior nutritional properties such as improved protein utilization, bloat-free, and anthelmintic characteristics. Sainfoin plants are adapted to dry and calcareous soils, winter hardy, and resistant to the alfalfa weevil. Low persistence of sainfoin in mixed stands and high cost of sainfoin seeds are creating dilemma among producers when incorporating sainfoin varieties into their forage mixtures.

Agriculture and Agri-Food Canada (AAFC) scientist Dr. Surya Acharya at the Lethbridge Research & Development Centre has developed a new variety of sainfoin (AC Mountainview) with excellent productivity and good longevity. It also has been proven that AC Mountainview maintained higher dry matter yield in mixed stands than other sainfoin varieties. These improvements will likely benefit farmers in providing a superb forage for grazing and adding fertility to the soil. To provide farmers with the necessary information and experience to establish their own high legume pasture, demonstration sites were established across the province of Alberta and into the BC Peace. These sites were seeded to a 60% legume mixture, which was comprised of 20% AAC Mountainview, 40% alfalfa, and 40% grass mixture.

Objectives

- To explore increased forage productivity, drought resistance, and nitrogen fixation benefits with a high legume stand
- To assess the bloat mitigation potential of sainfoin
- To examine establishment success (and the challenges of establishment), bloat mitigation, and longevity of the legume stand
- To explore the sainfoin performance under grazing pressure
- To capture the performance of sainfoin across a broad range of climatic regions.

Methods

In the Peace region, PCBFA carried out the High Legume Pasture Project with Conrad & Daniela Dolen in Fourth Creek, which was seeded in 2016 and established well.

In 2017, ten random forage samples were collected twice (before and after grazing). The first sampling was done in July (before grazing) with a 0.25 m x 0.25 m quadrat and the second was done after the first frost in September using a 1 m x 1m quadrat.

In July 2017 (prior to grazing), the percentage of each species in the High Legume Pasture mix stand was as follows: 71.5% for grasses, 19.5% for alfalfa, 5% for weeds and 4% for sainfoin. There were some clovers in the forage mixtures collected. Common weed species observed included foxtail barley (which is difficult to control in a grass-legume mix), Canada Thistle and Dandelion.

In 2017, a second sampling (after grazing) was done in September after the first frost. For the second harvest, average DM yield of alfalfa was 892 lbs/acre, and 536 lbs/acre for grasses. Only a few sainfoin stands was observed in the field.

Table 1: Forage weights from the first pasture clippings (July 2017, prior to grazing)

No.		% of sample (by weight)	Fresh weight (g)	Dry Weight (g)	No.		% of sample (by weight)	Fresh weight (g)	Dry Weight (g)
1	Sainfoin				2	Sainfoin	8.25	27.0	21.0
	Alfalfa	60.4	245.0	100.0		Alfalfa	18.6	61.0	32.0
	Grass	39.5	160.0	88.0		Grass	53.2	174.0	93.0
	Other legumes					Other legumes	6.73	22.0	17.0
	Weeds					Weeds	13.1	43.0	25.0
3	Sainfoin				4	Sainfoin	17.4	33.0	24.0
	Alfalfa	13.9	60.0	32.0		Alfalfa	30.6	58.0	31.0
	Grass	80.0	344.0	171.0		Grass	51.8	98.0	58.0
	Other legumes	6.04	26.0	19.0		Other legumes			
	Weeds					Weeds			
5	Sainfoin				6	Sainfoin	11.4	21.0	18.0
	Alfalfa	33.1	55.0	32.0		Alfalfa	20.1	37.0	22.0
	Grass	53.0	88.0	51.0		Grass	59.2	109.0	66.0
	Other legumes	13.8	23.0	20.0		Other legumes	9.30	17.0	15.0
	Weeds					Weeds			
7	Sainfoin	6.50	18.0	15.0	8	Sainfoin			
	Alfalfa	17.8	49.0	30.0		Alfalfa	73.0	322.0	118.0
	Grass	61.0	168.0	98.0		Grass	26.9	119.0	68.0
	Other legumes	14.5	40.0	26.0		Other legumes			
	Weeds					Weeds			
9	Sainfoin				10	Sainfoin			
	Alfalfa	14.9	31.0	23.0		Alfalfa	73.0	322.0	118.0
	Grass	73.4	152.0	88.0		Grass	26.9	119.0	68.0
	Other legumes	11.5	24.0	19.0		Other legumes			
	Weeds					Weeds			

Subsoiling to Reduce Soil Compaction in Pastures

By Lekshmi Sreekumar, PCBFA

Collaborator: Mackay Ross

Forage production in various beef cattle operations is declining year after year. This decline in forage production is attributed to several factors such as climate, soil compaction, decline in soil fertility, weed competition and reduced stand vigour. The consistent use of heavy machinery and cattle trampling in pastures have been identified as factors responsible for compacted soil layers in beef cattle production systems. Heavily compacted soils contain few large pores and have a reduced rate of both water infiltration and drainage from the compacted layer. Finally, while soil compaction increases soil strength, the plant roots must exert greater force to penetrate the compacted layer. The overall effect of compacted and unhealthy soil is reduced forage yield.

Subsoiling can break compacted soil layers without disturbing plant life, topsoil or surface residue. Studies have shown that fracturing compacted soil promotes root penetration by reducing soil density and strength, improving moisture infiltration and retention, and increasing the air spaces in the soil. Success depends on the type of equipment selected, its configuration, and the speed with which it is pulled through the ground. No one piece of equipment or configuration works best for all situations and soil conditions, making it difficult to define exact specifications for subsoiling equipment and operation. The objective of this study was to conduct an assessment on the suitability of different types of subsoilers (in combination with or without rolling) for reducing soil compaction, increasing soil infiltration and increasing the forage yield.

Methods:

An on-farm study was conducted from fall (October 2015) to summer (July 2016) on a pasture paddock in Cleardale. The paddock was initially seeded to creeping red fescue. Alsike clover was later broadcast (12 years later, 2011) onto the paddock.

A demonstration strip design was used.
We used 2 types of subsoilers - a Sumo (GLS-Grassland) subsoiler and an Agrowplow (Model AP91).
The subsoiling treatments consisted of the following:

1. Sumo alone – subsoiling to a depth of 12’’
2. Sumo + rolling - subsoiling to a depth of 12’’ followed by rolling
3. Agrowplow alone - subsoiling to a depth of 12’’
4. Agrowplow + rolling - subsoiling to a depth of 12’’ followed by rolling
5. Control (check)

The treatments were implemented in early fall on October 9, 2015.

At approximately 9 months after subsoiling, the following field measurements were taken on July 7, 2016:

1. Water infiltration with aluminized coated rings of 6’’ diameter and 5 ¼’’ height.
2. Compaction reading with a digital penetrometer at 1” interval to a soil depth of 12”
3. Forage moisture content
4. Forage DM yield and nutritional value

The measurements were taken again on August 24, 2017 after the pasture had been grazed four times in 2017, at intervals of 2-6 days with 20-25 cow/calf pairs.

Results and Interpretation:

Infiltration (Table 1)

Infiltration rate is a measure of how fast water enters the soil and is typically expressed in inches per hour. The highest infiltration rate of 1.23 inches/hr was recorded with Agrowplow alone followed by Agrowplow-Rolled (0.96 inches/hr). The Lowest infiltration rate was recorded for control (0.08 inches/hr). Between the Agrowplow and sumo subsoiler (alone or in combination), the Agrowplow seems to be more efficient in increasing the infiltration rate compared with sumo. Sumo rolled seems to have higher infiltration rate (0.89 inches/hr as compared with sumo alone (0.86 inches/hr).

The downward movement of water within the soil is called percolation, permeability or hydraulic conductivity. Permeability also varies with soil texture and structure. Permeability is generally rated from very rapid to very slow (Table 2). The infiltration rate of 1.23 inches/hr that was recorded for Agrowplow and 0.96 inches/hr recorded for Agrowplow-Rolled seems to show moderate water infiltration. Similar results were achieved with the Sumo alone and in combination with rolling. With the infiltration rate of 0.08 inches/hr recorded for control, the control clearly had slow water infiltration. The moderate infiltration rate attained with the subsoilers as compared with control indicates that subsoiling can reduce compaction a considerable amount, and facilitate better water infiltration, root penetration and forage production.

Forage Moisture &Dry Matter Yield (Table 1)

The highest forage moisture percent (86%) was recorded with Sumo-Rolled followed by Sumo (85%) and lowest in Agrowplow (79%). The lower water infiltration rates with Sumo and Sumo-Rolled resulted in higher moisture content in forages, compared to Agrowplow. The highest dry matter yield (957 lbs/acre) was recorded for Agrowplow-Rolled, compared with Sumo-Rolled (936 lbs/acre) followed by Agrowplow alone (909 lbs/acre). Again the data shows the effectiveness of Agrowplow-Rolled in mitigating soil compaction and increasing the forage yield.

Table 1. Soil water infiltration, forage moisture and dry matter yield

Sub-soiler	Infiltration rate (Inches/hr)	Forage moisture (%)	Dry matter yield (lbs/acre)
Sumo	0.86	85	874
Agrowplow	1.23	79	909
Sumo-Rolled	0.89	86	936
Agrowplow-Rolled	0.96	82	957
Control	0.08	84	698

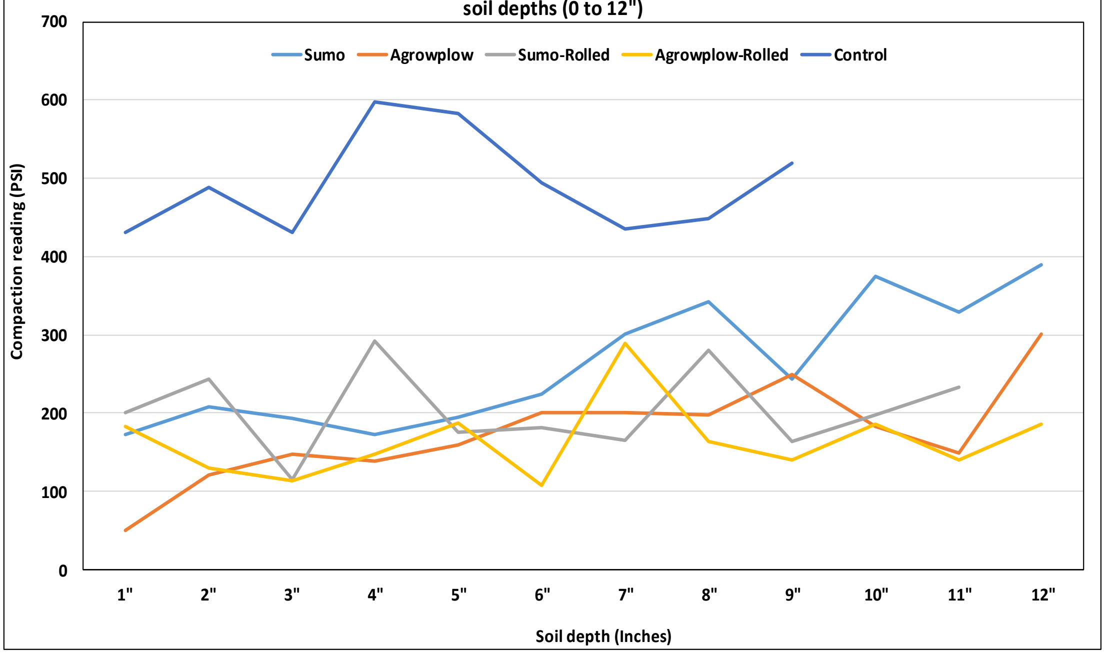
Table 2. Permeability classification systems	
Permeability class	**Rate (inches/hour)**
Very rapid	Greater than 10
Rapid	5 to 10
Moderately rapid	2.5 to 5
Moderate	0.8 to 2.5
Moderately slow	0.2 to 0.8
Slow	0.05 to 0.2
Very slow	Less than 0.05

Compaction

Soil compaction is measured by soil penetrometers in psi. Penetrometers measure soil strength and their movement through the soil, which is related to the soil's resistance to root penetration. Plant roots, however, grow around obstacles and can exert tremendous local pressure on soil pores so that penetrometers can only provide a relative root resistance value. Readings of 400-500 psi indicate potential soil compaction.

Here from figure 1, the compaction reading of 420 psi with the control indicate that soil compaction is an issue in this particular beef cattle production system, which results in lower forage productivity. Use of different subsoilers seemed to reduce the compaction values as compared to control. The highest reduction in compaction occurs under Agrowplow, followed by Agrowplow-rolled. In a nutshell, Agrowplow alone or in combination with rolling is found to be more effective in reducing the soil compaction as compared with the Sumo subsoiler.

Figure 1. Subsoiler types with and without rolling and thier effects on soil compaction at different soil depths (0 to 12")



Conclusion

Subsoiling proved to be an effective tool for reducing soil compaction, increasing soil water infiltration, improving plant nutrient absorption, and increasing forage productivity.

Crop Production Projects

Comparison of Yield and Agronomic Performance of Common CWRS & CPSR Wheat Varieties Grown in the Peace Region

By Akim Omokanye & Lekshmi Sreekumar, PCBFA
Collaborator/Funder: Alberta Wheat Commission

The annual wheat production in Alberta is about 8.4 million tonnes, according to the recent Alberta Crop Production Statistics. Spring wheat alone accounts for about 88% of the total wheat production in Alberta. In the Peace Country, producers have a preference for early or medium maturing varieties that have high yield potential. Grain quality and incidence of pests and diseases are also important considerations. Every year, several new wheat varieties are registered. It is important to identify varieties that are suited to the Peace region. The wheat varieties grown in the Peace region are mainly from the Canada Prairie Spring Red (CPSR) and Canada Western Red Spring (CWRS) wheat classes. Some of the most common varieties grown in the Peace region are Go Early, Stettler, CDC Landmark, CDC Stanley and Thorsby.

Objective

To compare grain yield, grain yield components, grain protein and straw quality of wheat varieties commonly grown in the Peace region of Alberta.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous crop: The site was sprayed out and left unseeded (chemical fallow) in 2016. In 2015, the site was seeded to barley. Before 2015, the site had been in an alfalfa dominated forage stand for hay production for over 10 years.
- Soil information (0-6” depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH of 5.8, organic matter of 7.0 %, and electrical conductivity of 0.21 dS/m. The soil was deficient in N and P, and had marginal amounts of K and S.
- The field was cultivated before seeding (disked and harrowed). Individual plot size was 11.04 m^2 (118.8 ft^2).
- Experimental Design: Randomized complete block design in 4 replications.
- Treatments: The 16 varieties seeded are listed below (10 CWRS & 6 CPSR varieties).
    1. Utmost - CWRS, awnless
    2. CDC Landmark - CWRS, awned
    3. AAC Viewfield - CWRS, awned
    4. CDC Stanley - CWRS, awnless
    5. Thorsby - CWRS, awnless
    6. CDC Go - CWRS, awned
    7. AAC Redwater - CWRS, awned
    8. Go Early - CWRS, awned
    9. Stettler - CWRS, awned
    10. CDC Titanium (Check for CWRS) - CWRS, awned
    11. 5700 PR (Check for CPSR) - CPSR, awned
    12. AAC Crusader - CPSR, awned
    13. HY 2013 - CPSR, awned
    14. Elagin ND - CPSR, awned
    15. AAC Tenacious - CPSR, awned
    16. AAC Penhold - CPSR, awned

- Seeding rate and seeding date: 350 plants/m^2 (32.4 plants/ft^2), seeded on May 30
- Seeding method: 6-row Fabro plot drill with 9” row spacing

- Fertility (actual lbs/acre): 89 N + 50 P + 29 K + 24 S
- Spraying: In-crop spraying was done once with Curtail M (800 ml/acre) + Fluroxyoyr (170ml/acre)
- Measurements: Data collection consisted of plant height from 5 random plants/plot (August 28), grain yield and grain yield components (kernel weight and test weight), grain protein and straw quality. Grain yield was adjusted to 12% moisture content. Field notes were taken on plant lodging just before grain harvest. All of the varieties were combined on September 26 with a Wintersteiger plot combine. Grain samples for protein content and straw samples for quality indicators were shipped to A&L Laboratory (Ontario) for analysis using standard laboratory methods.
- Field data were subjected to analysis of variance (ANOVA) using a pre-defined model for randomized complete block design in Costat statistical software procedure. When ANOVA indicated significant treatment effects, the means were separated by the least significant difference (LSD) at the 0.05 probability level.

Results and Discussion

Plant Height (Table 1)

Overall, plant height was statistically similar for all varieties tested (CWRS & CPRS). Among the CWRS varieties, Thorsby seemed to have slightly higher plant height value (111 cm). Among the CPSR, AAC Tenacious appeared to have higher plant height value (109 cm) than other CPSR varieties.

Grain Yield & Grain Yield Components (Table 1)

The grain yield, kernel weight and test weight were all significantly affected by the wheat varieties tested here.

Overall, grain yield was highest for the AAC Penhold variety (118.7 bus/acre), followed by AAC Viewfield variety (116.3 bus/acre), CDC Titanium (112.7 bus/acre) and then CDC Landmark (111.3 bus/acre). Overall, 12 of the varieties had grain yield of 100 bus/acre or more. For CWRS varieties, grain yield as percent of check (CDC Titanium) seemed to be higher (by a small margin) only for AAC Viewfield (103%) than other CWRS varieties tested here. For CPSR varieties, all varieties compared to 5700 PR (check for CPSR) appeared to have grain yield increases, which varied from 106% (for AAC Tenacious) to 146% (for AAC Penhold) over 5700 PR (check).

Looking at both classes of wheat tested (CWRS & CPRS), grain (kernel) weight was highest for CDC Landmark (47.7g/1000 kernel), followed closely by CDC GO (47.5g/1000 kernel) and then AAC Penhold (45.0g/1000 kernel). Kernel weight was <40 g/1000 kernel for 10 of the 16 varieties.

Overall, test weight varied from 62 lbs/bushel for Go Early, AAC Crusader and AAC Tenacious to 66 lbs/bushel for CDC Landmark.

Grain Crude Protein (CP) (Table 1)

The grain CP content was significantly affected by the varieties tested here. For CWRS varieties, CDC Titanium (check for CWRS) had the highest grain CP (21.4%). The grain CP content for CWRS was mostly >18%. For CPSR varieties, AAC Tenacious had the highest grain CP content (19.9%), while 5700 PR (check for CPSR) seemed to have lower grain CP than other CPSR varieties (except for AAC Crusader).

Straw Quality (Table 2)

Straw Crude Protein (CP): Generally, the straw CP content was significantly affected by the varieties tested here. For CWRS varieties, Utmost had the highest straw CP content (6.79%). For CPSR varieties, 5700 RR (check for CPSR) had the highest straw CP (7.04%).

Table 1. Plant height, grain yield and grain yield components, and grain crude protein (CP, % DM) content of 10 CWRS and 6 CPSR wheat varieties tested in Fairview in 2017. NS, not significant; and *, significance at P<0.05

Variety	Plant Height (cm)	Grain Yield (bus/acre)	Grain Yield as % of respective checks	Kernel Weight (g/1000 kernel)	Test Weight (lb/bus)	Crude Protein (% DM)
CDC TITANIUM (check for CWRS)	**100 abcd**	**112.7 abc**	**100**	**42.0 e**	**63 d**	**21.4 a**
UTMOST	106 abc	106.3 bcde	94	37.5 j	64 c	18.5 i
CDC LANDMARK	93 bcd	111.3 abcd	99	47.7 a	66 a	19.8 c
AAC VIEWFILED	89 d	116.3 ab	103	36.5 k	65 b	19.6 d
CDC STANLEY	100 abcd	102.1 cde	91	34.5 l	64 c	18.8 h
THORSBY	111 a	100.7 cde	89	41.0 f	63 d	19.0 f
CDC GO	93 bcd	109.7 abcd	97	47.5 b	65 b	19.5 d
AAC REDWATER	106 abc	108.6 abcde	96	39.0 g	64 c	17.6 l
GO EARLY	107 abc	96.4 ef	86	42.5 d	62 e	20.3 b
STETTLER	101 abcd	108.2 abcde	96	36.5 k	64 c	18.3 j
5700 PR (check for CPSR)	**95 abcd**	**81.4 g**	**100**	**38.0 i**	**64 c**	**17.4 m**
AAC CRUSADER	99 abcd	99.8 de	123	39.0 g	62 e	17.3 n
HY 2013	91 cd	102.1 cde	125	33.5 m	65 b	19.3 e
ELAGIN ND	97 abcd	100.1 de	123	38.5 h	64 c	18.9 g
AAC TENACIOUS	109 ab	86.4 fg	106	37.5 j	62 e	19.9 c
AAC PENHOLD	100 abcd	118.7 a	146	45.0 c	65 b	18.0 k
Mean	*100*	*103.8*		*39.7*	*63.8*	*19.01*
$LSD_{0.05}$	*16.9*	*12.2*		*0.17*	*0.40*	*0.08*
Significance	*NS*	*		*	*	*
Coefficient of variation,%	*10.1*	*8.25*		*0.31*	*0.44*	*0.32*

For mixed crop-livestock producers who may be thinking of using the residue from wheat as roughage for livestock, particularly beef cattle, none of the varieties had sufficient CP to meet the requirements of mature beef cattle. Only 5700 PR and Utmost appeared to have adequate forage value for a dry gestating beef cow in the mid pregnancy stage, which requires 7% CP.

Where the straw is left on the field to add organic matter and nutrients to the soil for subsequent crop production, both 5700 PR and Utmost would be valuable in adding more N to the soil (assuming the straw yield from both was substantial). The straw N content from 5700 PR & Utmost varied from 1.09-1.13% N. Other varieties had <1.00% N.

Energy (Table 2)

The forage total digestible nutrients (TDN) were generally >50%. Using wheat crop residue as roughage, the straw energy content (% TDN) from only 4 (Utmost, CDC Stanley, 5700 PR and AAC Penhold) of the 16 varieties tested here was adequate for a dry gestating beef cow in mid pregnancy stage. None of the varieties tested had enough TDN for pregnant beef cows in late pregnancy and lactating stages. The straw net energy for maintenance (NE_M) from all varieties was generally enough to meet the NE_M requirements of mature beef cattle, which are 0.97-1.10 Mcal/kg during pregnancy and 1.19-1.28 Mcal/kg during lactation.

Table 2. Straw quality of 10 CWRS and 6 CPSR wheat varieties tested in Fairview in 2017.
*NS, not significant; and *, significance at P<0.05; CV, Coefficient of variation.*

Quality Indicator	Unit	CWRS Varieties									CPSR Varieties							Statistics			
		CDC TITANIUM	UTMOST	CDC LANDMARK	AAC VIEWFIELD	CDC STANLEY	THORSBY	CDC GO	AAC REDWATER	GO EARLY	5700 PR	STETTLER	AAC CRUSADER	HY 2013	ELAGIN ND	AAC TENACIOUS	AAC PENHOLD	Mean	Significance	$LSD_{0.05}$	CV, %
CP	%	4.82	6.79	5.69	5.57	5.98	4.61	4.4	5.25	3.8	7.04	3.35	4.33	3.5	3.62	4.58	5.45	4.96	*	0.49	4.72
Sol-CP	% of CP	25.7	45.7	31.8	35.9	39.1	27.8	20.0	34.5	21.6	44.6	15.5	27.9	26.6	29.1	23.1	40.2	30.6	*	0.34	0.53
ADF-CP	%	1.93	1.85	2.12	2.06	1.94	2.03	2.2	1.71	2.17	1.59	2.29	1.66	2.09	2.32	1.83	1.62	1.98	NS	0.35	8.32
NDF-CP	%	2.13	2.15	2.41	2.29	2.17	2.51	2.6	1.93	2.47	2.63	2.39	2.17	2.69	2.4	1.95	2.28	2.28	*	0.48	9.86
UIP	Est % CP	37.1	27.2	34.1	32.0	30.4	36.1	40.0	32.8	39.2	27.7	42.2	36.0	50.7	46.3	38.4	29.9	36.2	*	0.32	0.42
ADF	%	44.9	42.7	47.1	43.9	40.5	46.2	48.0	45.5	47.1	41.1	48.1	46.0	48.4	48.7	46.7	42.9	45.5	*	0.37	0.39
NDF	%	73.8	66.3	73.2	71.0	65.6	75.3	74.4	70.0	78.2	68.0	78.1	75.7	78.1	79.0	74.3	71.1	73.2	*	0.33	0.21
TDN	%	54.0	55.6	52.2	54.7	57.3	53.0	51.6	53.4	52.2	56.9	51.5	53.1	51.2	51.0	52.5	55.5	53.5	*	0.46	0.40
NE_L	MCal/Kg	1.21	1.25	1.16	1.23	1.29	1.18	1.15	1.19	1.16	1.28	1.14	1.19	1.14	1.13	1.17	1.24	1.19	*	0.04	1.95
NE_G	MCal/Kg	0.56	0.60	0.51	0.58	0.65	0.53	0.49	0.54	0.51	0.64	0.48	0.53	0.48	0.47	0.51	0.60	0.54	*	0.04	3.61
NE_M	MCal/Kg	1.28	1.33	1.23	1.30	1.38	1.25	1.21	1.26	1.23	1.36	1.20	1.25	1.20	1.19	1.23	1.32	1.26	*	0.04	1.63
Ca	%	0.20	0.33	0.23	0.26	0.19	0.28	0.23	0.18	0.23	0.27	0.23	0.19	0.23	0.24	0.17	0.24	0.22	*	0.04	8.90
P	%	0.05	0.07	0.06	0.06	0.08	0.04	0.04	0.06	0.03	0.07	0.04	0.04	0.02	0.02	0.03	0.04	0.04	*	0.05	56.9
K	%	0.48	0.62	0.40	0.56	0.57	0.60	0.61	0.20	0.47	0.57	0.81	0.59	0.77	0.71	0.36	0.88	0.58	*	0.02	2.41
S	%	0.08	0.12	0.11	0.12	0.10	0.10	0.08	0.08	0.08	0.12	0.08	0.09	0.09	0.10	0.07	0.11	0.09	NS	0.02	12.0
Mg	%	0.15	0.14	0.22	0.18	0.13	0.13	0.16	0.14	0.16	0.12	0.10	0.10	0.10	0.12	0.12	0.13	0.13	*	0.04	15.4
Na	%	0.01	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	*	0.02	0.09
Zn	ppm	34.6	35.6	35.2	32.8	37.9	33.2	26.2	46.0	29.3	29.1	30.7	36.9	29.4	35.2	32.5	43.6	34.2	*	0.43	0.59
Fe	ppm	69.7	104	80.5	72.6	93.0	78.4	59.8	94.4	74.8	55.2	53.1	73.0	64.7	79.5	54.9	66.5	73.4	*	0.46	0.29
Mn	ppm	45.4	40.0	58.6	41.7	43.0	52.7	35.9	60.4	43.0	31.4	32.4	44.3	26.7	38.3	37.3	46.5	42.3	*	0.49	3.12
Cu	ppm	2.58	3.17	2.39	2.83	2.78	2.56	2.55	2.84	2.73	2.75	2.01	2.88	3.24	2.68	2.18	2.91	2.69	*	0.04	0.79
NFC	%	9.9	15.4	9.7	12.0	17.0	8.6	9.8	13.3	6.5	13.5	7.0	8.5	6.9	5.9	9.6	12.0	10.4	*	0.41	1.85
RFV		68.0	78.1	66.4	71.7	81.4	65.4	64.5	71.0	62.1	77.9	61.3	65.3	61.0	60.1	65.7	72.6	68.2	*	0.43	0.30

Straw Minerals (Table 2)
Each of the minerals measured here was highest for the following varieties:
Straw Ca: Utmost
Straw K: AAC Penhold
Straw Mg: CDC Landmark
Straw Zn: AAC Penhold
Straw Fe: Utmost
Straw Mn: CDC Landmark
Straw Cu: Utmost

The straw S content appeared to be similar for all varieties.

Except for AAC Tenacious, all wheat varieties tested here had adequate straw Ca and Fe content for a dry gestating beef cow in mid pregnancy stage. A few varieties had enough straw Mg and K for pregnant beef cows in mid pregnancy stage. All varieties were far from meeting the P and Cu requirements of a pregnant beef cow in mid pregnancy stage.

Conclusion

Grain yield and grain protein content are some of the objectives in wheat breeding programs, as these traits are important determinants of the economic value of the harvested product. In this study, AAC Penhold with the highest grain yield seemed to have lower protein than most varieties tested. Overall, CDC Titanium (check for CWRS) appeared to have some potential for both grain yield and high protein content, compared to both other CWRS varieties as well as CPSR varieties. It is important to note that straw is a low energy, and low protein feed. It is not as digestible as hay or greenfeed. In this study, only 4 (Utmost, CDC Stanley, 5700 PR and AAC Penhold) of the 16 varieties tested had enough TDN for a dry gestating beef cow in mid pregnancy stage. For CWRS varieties, Utmost had the highest straw CP content (6.79% CP) and for CPSR varieties, 5700 PR (check for CPSR) had the highest straw CP (7.04% CP). From the results of straw quality obtained here, it is evident that straw should not be fed to beef cattle without supplementation because rarely does straw provide enough energy, protein and minerals to meet a mature beef cow's requirements.

Acknowledgments

This study was funded by the Alberta Wheat Commission. Fertilizer was donated by CPS Fairview. Wheat varieties used were sourced from Fairview, Falher and High Prairie Co-op Seed Cleaning Plants, and from the following producers: Murray Lewis (Cleardale), Ron Heck (Fairview) and Nick Sekulic (Rycroft). The technical help by PCBFA staff, Thomas Claydon (PCBFA director) and GPRC farm (Fairview campus) is highly appreciated.

On-farm Evaluation of the Agronomic and Economic Benefits of Organic Based Crop Nutrient Sources on Oat and Pea Production

By Akim Omokanye

Collaborators:
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*Prairie Organic Grain Initiative (*Funder)
*Organic Alberta (*Funder)

Foliar feeding involves the application of nutrients (through spraying) to plant leaves and stems, and their absorption at those sites. It is a viable means of enhancing crop nutrition. Foliar feeding has been used as a means of providing supplemental doses of minor and major nutrients, stimulants, and other beneficial substances. Observed effects of foliar feeding have included yield increases, resistance to diseases and insect pests, improved drought tolerance, and enhanced crop quality. Plant response is dependent on species, nutrient form, concentration, and frequency of application, as well as the stage of plant growth. Foliar applications are often timed to coincide with specific vegetative or fruiting stages of growth. Several foliar feeding nutrients are available in the market, but in this study, we only used Compost Tea, Fish Fertilizer and Liquid Carbon 9-5-3, to learn if there was a measurable benefit to foliar feeding using these products.

Objectives

To find ways to improve plant and soil health, and ultimately yield and profitability.

Methods

The study was carried out at Mark and Tracy Vetsch's farm in Valleyview, MD of Greenview, Alberta. It was an on-farm study using multiple acre test plots across the entire field.

Two crop types (oats and peas) were used on separate fields, which were far apart. The oats were seeded on the field at NW5-72- 21W5 and the peas were seeded on the field at NW7-72- 21W5. Both fields were cultivated before seeding. Soil samples were taken from 0-6" depth just before the foliar feeders were sprayed.

Table 1 shows soil nutrients and quality as well as soil health indicators for both fields. The soil tests showed a pH of 5.9-6.1 for the fields. Soil organic matter was higher for the oat field (4.7-8.7%) than the pea field (2.8-3.0%). The soil nitrate-N was lower for the pea soil (4-5 ppm, 8-10 lbs/acre) than the oat soil (15-36 ppm, 30-72 lbs/acre). The soil health index was lower for the pea field (27.5) than the oat field (32.0), indicating that the oat field was probably slightly healthier and had slightly more microbial activities than the pea soil.

Table 2 shows % base saturation obtained from the fields and the desired levels for each measurement. Except for %Mg, which was within the 10-20% ideal (optimum) level for crop production, other elements (K & Ca) as well as K/Mg ratios were all below the ideal levels for crop production.

Morgan oats was seeded @ 140 lbs/acre (42 lbs/bushel) into 2.0" depth on May 27.

Meadow peas (yellow) was seeded @ 240 lbs/acre (12 seeds/ft^2) into 1.5-2.0" depth. The pea seed was inoculated with Tag Team® + AGTIV®.

Table 1. Soil chemical (nutrients) and health indicators measured from 0-6" depth taken just before spraying foliar feeders (CT+FF and Humalite).

Parameter	Peas		Oats	
	Pre-CT+FF	Pre-Humalite	Pre-CT+FF	Pre-Humalite
Chemical Parameter				
pH	6.1	6.0	5.9	6.1
Organic matter, %	3.0	2.8	8.7	4.7
EC, ms/cm	0.19	0.19	0.55	0.33
Nitrate-N, ppm	4	5	36	15
P (Bicarb method), ppm	20	15	16	13
P (Bray-P1 method), ppm	28	19	21	23
K, ppm	26	50	48	63
Mg, ppm	290	265	375	345
Ca, ppm	1120	1050	2180	1600
Na, ppm	31	27	25	30
S, ppm	10	9	32	18
Zn, ppm	3.5	31	6.5	4.9
Mn, ppm	19	23	8	19
Fe, ppm	136	105	119	113
Cu, ppm	0.5	0.4	0.6	0.5
B, ppm	0.1	0.3	0.7	0.3
Al, ppm	704	644	607	627
Soil Health Indicator				
Mineralizable N	43	36	52	45
CO_2 respiration	82	60	128	90
Biological quality rating	4	4	5	4
Active C	536	480	897	784
Solvita CO_2-C, ppm	82	60	128	90
Reactive C, ppm	536	480	897	784
Soil health index	27	28	33	31

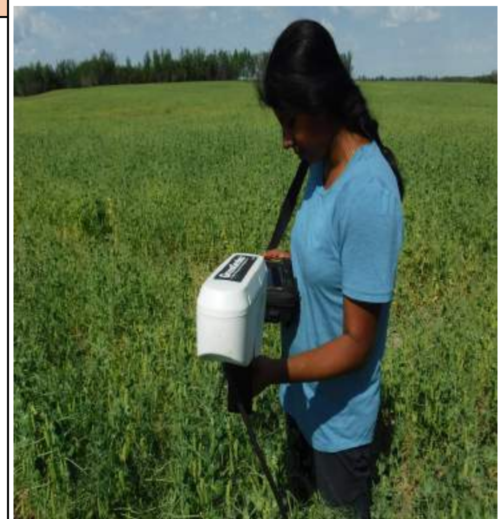


Table 2. Soil cation exchange capacity (CEC), K/Mg ratio, general fertility index (GFI) and % nutrients and base saturation from 0-6" depth taken just before spraying foliar feeders (CT+FF and Humalite). For GFI, L indicates low level & M indicates moderate level

Parameter	Peas		Oats		Ideal (optimum) level
	Pre-CT+FF	Pre-Humalite	Pre-CT+FF	Pre-Humalite	
CEC, meg/100g	13	11.3	17.8	14.7	
K/Mg Ratio	0.03	0.06	0.04	0.06	0.25-0.35
General Fertility Index	48	53	57	57	L
%K	0.5	19.6	0.7	1.1	3-5
%Mg	18.6	1.1	17.5	19.5	10-20
%Ca	43.1	46.6	61.2	54.3	65-72
%H	36.7	31.7	20	24.2	5-15
%Na	1	1	0.6	0.9	<1
Base saturation (Ca, Mg, K & H), %	98.9	99.00	99.4	99.1	

On June 7, red clover was seeded into the peas @ 5lbs/acre with a double disc drill (DDD). Peas were beginning to emerge when the red clover was being seeded. On June 10, sweet clover was seeded into the oats @ 6lbs/acre with a DDD when the oats were about 2” tall.

The organic based foliar feeders (fertilizers) used were Compost Tea (CT), Fish Fertilizer (FF) and Liquid Carbon 9-5-3 (from Canada Humalite International (CHI), Edmonton). The foliar fertilizers consisted of a combination of CT+FF as one foliar feeder type and Liquid Carbon 9-5-3 (Humalite) as another type of foliar feeder.

The treatments from the foliar feeders tested were:

1. Control
2. Humalite (CHI liquid carbon 9-5-3)- Just one application on July 5 @ 4 L/acre with 18 L of water
3. Early spraying of Compost Tea/Fish Fertilizer (CT-FF Early)– The combination of compost tea and fish fertilizer was sprayed early on July 6. This was done just once.
4. Delay spraying of Compost Tea/Fish Fertilizer (CT-FF Delay)– The combination of compost tea and fish fertilizer was sprayed early on July 20. This was done just once as well.
5. Two applications of Compost Tea/Fish Fertilizer (CT-FF 2Apps)- The combination of compost tea and fish fertilizer was sprayed twice, first on July 6 and then July 20.

Compost tea was applied @4 L/acre and fish fertilizer @ 6 L/acre. Water was 50 L/acre.

The budget for CHI liquid carbon 9-5-3 and compost tea + fish fertilizer were:

- Cost of compost tea (CT) + fish fertilizer (FF) = $35.00/acre ($10 for CT product, $15 for FF product & $10 for spraying application)
- Humalite (CHI liquid carbon 9-5-3) = $18.80 /acre (for product & spraying application).

Measurements taken:

- Soil nutrients and soil health indicators– base data sampling was taken this year in spring. Another set of samples will be taken in spring 2018 to enable comparisons of soils taken in both years.
- Crop yield and quality, thousand kernel weight, test weight (only for oats) were determined.
- The peas were assessed for nodulation.

- Straw yield and quality were determined as well.
- A spectroradiometer equipment known as Green-Seeker was used to measure Normalized Difference Vegetation Index (NDVI) at early/mid pod development stage.
- Simple economic performance using direct input costs and revenues.

Results and Discussion

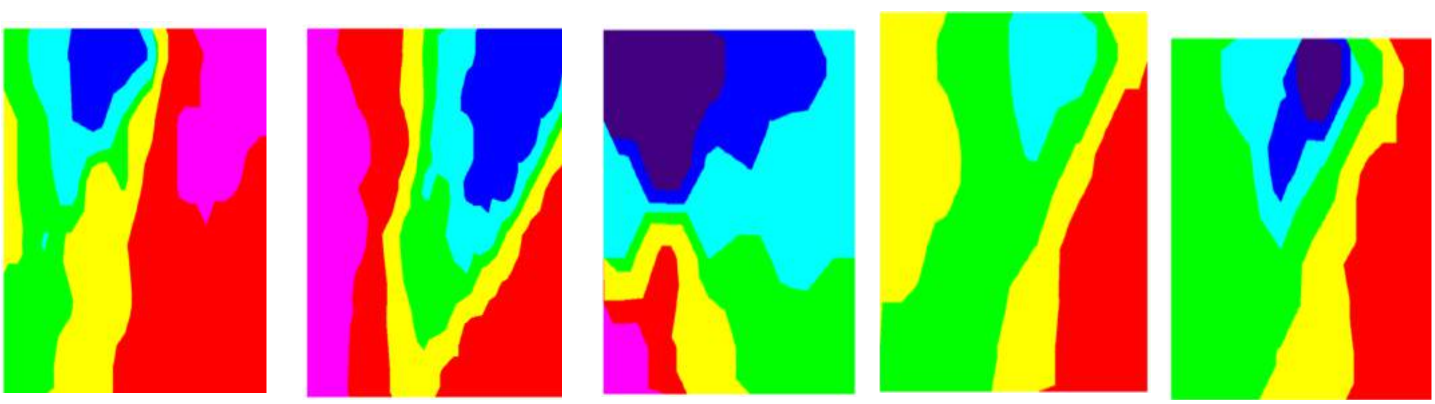
Pea Trial

Crop yield (Table 3): The pea yield varied from 35.1 bus/acre for CT+FF Delay to 45.7 bus/acre for CT+FF 2Apps. For some reason that is difficult to explain, CT+FF Delay produced lower yield than Control. For other foliar feeding treatments, yields over Control was 3% for CT+FF 2Apps, 4% for Humalite and 12% for CT+FF Early. Overall, in this study, foliar feeding treatments did not seem to improve yield over Control treatment much.

1000-seed weight (Table 3): The thousand pea grain weight varied from 209 grams/1000 grain for CT+FF Delay to 218 grams/1000 grain for Humalite. Also, CT+FF Delay had lower 1000-seed weight than Control and the reason for this is difficult to explain as well.

NDVI Values (Table 3): The results of the Green-Seeker optical unit showed that the NDVI score was highest for CT+FF 2Apps. Generally, all foliar feeding treatments seemed to give higher NDVI values than Control, which had an NDVI score of 0.78.

In simple terms, NDVI is a measurement of plant health based on how a plant reflects light (usually sunlight) at specific frequencies. The rules of thumb say that an NDVI plant health rating between 0 and 0.33 indicates unhealthy or stressed plant material, 0.33 to 0.66 is moderately healthy, and 0.66 to 1.00 is very healthy. Therefore looking at the NDVI values, all pea stands in this study seemed be healthy. CT+FF 2Apps appeared to producer slightly healthier pea crop than other foliar feeding treatments tested as well as control. Except for CT+FF Delay, all foliar feeding treatments had higher NDVI scores than Control.



Control, NDVI=0.78 | Humalite, NDVI=0.85 | CT+FF Early, NDVI=0.82 | CT+FF 2 Apps, NDVI=0.93 | CT+FF Delay, NDVI=0.78

Figure 1. NDVI scores of peas at early/mid pod stage following foliar feeding treatments

Grain Quality (Table 3)*:* The pea seed crude protein (CP) appeared to be similar for all foliar feeding treatments tested here, though CT+FF Delay foliar treatment tended to be slightly higher. There wasn't any apparent improvement with foliar feeding treatments here over Control for both macro and trace minerals measured.

Table 3. Crop yield & quality, and straw quality of peas when sprayed with foliar feeding products

Parameters	Unit	Control	Humalite	CT+FF Early	CT+FF 2Apps	CT+FF Delay	*Mean*
Crop Yield & Quality							
Seed yield	bus/acre	40.8	42.3	45.7	42.1	35.1	*41.2*
Seed yield increase as % of Control	%	100	104	112	103	86	
1000-Seed weight	Grams	215	218	211	216	209	*214*
NDVI values		0.78	0.85	0.82	0.93	0.78	*0.83*
CP	%	19.5	20	19.5	19.9	20.8	*19.9*
ADF (acid detergent fibre)	%	5.73	7.14	7.04	6.74	8.52	*7.03*
NDF (neutral detergent fibre)	%	9.01	10.5	10.2	9.79	11.6	*10.2*
TDN (total digestible nutrients)	%	84.4	83.3	83.4	83.6	82.2	*83.4*
NE_L (net energy for lactation)	Mcal/kg	1.96	1.93	1.93	1.94	1.9	*1.93*
NE_G (net energy for gain)	Mcal/kg	1.44	1.41	1.41	1.42	1.38	*1.41*
NE_M (net energy for maintenance)	Mcal/kg	2.16	2.13	2.13	2.14	2.1	*2.13*
Calcium	%	0.08	0.09	0.09	0.09	0.1	*0.09*
Phosphorous	%	0.25	0.28	0.32	0.31	0.19	*0.27*
Potassium	%	1.02	1.13	1.11	1.13	1.13	*1.1*
Sulphur	%	0.16	0.17	0.16	0.18	0.22	*0.18*
Magnesium	%	0.13	0.14	0.13	0.13	0.13	*0.13*
Sodium	%	0.01	0.01	0.01	0.01	0.01	*0.01*
Copper	ppm	7.28	8.42	8.55	8.95	7.49	*8.14*
Zinc	ppm	35.4	34.6	54.2	52.6	41.6	*43.7*
Iron	ppm	57.4	65.2	67.2	57.9	66.7	*62.9*
Manganese	ppm	12.5	13.7	10.2	11.3	11.2	*11.8*
NFC (Non-Fibre Carbohydrate)	%	60	58	58.7	58.7	56	*58.3*
Starch	%	46.5	44.3	45.2	43.6	41.6	*44.2*
Crude fat	%	1.56	1.52	1.24	1.44	1.7	*1.5*
Ash	%	2.29	2.29	2.5	2.49	2.4	*2.39*
Straw Quality							
CP	%	4.01	4.07	4.27	3.37	4.82	*4.11*
ADF (acid detergent fibre)	%	49	47.6	46.4	49.6	48.4	*48.2*
NDF (neutral detergent fibre)	%	61.2	62.2	61.7	63.9	62.8	*62.4*
TDN (total digestible nutrients)	%	50.6	51.8	52.7	50.2	51.1	*51.3*
NE_L (net energy for lactation)	Mcal/kg	1.13	1.15	1.18	1.12	1.14	*1.14*
NE_G (net energy for gain)	Mcal/kg	0.46	0.49	0.52	0.45	0.48	*0.48*
NE_M (net energy for maintenance)	Mcal/kg	1.18	1.21	1.24	1.17	1.2	*1.2*
Calcium	%	1.58	1.51	1.85	1.64	1.63	*1.64*
Copper	ppm	3.87	3.06	3.98	4.44	4.75	*4.02*
Phosphorous	%	0.04	0.04	0.06	0.04	0.04	*0.04*
Potassium	%	0.97	0.67	1.04	1	0.67	*0.87*
Sulphur	%	0.06	0.06	0.05	0.08	0.12	*0.07*
Magnesium	ppm	0.32	0.32	0.36	0.34	0.28	*0.32*
Zinc	ppm	9.7	8.17	20.2	10.4	19.6	*13.6*
Iron	ppm	15.5	22.5	18.9	8.86	11.8	*15.5*
Manganese	ppm	37.4	39.6	25.6	20	33.8	*31.3*
Sodium	%	0.05	0.02	0.04	0.06	0.02	*0.04*
NFC (Non-Fibre Carbohydrate)	%	23.2	22.2	22.5	21.2	20.8	*22.0*

Pea Straw Quality (Table 3): The straw CP was generally below 5%, varying from 3.37-4.82%. A mature beef cow requires a ration with CP of 7% in mid pregnancy, 9% in late pregnancy and 11% after calving. Looking at the straw CP obtained in this study, it is obvious that all foliar feeding treatments and Control had very low

CP and they thereby all fell far short of meeting the CP requirements of mature beef cattle.

The straw energy (%TDN) varied from 50.2 to 52.7% TDN for foliar feeding treatments and Control. For a mature beef cow to maintain her body condition score (BCS) through the winter, the ration must have a TDN energy reading of 55% in mid pregnancy, 60% in late pregnancy and 65% after calving. Overall, all foliar feeders and Control fell short of meeting the TDN requirements of mature beef cattle at different stages.

The NE_M varied from 1.17 to 1.24 Mcal/kg for the foliar feeding treatments and Control. The NE_M requirements by mature beef cattle (1.19-1.28 Mcal/kg) have been met by all treatments. The NE_M is an estimate of the energy value of a feed used to keep an animal in energy equilibrium, neither gaining weight nor losing weight.

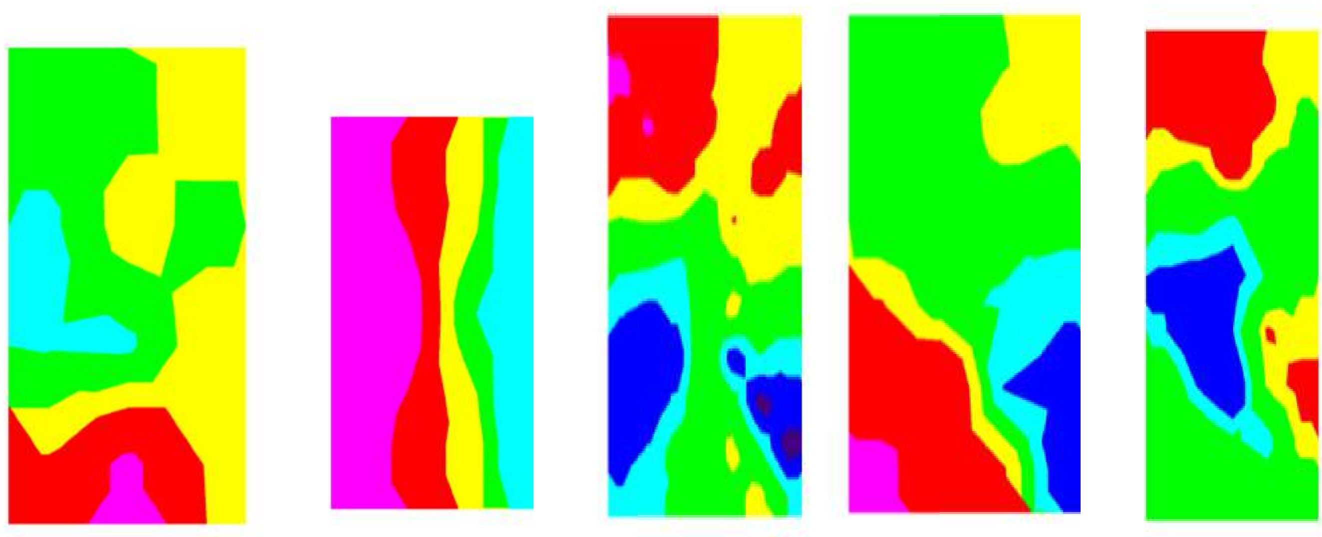
Generally, the foliar feeding treatments did not consistently improve straw minerals more than Control. However, the pea straw Ca, K and Mg contents appeared to be better with CF+FF Early application than other foliar feeding treatments.

In terms of beef cattle mineral requirements, only the Ca, K and Mg requirements of mature beef cattle were met by all foliar feeding treatments and Control. Other minerals from all treatments fell short of meeting mature beef cattle requirements.

Oats Trial

Grain Yield: In this study, the oat grain yield did not seem to be improved by foliar feeding treatments over Control. Overall the oat grain yield varied from 76.1-83.6 bus/acre.

1000-Kernel weight and Test Weight: The 1000-kernel weight and oat test weight appeared to be similar for all treatments. The 1000-kernel weight varied from about 42 to 46 grams/1000 oats kernel, while the test weight varied from 36-39 lbs/bus.



Control, NDVI=0.77 **Humalite, NDVI=0.85** **CT+FF Early, NDVI=0.85** **CT+FF Delay, NDVI=0.81** **CT+FF 2 Apps, DVI=0.85**

Figure 2. NDVI scores of oats at milk stage following foliar feeding treatments

Table 4. Crop yield & quality, and straw quality of oats when sprayed with foliar feeding products

Parameters	Unit	Control	Humalite	CT+FF Early	CT+FF 2Apps	CT+FF Delay	*Mean*
Crop Yield & Quality							
Grain Yield	Bus/acre	82.1	78.2	80.8	76.1	83.6	*80.2*
Grain yield increase as % of Control	%	100	95	98	93	102	
1000 Seed weight	Grams	43.3	42.8	42.3	44.3	46	*43.7*
Test weight	lb/bus	36.8	36	38.5	39	37	*37.5*
NDVI values		0.77	0.85	0.85	0.86	0.81	
CP	%	12.1	10.2	8.48	9.92	11.2	*10.4*
ADF (acid detergent fibre)	%	21	21	20.4	18.8	18.9	*20*
NDF (neutral detergent fibre)	%	35.8	41.2	40.1	28.2	36.3	*36.3*
TDN (total digestible nutrients)	Mcal/kg	72.5	72.5	73	74.2	74.1	*73.3*
NE_L (net energy for lactation)	Mcal/kg	1.66	1.66	1.67	1.7	1.7	*1.68*
NE_G (net energy for gain)	Mcal/kg	1.09	1.1	1.11	1.15	1.14	*1.12*
NE_M (net energy for maintenance)	%	1.82	1.82	1.83	1.87	1.86	*1.84*
Calcium	ppm	0.14	0.12	0.12	0.11	0.11	*0.12*
Copper	%	4.82	4.44	3.2	4.94	4.22	*4.32*
Phosphorous	%	0.31	0.28	0.34	0.31	0.31	*0.31*
Potassium	%	0.52	0.51	0.51	0.52	0.54	*0.52*
Sulphur	%	0.17	0.16	0.15	0.18	0.16	*0.16*
Magnesium	ppm	0.15	0.13	0.14	0.12	0.13	*0.13*
Zinc	ppm	28.4	34.7	39.6	38.3	22.4	*32.7*
Iron	ppm	123	78.1	78	64.4	82.4	*85.2*
Manganese	%	32.6	49	24.4	49.8	47.8	*40.7*
Sodium	%	0.02	0.02	0.01	0.02	0.01	*0.02*
NFC	%	40.5	37	39.8	50.3	40.9	*41.7*
Starch	%	35.6	35.5	41	46.6	42.3	*40.2*
Crude fat	%	4.04	4.21	4.53	3.63	4.98	*4.28*
Ash		2.69	3.02	3.37	3.12	3.2	*3.08*
Straw Quality							
CP	%	2.39	2.02	2.32	3.01	2.85	*2.52*
ADF (acid detergent fibre)	%	52.5	57.7	56.6	57.1	55.8	*55.9*
NDF (neutral detergent fibre)	%	80.4	80.8	78.1	77.7	78	*79*
TDN (total digestible nutrients)	%	47.9	43.9	44.7	44.3	45.4	*45.2*
NE_L (net energy for lactation)	Mcal/kg	1.06	0.96	0.98	0.97	1	*0.99*
NE_G (net energy for gain)	Mcal/kg	0.38	0.26	0.29	0.28	0.31	*0.3*
NE_M (net energy for maintenance)	Mcal/kg	1.1	0.99	1.01	1	1.03	*1.03*
Calcium	%	0.31	0.2	0.25	0.2	0.2	*0.23*
Copper	ppm	3.08	2.43	3.15	2.76	2.46	*2.78*
Phosphorous	%	0.01	0.1	0.05	0.04	0.03	*0.05*
Potassium	%	2.15	1.96	1.76	2.59	2.24	*2.14*
Sulphur	%	0.07	0.15	0.37	0.11	0.13	*0.17*
Magnesium	ppm	0.09	0.05	0.06	0.07	0.06	*0.07*
Zinc	ppm	13.8	11.1	50.2	10.6	16.8	*20.5*
Iron	ppm	10.4	5.96	19.1	17.7	10.9	*12.8*
Manganese	ppm	20.3	4.21	53.8	26.1	49.4	*30.8*
Sodium	%	0.33	0.35	0.69	0.16	0.12	*0.33*
NFC	%	5.63	6.66	8.49	8.39	9	*7.63*

Table 5. Crop production costs for peas and oats following foliar feeding treatments ($/acre). Note: This is only a simple cost analysis and is not intended as an in depth study of the cost of production.

Direct input costs (labour & materials)	Peas					Oats				
	Control	Humalite	CT+FF Early	CT+FF 2Apps	CT+FF Delay	Control	Humalite	CT+FF Early	CT+FF 2Apps	CT+FF Delay
Tillage/acre*	$60	$60	$60	$60	$60	$27	$27	$27	$27	$27
Seed/acre	$35	$35	$35	$35	$35	$22	$22	$22	$22	$22
Inoculant/acre	$15	$15	$15	$15	$15					
Seeding/acre	$25	$25	$25	$25	$25	$25	$25	$25	$25	$25
Humalite/acre		$8.80					$8.80			
Compost Tea/acre			$6	$12	$6			$6	$12	$6
Fish fertilizer/acre			$19	$38	$19			$19	$38	$19
Foliar application/acre		$5	$5	$10	$5		$5	$5	$10	$5
Harvest/acre	$35	$35	$35	$35	$35	$35	$35	$35	$35	$35
Total Direct Input/acre	$170	$184	$200	$230	$200	$109	$123	$139	$169	$139
Estimated Farmgate										
Market Price $**	$15.00	$15.00	$15.00	$15.00	$15.00	$6.00	$6.00	$6.00	$6.00	$6.00
Yield per acre (bus)	40.8	42.3	45.7	42.1	35.1	82.1	78.2	80.8	76.1	83.6
Revenue/acre	$612.00	$634.50	$685.50	$631.50	$526.50	$492.60	$469.20	$484.80	$456.60	$501.60
Marginal Returns/acre										
Over Direct Input Costs	$442.00	$450.70	$485.50	$401.50	$326.50	$383.60	$346.40	$345.80	$287.60	$362.60

Peas: tillage consisted of plow/ level /seed bed prep /post seeding harrow
Oats: tillage consisted of fall tillage ($12/acre), spring tillage/post seeding harrowing ($15)
** Market Price $: Producer's contracts

NDVI Values: The results of the Green-Seeker optical unit showed that NDVI score was similar and higher for all foliar feeding treatments than Control. Following the rules of thumb, which say that an NDVI score between 0.66 to 1.00 indicates that the plant is very healthy, all foliar feeding treatments as well as Control had healthy plants. However, the NDVI scores of 0.81-0.85 for the foliar feeders could indicate the positive effects of the foliar feeders in producing even healthier plants than Control (NDVI=0.77).

Oat Straw Quality (Table 5): The oat straw CP content from all foliar feeding treatments as well as control was generally below 4% CP. The oat straws from all treatments therefore fell short in meeting the minimum CP requirement of mature beef cattle, which is 7% CP for a dry gestating beef cow in mid pregnancy. Similarly, the minimum energy requirement of mature beef cattle, which is 55% TDN at mid pregnancy was not met by any foliar feeding treatments and control, as the oat straw TDN was generally <50% TDN. Except for K & Na, the minerals fell short of meeting mature beef cattle mineral requirements.

Because of the inability of oat straw to meet the required CP, TDN and minerals for mature beef cattle, some form of supplementation would be required when oat straw is fed to mature beef cattle.

Cost of Production Comparison for Peas and Oats

The cost comparison of foliar feeding peas and oats compared to Control is provided above in Table 5. As expected, total direct (input) cost was lower for Control than foliar feeding treatments using CT+FF and Humalite for both peas and oats. The highest input costs obtained for CF+FF 2 Apps in both cases, simply resulted from the second application of CT+FF.

For peas, the return was highest for CT+FF Early ($485.50) and lowest for CF+FF Delay ($326.50).

Only 2 (Humalite and CT+FF Early) of the 4 foliar feeding treatments appeared to have some positive gains over control. The extra income from the 2 treatments over the control was $8.70/acre for Humalite and $43.50 for CT+FF Early.

For oats, the return was lowest for CF+FF 2Apps ($287.60) and highest for Control ($383.60). The profit over control for oats was negative for the 4 foliar feeding treatments tested here.

Conclusion

The results did not show much improvement in crop yield and quality from the foliar feeders (fertilizers) tested compared to control. However, from the NDVI scores obtained in this study, there seemed to be an indication that there were some positive impacts on crop health from 3 (Humalite, CT+FF Early and CT+FF 2Apps) of the 4 foliar feeding treatments. For peas, there seemed to be some extra income from Humalite and CT+FF Early over control. Overall, there was not a clearly defined outcome. Timing of applications of the foliar feeding treatments used in this study was thought to be partially responsible for lack of any significant responses this year. The Compost + Fish fertilizer treatments in particular were applied earlier than recommended. The producer would like to replicate the trial a second year to be more certain of outcomes.

Preliminary Testing of Soybean Varieties for Seed Production

By Akim Omokanye

Soybeans are an important warm season oilseed crop, with production occurring throughout the world. The crop is processed (crushed) to produce a highly desired protein meal for animal diets, as well as vegetable oil for human consumption. Alberta swine and poultry producers currently import large quantities of soybean meal from the U.S. Several soybean varieties are available in the market. Agronomically, soybeans have the advantage of fixing nitrogen when properly inoculated, and do not require a lot of specialized equipment to grow. In Alberta, soybeans are grown on a limited scale on irrigated land in Southern Alberta but do not compete well for acreage with higher value irrigated crops. However, in recent years we have seen a rapid increase in soybean production in Manitoba and Saskatchewan, demonstrating that soybeans can find a place in dry land crop rotations where growing conditions are favorable. Furthermore, agricultural technology companies are developing shorter season varieties which may be suitable for production in larger areas of Alberta. Available soybean seed varieties dictate maturity dates. Early varieties may be useful in the Peace Country region where the limiting factor is the length of the growing season. To ensure we have the right variety that can be used in the region by producers who may want to try growing some soybeans, it is essential to test a range of varieties for their suitability in the Peace. It is important to select varieties based on heat unit requirements, high yields, fast emergence, minimal stress, adaptability, and disease resistance.

Methods

- Project Site: Fairview Research Farm (NW5-82-3W6) on RR #35, MD of Fairview.
- Previous Crop: Oats for greenfeed in 2016, forage grasses from 2010-2015
- Site soil information(0-6” depth): Soil tests done at Exova laboratory (Edmonton) prior to seeding showed pH = 5.6 and soil organic matter = 8.0%.
- The field was cultivated (disked and harrowed) before seeding.
- Experimental Design: Randomized complete block design in 3 replications.
- Treatments: 9 Roundup Ready soybean varieties were seeded:
    1. TH 35002
    2. Leroy RR2Y
    3. Currie R2
    4. Reston RR2Y
    5. Akras R2
    6. TH 33003
    7. Starcity RR2X
    8. Newton
    9. Watson RR2Y
- Seeding Date was June 1
- Seeding Rate: 55 seed/m^2
- Seed was inoculated at seeding
- Seeding method: 6-row Fabro plot drill with 9” row spacing
- Fertility (actual lbs/acre): 50 P + 41 K + 18 S
- Plot size: 11.04 m^2 (118.8 ft^2)
- Sprayings: Pre-emergent with Roundup Weathermax

Results

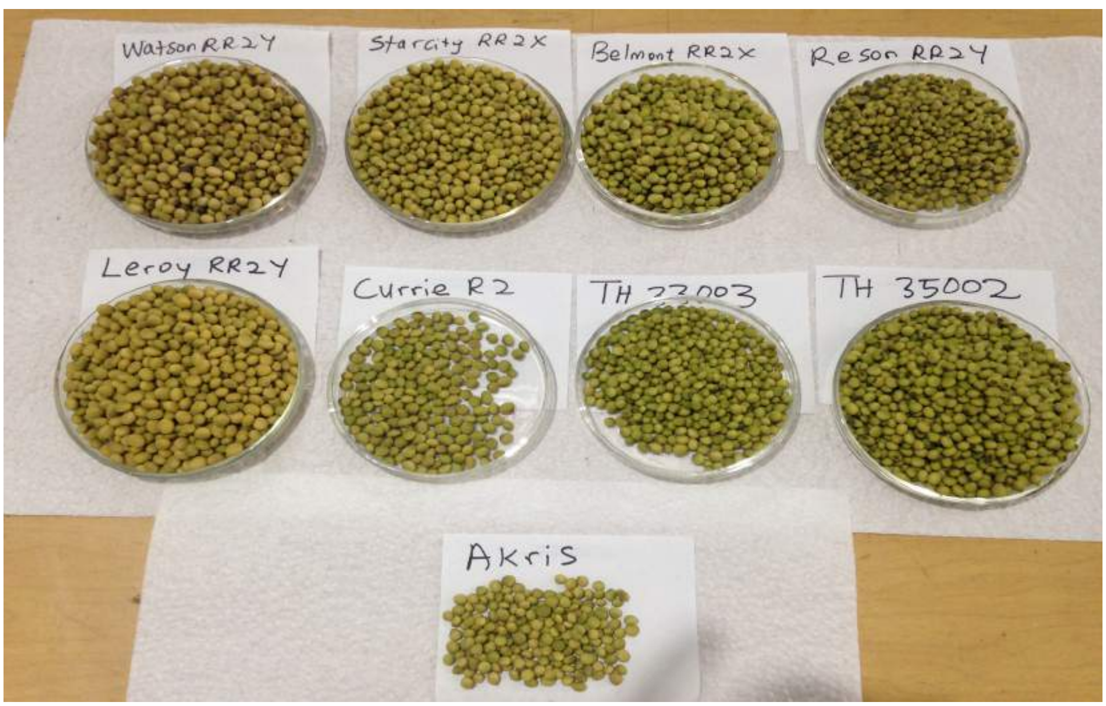
In our test, 3 (Leroy RR2Y, TH 33003 and Watson RR2Y) of the 9 soybean varieties tested appeared to have higher 1000 seed weight and yield than other varieties.

Seed yield was higher and similar for both Starcity RR2X and Leroy RR2Y, each with about 23 bushels/acre seed yield. Next to Starcity RR2X and Leroy RR2Y in seed yield was Watson RR2Y with about 18 bushels/acre seed yield.

Looking at Table 1, soybean varieties with lower heat units (2225-2275) seemed to favour higher seed production than those requiring >2275 heat units. This is expected as soybean is a warm season crop. This preliminary study therefore shows that soybeans with lower heat unit/early maturing varieties would hold high promise for the short season in the Peace areas.

Table 1. Seed yield of soybean varieties tested in Fairview in 2017

Variety	Heat Unit	1000-seed weight (g)	Grain yield (lbs/ac)	Grain yield (bushels/ac)
TH 35002	2375	76	863	14.4
Leroy RR2Y	2225	100	1357	22.6
Currie R2	2500	65	116	1.9
Reston RR2Y	2325	55	388	6.5
Akras R2	2375	50	87	1.5
TH 33003	2400	64	271	4.5
Starcity RR2X	2275	106	1377	23.0
Newton	2375	82	572	9.5
Watson RR2Y	2225	108	1067	17.8



Pasture Rejuvenation Project

On-farm evaluation of forage-stand rejuvenation methods to determine the most effective and profitable methods for Northern Alberta producers

By *Akim Omokanye, PCBFA*

Collaborators:	Soames Smith (Rycroft) Bill Smith (Grovedale)
Funding Received from:	Alberta Crop Industry Development Fund (ACIDF)
Supported by:	Agriculture Opportunity Fund (AOF), Alberta Agriculture & Forestry MD of Greenview MD of Spirit River

According to a recent report by Statistics Canada (2014), Alberta, with its vast rangelands and plentiful feed supply, dominates Canada's beef production. The 2011 Census of Agriculture by Statistics Canada (2012) showed that Alberta accounted for about 40% of the national cattle herd, with pasture land accounting for 43% of total farm area in Alberta. Cow-calf producers know that grazing on productive pastures can be very profitable. However, over time, the productivity and livestock carrying capacity of seeded hay fields and pastures on beef cattle operations may decline, largely a result of reduced stand vigor, consequence of drought, pests, weeds, the invasion of unpalatable or less productive species, overgrazing and poor soil fertility. Producing high quality forage and maintaining productive forage stands is a major challenge that Alberta's beef producers encounter. Rejuvenation is a complex and costly challenge for producers. With the high costs and loss of productive time associated with forage stand termination and re-establishment, producers are anxious to identify all options for sustaining a forage stand.

Producers' questions in the Peace and elsewhere on forage-stand rejuvenation methods always include: How much more forage does a re-seed produce? How will I gain from forage stand rejuvenation? Where will I see the benefits of forage stand rejuvenation? Which re-seeding methods and what seeding equipment should I use? How can I reduce soil compaction and improve soil health conditions, as well as improve water infiltration? Can I seed in fall instead of spring? Are there studies comparing emerging new ideas of methods of rejuvenation to already established methods?

Recent on-farm studies in parts of the Peace region of Alberta identified high soil compaction, reduced soil water infiltration, and low legume content as factors affecting the condition of forage stands (Omokanye, 2015). With these factors, consequently, the profitability of the beef cattle industry is negatively affected. Though different methods of rejuvenation have been examined in Western Canada (e.g. Jungnitsch et al., 2005; Nazarko, 2008; AARD, 2013) and the USA (e.g. Undersander et al., 2001), most of these studies have only examined a few methods at a time. Local on-farm research is needed to compare all, or at least most, of the practical methods of rejuvenation to determine the most effective and profitable methods for producers in comparison to a complete break and reseed scenario. To answer producers' questions, the present project looked at a dozen methods of rejuvenation of depleted forage stands at two locations in the Peace.

Specific Objective

The objective of this project is to examine various methods of forage stand rejuvenation and types of equipment in an effort to demonstrate practical, sustainable forage production and low cost options with maximal success.

Methods

The project was carried out on-farm from 2015-2017 at the following cow-calf producers' farms in the Peace River region:

Site 1 is at Uddersmith Dairy- Soames Smith (organic beef farm), near Rycroft.

Site 2 is at Bill Smith's (conventional beef farm) in Grovedale.

Old pastures were used at both sites. Before the trial commenced in 2015, the sites had been sown to forage mixtures (which included alfalfa & meadow brome), more than 15 years before. The sites had declined in productivity over the years.

Table 1. A list of methods of pasture rejuvenation treatments investigated and brief description of activities carried out at both sites

Rejuvenation Method	Site 1	Site 2
1. Control check strip		
2. Sub-soil (deep tillage) to 12" soil depth with an Agrowplow subsoiler, Model AP11) in the fall	October 31, 2015; AP11 had 7 shanks with 13" shank spacings	October 30, 2015; AP11 had 7 shanks with 13" shank spacings
3. Spread beef cattle manure (solid) & sub-soil to 12" depth with an Agrowplow subsoiler (deep tillage with AP11) in the fall (only at Site 1)	Manure spread on October 29, 2014; at a rate of 52 lb available N/acre was applied; Subsoil on October 31, 2015	*Not done at this site*
4. Spring sod-seeding of forage mixture (60% grass & 40% legume) with an Agrowplow no-till seed drill	June 16, 2015; Seeded @ 15 lbs/acre	June 18, 2015; @ 15 lbs/acre
5. Spring sod-seeding (as in treatment #4) with a conventional no-till seed drill (CD).	June 16, 2015 Seeded @ 15 lbs/acre	June 18, 2015; @ 15 lbs/acre
6. Summer pasture rest (no grazing or haying) in 2015 only (Site 1 only)	Rested	*Not done at this site*
7. Pasture renewal - break the existing pasture (till land) and then reseed with forage mixture (as in treatment #4).	June 16, 2015; Seeded @ 15 lbs/acre	June 18, 2015; @ 26 lbs/acre; fertilizer applied (actual lb/acre): 30 N + 27 P + 14 K + 7 S
8. Fall/frost sod-seeding of forage mixture (as in treatment #4) with an Agrowplow no-till seed drill.	October 20, 2015 Seeded @ 15 lbs/acre	October 22, 2015; @ 15 lbs/acre
9. Fall/frost sod-seeding of forage mixture (as in treatment #4) with a conventional no-till drill (CD).	October 20, 2015 Seeded @ 15 lbs/acre	October 22, 2015; @ 15 lbs/acre
10. High stock density grazing of pasture to create a mob grazing effect	July 25, 2015	July 30, 2015
11. Bale grazing practice in winter. This practice involves setting dry hay bales out across a pasture or hay field from fall through winter to early spring.	February 18, 2016	February 29, 2016
12. Dry Fertilizer application (only at Site 2)	*Not done at this site*	June 16, 2015; fertilizer applied (actual lb/acre): 52 N + 54 P + 28 K + 14 S

The methods of pasture rejuvenation that were examined were established using a Randomized Complete Block Design (RCBD) with three (3) replications at each site. Each treatment plot was about 0.25 acres in size making it approximately 10 acres (including gaps between treatment plots and replicates) at each site.

All the treatments were implemented in 2015. The methods of pasture rejuvenation that we evaluated at the sites are provided in Table 1. Descriptions of each treatment have also been provided (see Table 1).

The forage mixture seeded consisted of 60% smooth brome grass, 10% cicer milkvetch and 30% alfalfa, making it a 60:40 grass-legume ratio.

In spring 2015, prior to treatment implementation, baseline data was collected. Soil nutrients and quality were determined at both sites from May 30 - June 4, 2015. Forage yield and quality, plant composition/ proportion, soil moisture content, soil compaction readings, and water infiltration rate were measured.

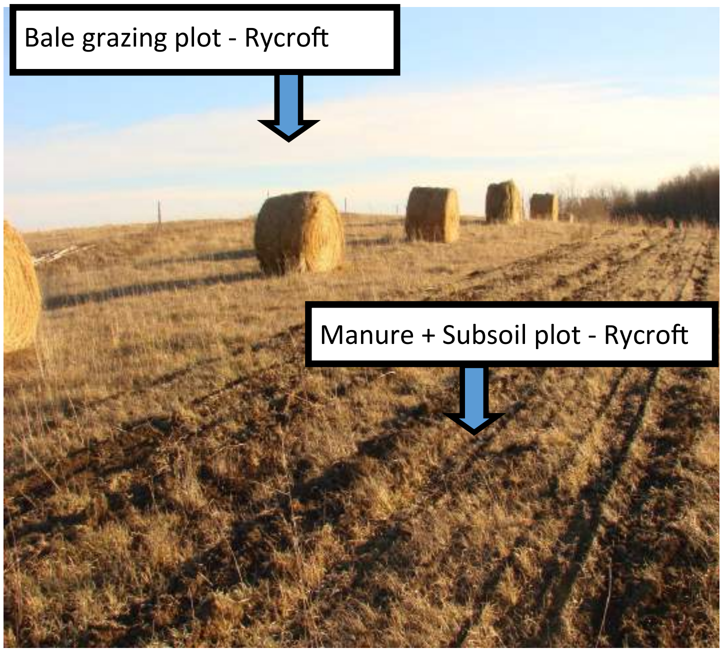
Part of the initial soil analysis, which was carried out at EXOVA (Edmonton), consisted of soil particle size analysis, soil texture and base saturation %. This was carried out at both sites in June 2015, from 0-6” at random spots across the entire field prior to any treatment implementation, shown in Table 2. The base saturation (BS,%) is the % of the cation-exchange capacity (CEC) occupied by the basic cations Ca^{2+}, Mg^{2+} and K^{+}. CEC is a measure of how many cations can be retained on soil particle surfaces. CEC affects many aspects of soil chemistry, and is used as a measure of soil fertility, as it indicates the capacity of the soil to retain several nutrients in plant-available form.

Table 2. Soil particle size analysis and base saturation elements from surface soil (0-6") before the start of the project for both sites

Soil particle/texture	**Site 1**	**Site 2**	
Sand, %	14.6	46.7	
Silt, %	46.8	37.8	
Clay, %	38.6	15.6	
Soil texture	Silt clay	Loam	
% Nutrient saturation	**Site 1**	**Site 2**	**Ideal level**
Ca, %	59.8	75.3	60-70
Mg, %	14.9	17.7	10-20
Na, %	0.45	0.80	0.5-3.0
K, %	5	3.9	2-5
% Base saturation (%Ca + Mg + K)	79.7	96.9	
TEC, meq/100g	25.6	12.8	


Renovation treatment method –Break & reseed, Rycroft

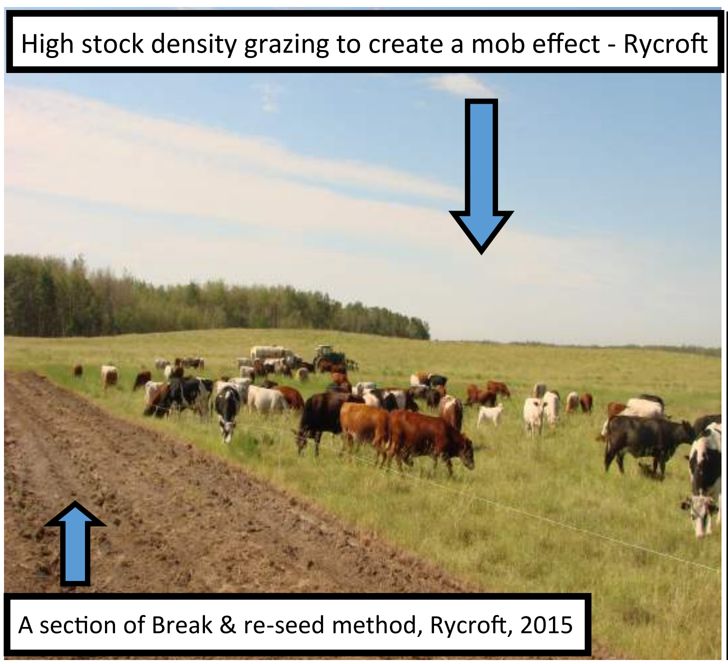

Manure + sub-soil to 12” treatment - Rycroft



Bale grazing plot - Rycroft

Manure + Subsoil plot - Rycroft

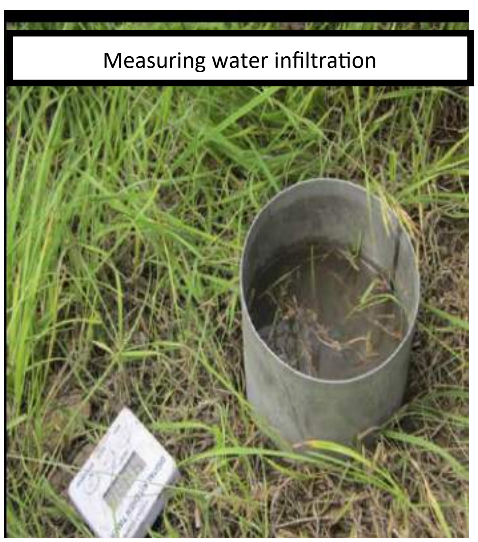
Bale Grazing in progress, Rycroft



High stock density grazing to create a mob effect - Rycroft

A section of Break & re-seed method, Rycroft, 2015

A section of Break & re-seed method, Rycroft, 2016



Measuring water infiltration

Subsoil in fall treatment

Spring sod seeding with Agrowdrill treatment

Measurements from 2016 to 2017:

1. Forage yield and quality, and forage botanical composition

   For the proportion of plant type and forage yield - the stand composition of different forage species, varieties and other plants will be determined from 1 m x 1m quadrat areas (randomly placed at several locations), and clipped at a height of 3-4 inches above the soil surface. Forage biomass yield from several large areas (long and wide strips) will be determined by using conventional hay making methods and equipment. The goal of sampling a large area is to collect a sample that provides good representation for the entire area as well as to reduce sampling error.

   Forage quality (including trace minerals) from dry composite forage samples will be determined by A & L Canada Laboratory Ltd, a commercial laboratory in Ontario using standard AOAC approved laboratory methods for wet chemistry and NIR.

2. Soil health indicators
   a) Soil compaction readings from 1 to 12 inches using a digital penetrometer
   b) Surface soil water infiltration rates determined using the ring method (Nicholas, 2004)
   c) Soil nutrients, pH & organic matter from 0-6” & 6-12”
   d) Carbon & N and C:N ratio from 0-6” soil depth.

Field notes on the initial pasture assessments and seeding establishment success were taken. Establishment success was determined by observing unseeded treatment compared to seeded area for plant counts, DM yield and forage quality.

Results

Site 1: Rycroft

Soil Quality Indicators

Soil pH and Soil Organic Matter (SOM) (Table 3)

The soil pH values did not change drastically for any of the rejuvenation methods over the 2 years. The mean soil pH across rejuvenation methods was similar for both years (6.90 vs 6.95).

In 2016, the surface SOM appeared to be generally slightly higher for the 'Manure + subsoil in fall' and 'Break & re-seed' methods. In 2017, 'Bale grazing' and 'Manure + subsoil in fall' had slightly higher surface SOM than other rejuvenation methods. Some rejuvenation methods did not show any significant increases in SOM from 2016 to 2017. Only 'Bale grazing' and 'Mob grazing', and to some extent 'Manure + subsoil in fall', appeared to show some potential for slight consistent increases in surface SOM from 2016 to 2017. SOM increased up to 1.1% for 'Bale grazing', 0.5% for 'Manure + subsoil in fall' and 0.85% for 'Mob grazing'. Generally, the surface soil had higher SOM values than subsurface soil for all treatments in both years.

Table 3. Soil pH, soil organic matter (SOM) and electrical conductivity (EC) from 0-6" and 6-12" soil depths in 2016 and 2017 from Site 1. **, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

	pH				SOM %				EC ds/m			
	2016		2017		2016		2017		2016		2017	
Rejuvenation method	**0-6"**	**6-12"**	**0-6"**	**6-12"**	**0-6"**	**6-12"**	**0-6"**	**6-12"**	**0-6"**	**6-12"**	**0-6"**	**6-12"**
Check	7.10	6.40	6.80	6.80	6.50	3.80	6.30	4.50	0.27	0.22	0.10	0.10
Bale grazing	6.60	6.60	6.95	7.00	7.10	4.30	8.20	4.95	0.55	0.17	0.44	0.30
Break & re-seed	6.40	7.30	6.50	6.50	8.10	5.85	6.50	6.40	0.29	0.42	0.03	0.24
Fall seeding with Agrowdrill	6.90	6.70	6.50	6.70	7.90	4.60	7.10	3.70	0.67	0.22	0.30	0.24
Fall seeding with CD	6.80	6.80	7.00	7.10	7.20	4.50	6.40	4.20	0.22	0.17	0.20	0.23
Manure & subsoil in fall	7.20	7.10	7.00	6.90	8.40	3.80	8.30	6.20	0.52	0.27	0.32	0.32
Subsoil in fall	7.30	7.50	6.95	7.00	7.40	4.80	6.40	5.90	0.40	0.34	0.25	0.29
Mob grazing	7.00	6.40	7.20	7.40	6.95	3.40	7.40	5.30	0.25	0.11	0.39	0.44
Rest	6.80	6.80	6.70	6.90	7.80	4.10	6.70	4.10	0.23	0.52	0.31	0.21
Spring seeding with Agrowdrill	6.95	7.40	7.00	7.20	6.90	3.20	5.10	4.95	0.22	0.18	0.25	0.20
Spring seeding with CD	6.80	7.10			7.70	3.80	6.20	3.70	0.21	0.19	0.27	0.22
Mean	*6.90*	*6.92*	*6.86*	*6.95*	*7.45*	*4.20*	*6.78*	*4.90*	*0.35*	*0.26*	*0.26*	*0.25*
Significance												
Treatment	*		*		*		*		*		*	
Depth	*NS*		*		*		*		*		*	
Treat.× Depth	*		*		*		*		*		*	
$LSD_{0.05}$												
Treatment	*0.21*		*0.02*		*0.22*		*0.21*		*0.12*		*0.06*	
Depth	*0.08*		*0.01*		*0.09*		*0.08*		*0.06*		*0.03*	
Treat.× Depth	*0.3*		*0.04*		*0.31*		*0.30*		*0.19*		*0.09*	
CV %	*2.10*		*0.30*		*2.70*		*2.50*		*2.52*		*2.10*	

Soil Water Infiltration, Compaction and Soil Moisture (Table 4)
In 2016, the soil water infiltration rate was higher for 'Subsoil in fall', 'Manure + subsoil in fall', 'Bale grazing', 'Fall seeding with Agrowdrill', 'Break & re-seed' and 'Mob grazing' than other rejuvenation methods examined. In 2017, the 2 deep tillage treatments ('Subsoil in fall', 'Manure + subsoil in fall') and 'Break & re-seed' appeared to have far higher infiltration rates than other rejuvenation methods tested here. Overall, 'Subsoil in fall', 'Manure + subsoil in fall', 'Break & re-seed', and 'Bale grazing' seemed to consistently infiltrate more water through the surface soil, even after 2 years of implementing those rejuvenation methods.

As observed for soil infiltration rate, across the different rejuvenation methods, mean soil compaction in 2016 and 2017 appeared to be consistently improved with the 'Subsoil in fall', 'Manure + subsoil in fall', 'Break & re-seed', and 'Bale grazing' methods more than other methods. In 2016, 'Break & re-seed' had the least compacted soil, while in 2017, both 'Break & re-seed' and 'Bale grazing' had the least mean compaction values (Table 4). Over the 2 years, the mean soil compaction at 0 to 12" soil depth for each rejuvenation method showed that 'Subsoil in fall', 'Manure + subsoil in fall', 'Break & re-seed', and 'Bale grazing' were consistently less compacted than other rejuvenation methods (Figure 1). 'Break & re-seed' had the least compacted soil up to 12" depth.

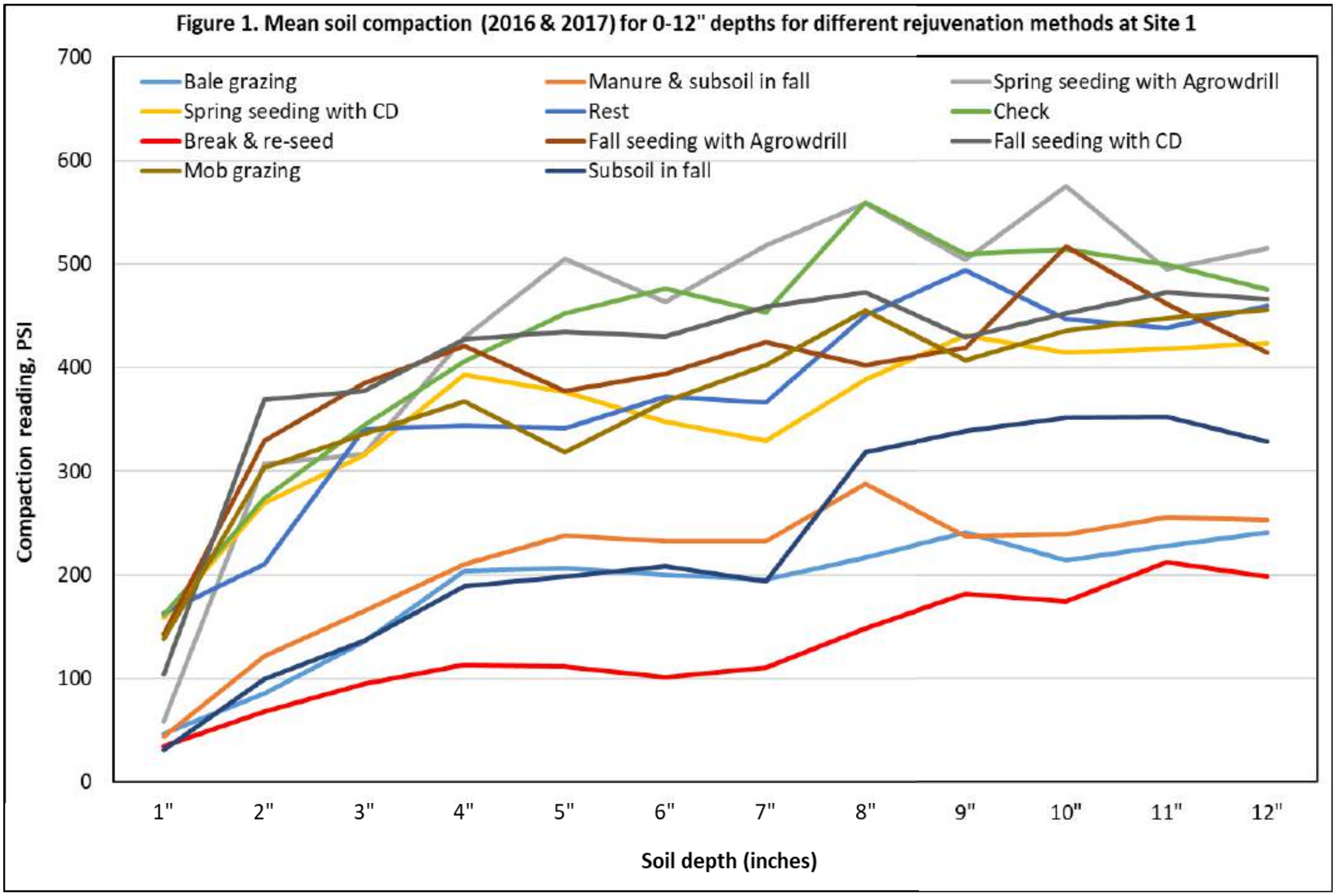
Soil moisture seemed to be statistically similar for all rejuvenation methods in 2016. But in 2017, 'Bale grazing' had significantly higher soil moisture than the other methods (Table 4). Overall, in 2017, 'Bale grazing', 'Subsoil in fall', 'Manure + subsoil in fall', and 'Break & re-seed' had 10-34% higher soil moisture content than check. Other treatments had lower soil moisture content than check.

Table 4. Infiltration rates, compaction readings, soil moisture and C:N ratios from 0-6" soil depth in 2016 and 2017 at site 1. **, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

Carbon : Nitrogen Ratio (C:N)

	Infiltration (inch/hr)		Compaction (PSI)		Soil moisture (%)		C %		N %		C:N ratio	
Rejuvenation Method	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Check	0.05	0.05	399	455	16.5	13.5	4.33	3.51	0.36	0.27	12.0	13.0
Bale grazing	0.72	0.54	233	136	16.4	18.1	4.85	4.16	0.39	0.34	12.4	12.2
Break & re-seed	0.50	0.94	124	134	13.2	14.8	5.35	3.00	0.46	0.28	11.6	10.7
Fall seeding with Agrowdrill	0.67	0.21	343	452	18.6	13.0	5.20	3.73	0.43	0.28	12.1	13.3
Fall seeding with CD	0.07	0.24	345	470	13.4	12.8	4.32	3.61	0.36	0.30	12.0	12.0
Manure & subsoil in fall	0.59	1.09	274	145	16.5	15.5	5.12	2.62	0.42	0.23	12.2	11.4
Subsoil in fall	0.84	1.14	232	172	19.6	14.8	5.00	3.50	0.44	0.30	11.4	11.7
Mob grazing	0.45	0.22	446	462	15.4	12.4	4.34	4.10	0.37	0.34	11.7	12.1
Rest	0.21	0.18	292	446	18.7	13.0	4.77	3.52	0.43	0.32	11.1	11.0
Spring seeding with Agrowdrill	0.09	0.39	448	427	14.2	12.9	4.87	4.74	0.43	0.40	11.3	11.9
Spring seeding with CD	0.22	0.27	237	448	16.8	12.9	5.38	4.27	0.47	0.38	11.4	11.2
Mean	*0.436*	*0.52*	*297*	*329*	*16.3*	*14.0*	*4.92*	*3.73*	*0.42*	*0.32*	*11.7*	*11.8*
Significance	*NS*	***	***	***	*NS*	***	*NS*	***	*NS*	*NS*	*NS*	***
$LSD_{0.05}$	*0.26*	*0.31*	*153*	*115*	*5.05*	*2.20*	*1.19*	*0.62*	*0.23*	*0.27*	*1.09*	*1.17*
CV,%	*0.37*	*39.7*	*19.7*	*24.6*	*3.86*	*9.62*	*8.30*	*3.45*	*2.40*	*4.94*	*1.25*	*2.78*

The C:N ratio of surface soil (0-6" depth) was statistically similar for all rejuvenation methods and only ranged from 11.1 to 12.4 in 2016. In 2017, the C:N ratio showed significant differences with respect to rejuvenation methods, and this varied from 10.7 for 'Break & re-seed' to 13.3 for 'Fall seeding with Agrowdrill' (Table 4).



Soil Nutrients

Soil N - In 2016, in the surface soil (0-6”), N was greatly improved by ‘Mob grazing’, followed closely by ‘Bale grazing’. ‘Mob grazing’ exceeded other methods, including ‘Bale grazing’, by 38-124 lb N/acre (Figure 2). On the other hand, ‘Bale grazing’ improved soil N by up to 86 lbs N/acre over other methods (excluding ‘Mob grazing’). In 2017, ‘Bale grazing’ had the most soil N in the surface soil, followed by ‘Mob grazing’, and then ‘Manure + subsoil in fall’. Except for ‘Break & re-seed’ in 2016 and ‘Manure + subsoil in fall’ in 2017, the subsurface soil generally had lower soil N than surface soil.

Overall, ‘Bale grazing’, ‘Manure + subsoil in fall’, ‘Mob grazing’, and to some extent ‘Rest’, have all shown some potential for improving soil N, compared to other methods. The greatest improvement in subsurface soil appeared to be from ‘Bale grazing’ and ‘Mob grazing’ in 2017.

Soil P - The surface soil P was consistently higher for ‘Bale grazing’, ‘Manure + subsoil in fall’ and ‘Mob grazing’, compared to other methods of rejuvenation (Figure 3). In 2016, ‘Manure + subsoil in fall’ had the most surface soil P, while in 2017, ‘Bale grazing’ showed higher surface soil P value. In 2016, surface soil had more soil P than subsurface soil. In 2017, in most cases, surface soil P was similar or slightly higher than subsurface soil P.

In general, across the 2 years, ‘Bale grazing’, ‘Manure + subsoil in fall’ and ‘Mob grazing’ all increased soil P more than other methods.

Soil K - The surface soil K was higher for ‘Bale grazing’, ‘Manure + subsoil in fall’ and ‘Mob grazing’ than for other methods of rejuvenation in 2016 (Figure 4). Surface soil K was similar in both years for most methods

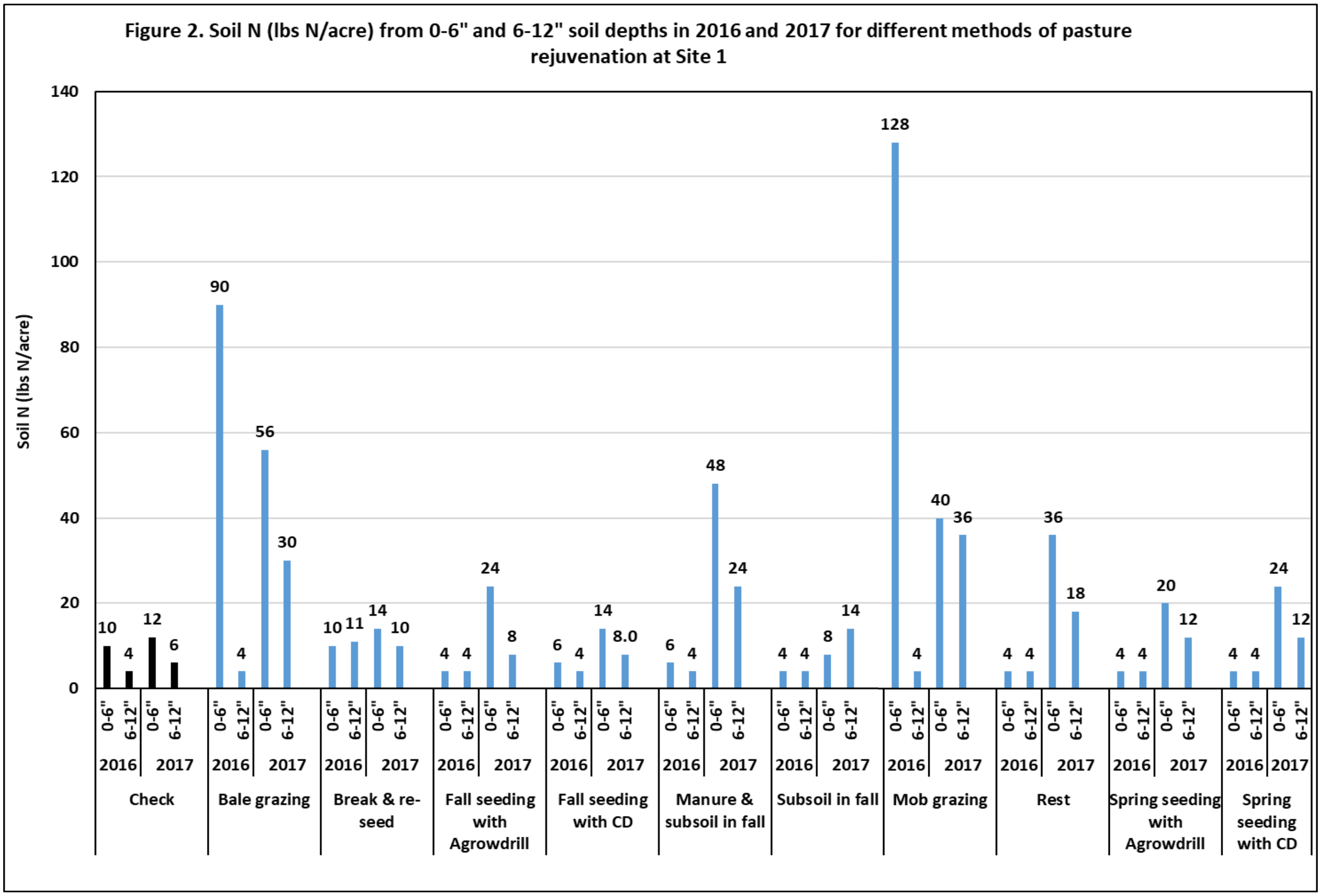


Figure 2. Soil N (lbs N/acre) from 0-6" and 6-12" soil depths in 2016 and 2017 for different methods of pasture rejuvenation at Site 1
Soil N (lbs N/acre)
140
120
100
80
60
40
20
0
10 4 12 6
90 4 56 30
10 11 14 10
4 4 24 8
6 4 14 8.0
6 4 48 24
4 4 8 14
128 4 40 36
4 4 36 18
4 4 20 12
4 4 24 12
0-6"
6-12"
2016
2017
Check
Bale grazing
Break & re-seed
Fall seeding with Agrowdrill
Fall seeding with CD
Manure & subsoil in fall
Subsoil in fall
Mob grazing
Rest
Spring seeding with Agrowdrill
Spring seeding with CD

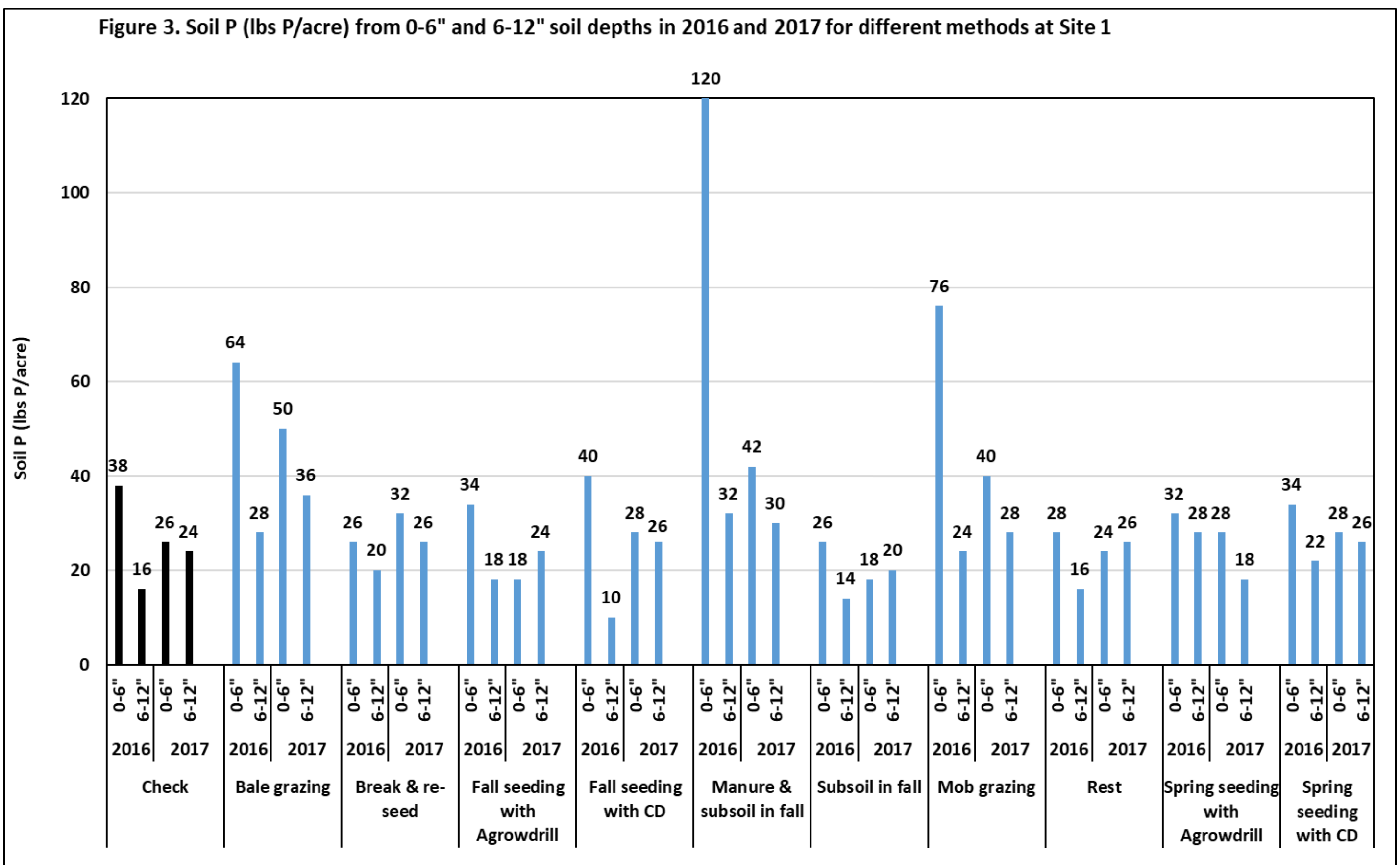
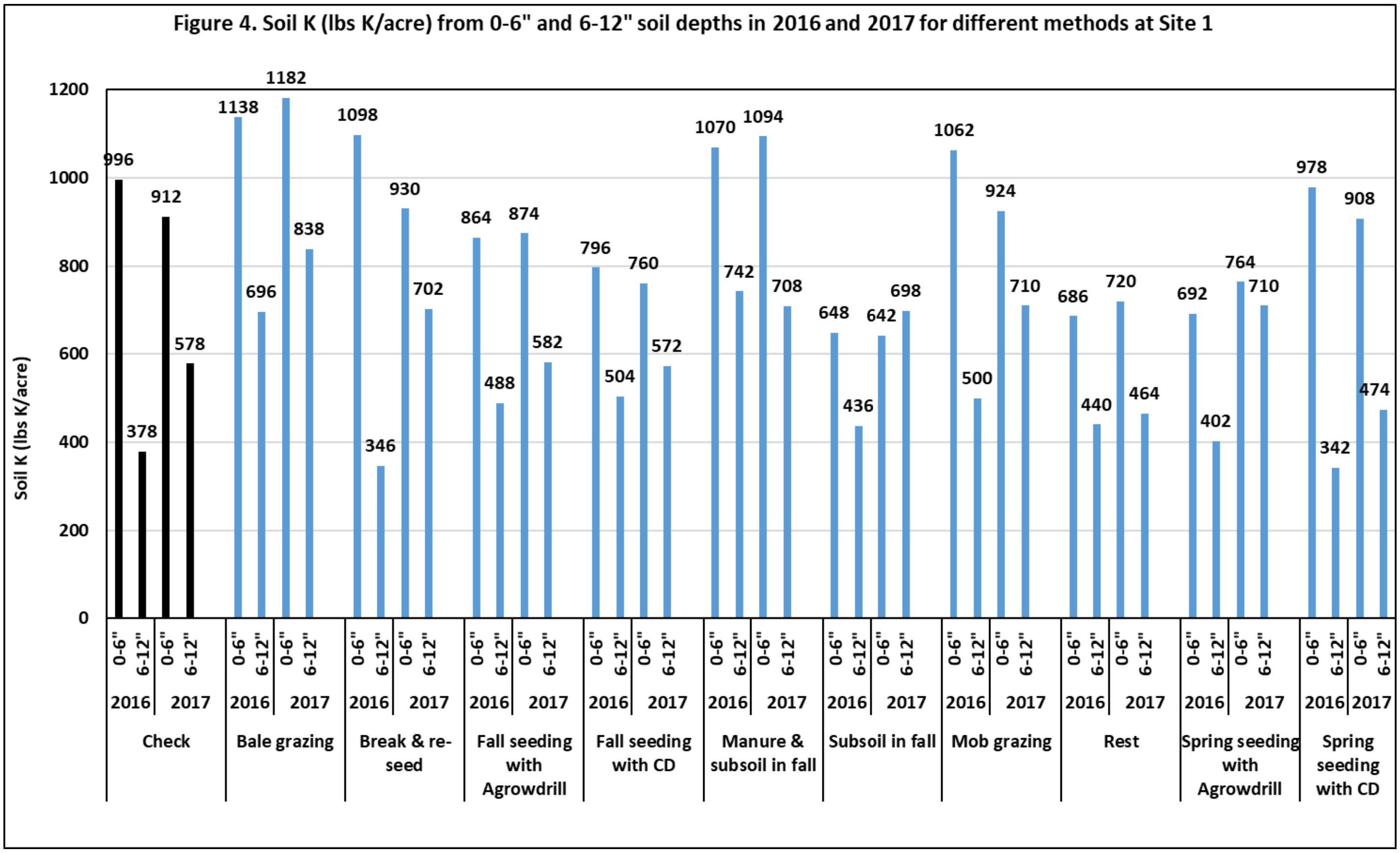


Figure 3. Soil P (lbs P/acre) from 0-6" and 6-12" soil depths in 2016 and 2017 for different methods at Site 1
Soil P (lbs P/acre)
120
100
80
60
40
20
0
38 16 26 24
64 28 50 36
26 20 32 26
34 18 18 24
40 10 28 26
120 32 42 30
26 14 18 20
76 24 40 28
28 16 24 26
32 28 28 18
34 22 28 26
0-6"
6-12"
2016
2017
Check
Bale grazing
Break & re-seed
Fall seeding with Agrowdrill
Fall seeding with CD
Manure & subsoil in fall
Subsoil in fall
Mob grazing
Rest
Spring seeding with Agrowdrill
Spring seeding with CD



of rejuvenation. In both years (2016 and 2017), the surface soil K was mostly higher than subsurface soil K.

Soil S - Except for 'Manure + subsoil in fall', which had 20-22 lbs S/acre in the surface and subsurface soils, other methods had 16 lbs S/acre or slightly less. Generally, soil S did not appear to change much at both soil depths from 2016 to 2017 (data not shown).

Forage Dry Matter (DM) Yield and Composition (Table 5)

The total DM yield differed significantly with respect to methods of rejuvenation in 2016 and 2017. In both years, the top 4 forage DM yields were from the treatments 'Bale grazing', 'Break & re-seed', 'Manure + subsoil in fall' and 'Mob Grazing'. These top 4 had far more forage DM yield than Check in both years. Most of the other methods did not significantly improve forage DM yield over Check. In both years, 'Bale grazing' had higher forage DM yield values than other methods. Over the 2 years (2016 & 2017), the mean forage DM yield from 'Bale grazing' as a % of check was up to 200%.

In both years, the total forage DM yield consisted of up to 89% grasses . The grass component of the forage yield was generally higher than legumes and other plants (mainly dandelions). 'Fall seeding with Agrowdrill' and 'Spring seeding with Agrowdrill' seemed to have slightly higher forage legume content (particularly clovers, native vetches and alfalfa) than other methods.

Forage Quality Indicators (Table 6)

Crude protein (CP) - The forage CP was statistically similar in 2016, varying from about 9-12% for the methods of rejuvenation. In 2017, forage CP varied significantly from about 8% CP for 'Spring seeding with Agrowdrill' to 14% CP for 'Manure + subsoil'. Of the eleven (11) methods investigated, only 'Fall seeding with CD', 'Manure & subsoil in fall' and 'Mob grazing' appeared to consistently show some increases in forage CP from 2016 to 2017. Other methods had similar or indefinite trend from 2016 to 2017.

Table 5. Forage dry matter (DM) yields and forage composition for different methods in 2016 and 2017
**, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

	Total DM				Grass Plant		Legume Plant		Other Plant	
Rejuvenation Method	**2016**	**2017**	**Mean**	**Mean forage DM Yield as % of check**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Check	970	2019	1495	100	60.5	68.8	14.9	17.2	24.6	14.0
Bale grazing	1939	4052	2996	200	78.4	82.2	32.5	17.8		
Break & re-seed	1447	3385	2416	162	88.0	85.3		5.2	12.0	9.5
Fall seeding with Agrowdrill	1158	2265	1712	114	51.1	54.0	48.9	43.2		2.7
Fall seeding with CD	1066	2081	1574	105	60.4	67.5	23.0	15.3	16.5	17.3
Manure & subsoil in fall	1506	3687	2597	174	55.4	66.1	34.3	24.0	10.3	9.9
Subsoil in fall	1210	2417	1814	121	64.0	73.0	28.7	19.8	7.3	7.2
Mob grazing	1063	2786	1925	129	89.0	71.0	4.2	6.7	6.8	22.3
Rest	1212	1916	1564	105	63.0	74.8	21.6	7.8		17.4
Spring seeding with Agrowdrill	1533	2149	1841	123	39.4	49.0	47.6	38.6	12.9	12.4
Spring seeding with CD	810	2393	1602	107	76.2	66.2	23.8	10.4		23.4
Mean	*1265*	*2650*	*2021*		*65.9*	*68.9*	*28.0*	*18.7*	*12.9*	*13.6*
Significance	*	*NS*			*	*	*	*	*	*
$LSD_{0.05}$	*705*	*1425*			*12.9*	*16.6*	*9.26*	*13.9*	*6.14*	*5.96*
CV,%	*17.3*	*26.7*			*8.14*	*13.6*	*21.9*	*25.7*	*27.4*	*23.9*

Minerals

Only 4 macro minerals measured in this study and their values are shown in Table 6. The forage Ca was similar in 2016 for all methods, but the forage CA did differ among some methods tested in 2017. The forage Ca content was about 0.30% and above for methods of rejuvenation in both years. Bale grazing was consistently higher in forage Ca than other methods in both years.

The forage P was similar for all methods in 2016, but differed in 2017 among some methods. From 2016 to 2017, no particular method consistently had higher forage P than another method including Check.

The forage Mg varied from 0.16-0.30% Mg for the different methods including Check in 2016. In 2017, the forage Mg varied from 0.13-0.24% Mg. For all methods, the forage Mg was either similar for both 2016 and 2017 or 2016 had higher value than 2017.

Similar to forage P and Mg, no particular method including Check consistently had higher forage K in 2016 than 2017.

Energy

The forage total digestible nutrients (TDN) and other forms of energy measured here are shown in Table 6. The forage TDN was similar for all methods in both years, indicating that the methods did not appear to improve forage TDN much during the study period. The forage TDN varied from 50.3-55.3% TDN in 2016 and from 57.0-61.5% TDN in 2017.

Other forms of energy measured here, particularly metabolizable energy (ME), net energy for lactation (NE_L), net energy for maintenance (NE_M) and net energy for gain (NE_G), did not appear to be different among rejuvenation methods including Check in both years.

Table 6. Forage quality indicators of total forage dry matter (DM) for different methods in 2016 and 2017

**, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

	CP		Ca		P		Mg		K	
Rejuvenation Method	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**	**2016**	**2017**
Check	10.8	11.1	0.58	0.63	0.20	0.25	0.21	0.20	2.57	2.65
Bale grazing	12.4	11.7	1.01	0.96	0.2	0.21	0.25	0.24	2.24	3.58
Break & re-seed	12.0	11.1	0.81	0.34	0.24	0.19	0.22	0.20	2.85	3.06
Fall seeding with Agrowdrill	10.1	10.2	0.55	0.53	0.22	0.22	0.17	0.17	2.81	2.60
Fall seeding with CD	8.91	11.1	0.48	0.47	0.24	0.28	0.18	0.16	2.42	2.63
Manure & subsoil in fall	11.2	14.3	0.83	0.81	0.22	0.26	0.30	0.19	2.16	2.64
Subsoil in fall	12.3	10.9	0.80	0.73	0.24	0.27	0.23	0.19	2.49	3.08
Mob grazing	10.5	13.1	0.70	1.18	0.23	0.23	0.16	0.22	2.3	2.54
Rest	11.4	10.2	0.71	0.62	0.25	0.26	0.24	0.17	2.59	2.72
Spring seeding with Agrowdrill	9.59	7.87	0.60	0.29	0.27	0.18	0.23	0.13	2.77	2.29
Spring seeding with CD	11.7	12.4	0.81	0.61	0.23	0.27	0.29	0.17	2.67	3.08
Mean	*10.9*	*11.5*	*0.69*	*0.69*	*0.22*	*0.23*	*0.22*	*0.18*	*2.51*	*2.78*
Significance	*NS*	***	*NS*	***	*NS*	***	*NS*	*NS*	*NS*	*NS*
$LSD_{0.05}$	*3.55*	*3.15*	*0.63*	*0.43*	*0.10*	*0.06*	*0.15*	*0.08*	*0.66*	*1.23*
CV,%	*14.7*	*12.3*	*41.1*	*35.4*	*20.3*	*11.6*	*31.5*	*20.5*	*12.0*	*20.1*

	ADF		NDF		NFC		TDN		DE	
Rejuvenation Method	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Check	40.9	37.1	66.6	59.5	11.8	18.6	55.0	59.0	2.42	2.60
Bale grazing	40.7	36.8	62.3	55.6	14.5	21.9	55.1	59.3	2.43	2.62
Break & re-seed	40.6	39.0	62.7	64.8	14.6	13.3	55.3	57.0	2.44	2.51
Fall seeding with Agrowdrill	43.5	37.6	67.3	60.8	11.8	18.2	52.2	58.5	2.31	2.58
Fall seeding with CD	42.1	40.0	68.3	64.7	12.0	13.3	53.6	56.0	2.37	2.47
Manure & subsoil in fall	42.1	34.7	66.2	55.4	11.8	19.5	53.6	61.5	2.37	2.71
Subsoil in fall	43.7	36.8	65.4	57.7	11.5	20.6	51.9	59.3	2.30	2.62
Mob grazing	41.9	36.2	64.7	56.1	14.0	20.0	53.9	60.0	2.38	2.65
Rest	42.5	37.6	67.2	61.1	10.6	17.9	53.2	58.5	2.35	2.58
Spring seeding with Agrowdrill	41.5	38.4	66.2	64.3	13.4	17.0	54.3	57.6	2.40	2.54
Spring seeding with CD	45.2	37.4	65.8	61.2	11.7	15.6	50.3	58.7	2.22	2.59
Mean	*42.2*	*37.2*	*65.7*	*59.6*	*12.4*	*17.9*	*53.4*	*58.8*	*2.35*	*2.59*
Significance	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
$LSD_{0.05}$	*4.47*	*5.13*	*7.45*	*9.13*	*5.81*	*8.28*	*4.77*	*5.48*	*0.21*	*0.24*
CV,%	*4.80*	*6.26*	*5.14*	*6.95*	*21.2*	*20.9*	*4.06*	*4.23*	*4.10*	*4.20*

	ME		NE_L		NE_M		NE_G		RFV	
Rejuvenation Method	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Check	2.01	2.16	1.23	1.33	1.17	1.30	0.61	0.73	80	94
Bale grazing	2.02	2.17	1.24	1.34	1.17	1.31	0.61	0.74	86	101
Break & re-seed	2.02	2.08	1.24	1.28	1.18	1.23	0.61	0.67	86	85
Fall seeding with Agrowdrill	1.91	2.14	1.16	1.32	1.07	1.29	0.52	0.71	77	91
Fall seeding with CD	1.97	2.05	1.20	1.26	1.12	1.20	0.56	0.63	77	83
Manure & subsoil in fall	1.97	2.25	1.20	1.39	1.12	1.39	0.56	0.81	79	105
Subsoil in fall	1.90	2.18	1.16	1.34	1.06	1.31	0.50	0.74	78	98
Mob grazing	1.98	2.20	1.21	1.36	1.13	1.34	0.57	0.76	82	101
Rest	1.95	2.14	1.19	1.32	1.11	1.29	0.55	0.71	77	91
Spring seeding with Agrowdrill	1.99	2.11	1.21	1.30	1.14	1.25	0.58	0.69	80	86
Spring seeding with CD	1.84	2.15	1.12	1.32	1.00	1.29	0.45	0.72	76	91
Mean	*1.95*	*2.15*	*1.19*	*1.32*	*1.11*	*1.29*	*0.55*	*0.72*	*79.2*	*94*
Significance	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
$LSD_{0.05}$	*0.17*	*0.20*	*0.11*	*0.13*	*0.16*	*0.18*	*0.15*	*0.16*	*13.1*	*21.8*
CV,%	*4.08*	*4.28*	*4.54*	*4.63*	*6.75*	*6.36*	*12.7*	*10.4*	*7.52*	*10.5*

Site 2: Grovedale

Soil Quality Indicators

Soil pH and Soil Organic Matter (SOM)

As expected, the soil pH was not significantly affected by methods of pasture rejuvenation. The mean soil pH across methods of rejuvenation only varied from 6.69-6.95 for 0-6" soil depth in 2016 and 2017, and from 6.61-7.08 for 6-12" soil depth in 2016 and 2017.

'Bale grazing' appeared to have consistently higher SOM values from 0-6" soil depth than other methods of rejuvenation in 2016 and 2017. In 2017, 'Bale grazing' had 1.70 - 3.80% more SOM than other methods, including Check. As expected, generally SOM was higher in the surface soil than subsurface soil in both years for all rejuvenation methods investigated.

Table 7. Soil pH, soil organic matter (SOM) and electrical conductivity (EC) from 0-6" and 6-12" soil depths in 2016 and 2017 from Site 2. **, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

	pH				SOM %				EC ds/m			
	2016		2017		2016		2017		2016		2017	
Rejuvenation Method	0-6"	6-12"	0-6"	6-12"	0-6"	6-12"	0-6"	6-12"	0-6"	6-12"	0-6"	6-12"
Check	6.70	6.40	7.50	7.40	3.93	2.00	4.95	0.40	0.34	0.23	0.22	0.07
Bale grazing	6.90	6.70	7.10	7.10	7.20	1.40	7.90	3.50	0.52	0.22	0.37	0.20
Break & re-seed	6.60	6.80	6.80	7.10	6.60	3.50	5.50	0.40	0.27	0.26	0.20	0.07
Fall seeding with Agrowdrill	6.50	6.80	7.00	7.10	5.00	1.20	5.40	0.50	0.25	0.17	0.20	0.06
Fall seeding with CD	6.70	6.70	6.80	7.20	6.80	3.00	6.00	0.30	0.3	0.23	0.20	0.09
Fertilizer application	6.60	6.40	6.80	7.00	4.90	2.10	4.10	2.10	0.27	0.20	0.32	0.10
Mob grazing	6.50	6.80	7.00	7.00	6.75	3.80	6.20	3.20	0.27	0.26	0.21	0.20
Subsoil in fall	6.90	6.30	6.80	7.10	6.10	2.90	6.00	2.80	0.29	0.29	0.32	0.10
Spring seeding with Agrowdrill	6.70	6.6	6.90	7.00	5.5	1.6	4.2	2.95	0.26	0.2	3.36	0.20
Spring seeding with CD	6.8	6.6	6.8	6.8	5.5	1.5	5.9	1.7	0.29	0.22	0.25	0.10
Mean	*6.69*	*6.61*	*6.95*	*7.08*	*5.83*	*2.30*	*5.62*	*1.79*	*0.31*	*0.23*	*0.57*	*0.12*
Significance												
Treatment	*NS*		*NS*		*		*		*		*	
Depth	*NS*		*NS*		*		*		*		*	
Treat.× Depth	*NS*		*NS*		*		*		*		*	
$LSD_{0.05}$												
Treatment	*0.4*		*2.16*		*0.4*		*0.99*		*0.01*		*0.009*	
Depth	*0.23*		*0.92*		*0.17*		*0.422*		*0.00*		*0.004*	
Treat.× Depth	*0.51*		*3.06*		*0.56*		*1.4*		*0.01*		*0.01*	
CV %	*1.22*		*21*		*7*		*18.7*		*3.00*		*2.1*	

Soil Water Infiltration, Compaction and Soil Moisture (Table 8)

The soil water infiltration rate was greatly improved by 'Subsoil in fall' and 'Break & re-seed' in 2016. In 2017, the top 3 methods and their order with respect to water infiltration rate were: Subsoil in fall > (0.94 inches/hour) > Bale grazing (0.77 inches/hour) >Break & re-seed (0.49 inches/hour). Infiltration rate generally increased from 2016 to 2017 for all methods (except for 'Break & re-seed' and 'Subsoil in fall'). The greatest increase in water infiltration rate in 2017 over that of 2016 was recorded for 'Bale grazing'. The rate at which water infiltrated into the soil was the same for 'Subsoil' in fall for both years.

In terms of mean soil compaction (average of 1-12" soil depths), only 'Bale grazing', 'Subsoil in fall' and 'Break & re-seed' seemed to reduce soil compaction over control in both years. The mean soil compaction was lowest for 'Subsoil in fall', followed by 'Bale grazing' and 'Break & re-seed' in that order for both years. Looking at soil compaction at different depths, 'Subsoil in fall', followed by 'Break & re-seed' had the least compacted soil from 1 to 12" soil depths (Figure 5). 'Bale grazing' also showed less compacted soil, particularly in the surface soil (0-6" soil depth, Figure 5).

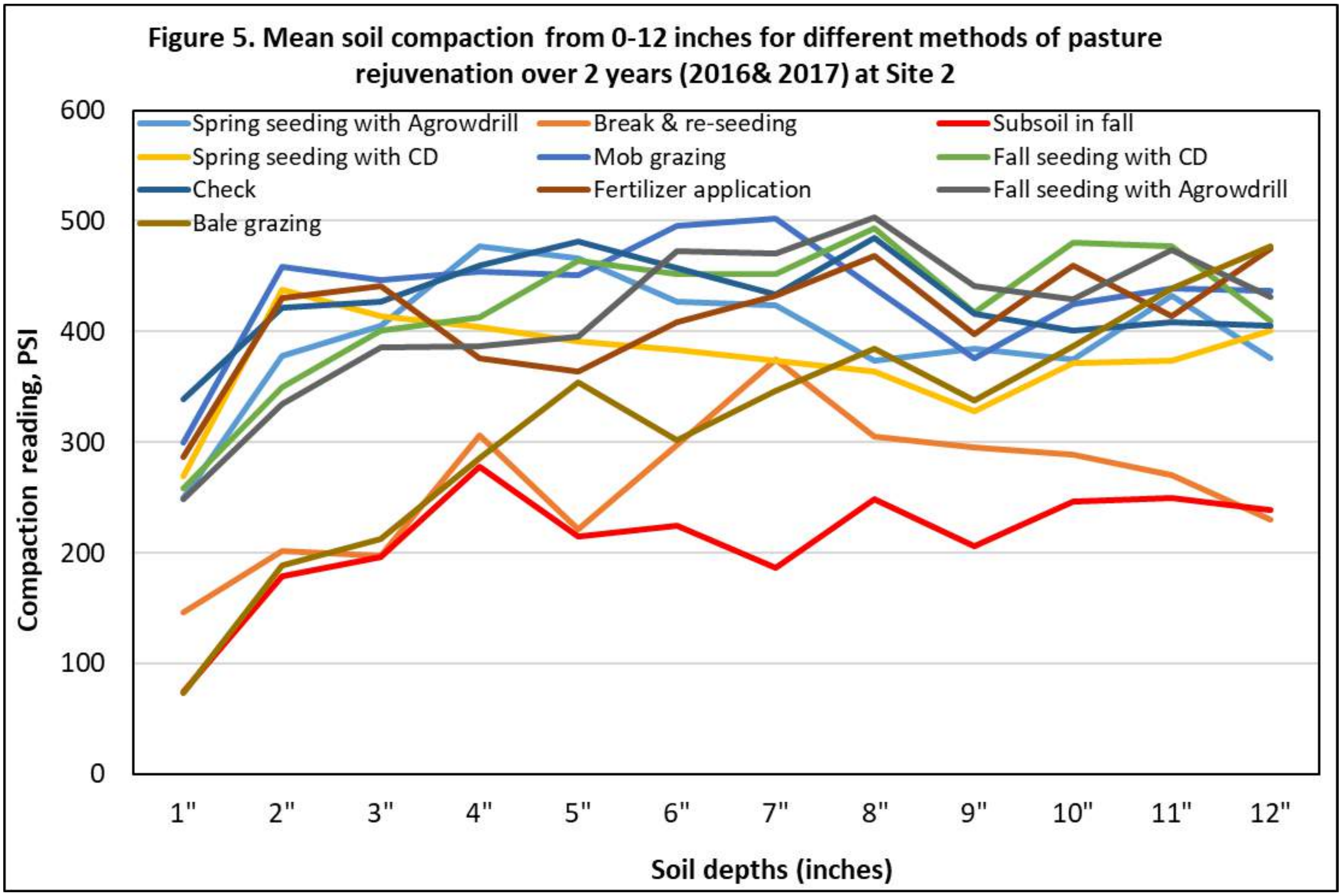
The soil moisture content was similar for all methods in 2016, while 'Bale grazing', 'Subsoil in fall' and 'Break & re-seed' significantly improved soil moisture content in 2017. While 'Bale grazing' and 'Subsoil in fall' greatly improved soil moisture from 2016 to 2017 by 9.8% and 4.4% respectively, other methods had far less improvement in soil moisture.

Carbon : Nitrogen Ratio (C:N) (Table 8)

The C:N ratio of surface soil (0-6" depth) was similar for all methods in both years.

Table 8. Infiltration rates, compaction readings, soil moisture and C:N ratios from 0-6" in 2016 and 2017 at site 2. **, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

	Infiltration (inch/hr)		Compaction (PSI)		Soil moisture (%)		C %		N %		C:N ratio	
Rejuvenation Method	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Check	0.05	0.29	420	447	13	10.0	3.73	3.11	0.28	0.23	12.0	13.5
Bale grazing	0.26	0.77	268	216	11.6	21.4	4.01	3.92	0.24	0.24	12.4	16.3
Break & re-seed	0.81	0.69	351	235	12.7	14.4	3.56	3.09	0.26	0.2	11.6	15.5
Fall seeding with Agrowdrill	0.08	0.27	374	422	12.9	10.1	3.33	3.25	0.24	0.21	12.0	15.5
Fall seeding with CD	0.05	0.39	414	405	12.8	8.70	4.4	3.40	0.31	0.23	12.2	14.8
Fertilizer application	0.05	0.22	388	437	11.1	10.0	2.83	2.93	0.20	0.18	12.1	16.3
Mob grazing	0.07	0.19	463	433	10.1	11.9	5.3	2.95	0.39	0.21	11.7	14.0
Subsoil in fall	0.94	0.94	144	203	12.1	16.5	3.92	3.58	0.29	0.26	11.1	13.8
Spring seeding with Agrowdrill	0.05	0.23	445	368	11.6	10.6	3.14	3.30	0.23	0.24	11.4	13.8
Spring seeding with CD	0.04	0.28	458	398	12.8	10.6	3.62	3.49	0.23	0.23	11.3	15.2
Mean	*0.24*	*0.43*	*373*	*356*	*12.1*	*12.4*	*3.78*	*3.30*	*0.27*	*0.22*	*11.8*	*14.9*
Significance	*	*NS*	*	*	*NS*	*	*	*	*NS*	*NS*	*NS*	*NS*
LSD(0.05)	*0.6*	*0.47*	*119*	*86.2*	*5.9*	*1.66*	*0.64*	*0.33*	*0.07*	*0.05*	*1.2*	*0.73*
CV	*24*	*25.9*	*13.7*	*14.1*	*11.9*	*7.82*	*0.30*	*1.89*	*2.9*	*5.2*	*1.31*	*6.31*



Soil Nutrients

Soil N (Figure 6) - In both years, 'Bale grazing' consistently improved soil N in the surface soil more than other methods. In 2016, other than 'Bale grazing' (which showed higher soil N at 0-6" than 6-12"), other methods mostly had similar soil N at both depths. In 2017, 'Bale grazing', as well as 'Fertilizer application', 'Mob grazing' and 'Break & re-seed' seemed to have increased the amount of soil N in the surface soil (0-6") more than subsurface soil (6-12"). In 2016, subsurface (6-12") soil N did not change much with respect to methods investigated, but in 2017, 'Bale grazing', 'Fertilizer application', 'Mob grazing' and 'Subsoil in fall' had substantially increased subsurface (6-12") soil N by up 6-18 lbs N/acre.

Soil P (Figure 7) - The soil P did not vary much in 2016 between the different methods. In 2017, 'Bale grazing' showed significant soil P improvement in both surface (0-6") and subsurface (6-12") soil depths, compared to other methods examined in this study. 'Bale grazing' had 24-36 lbs P/acre more than other methods in the surface soil. Generally, 'Bale grazing', 'Fertilizer application' and 'Mob grazing' showed more soil P in the surface soil (0-6") in 2017 than 2016. In both years (except for 'Bale grazing' in 2017), subsurface soil mostly had similar soil P values for any particular treatment.

Soil K (Figure 8) - Only 'Bale grazing' showed greater improvement in soil K over Check treatment in the surface soil in both years. The surface soil (0-6") mostly had higher soil K than subsurface soil (6-12") in both years.

Soil S - For some reason, check appeared to have higher surface soil S in 2016 and 2017 than other methods (data not shown). Generally, the different methods did not show any consistent trend with respect to soil S from 2016 to 2017.

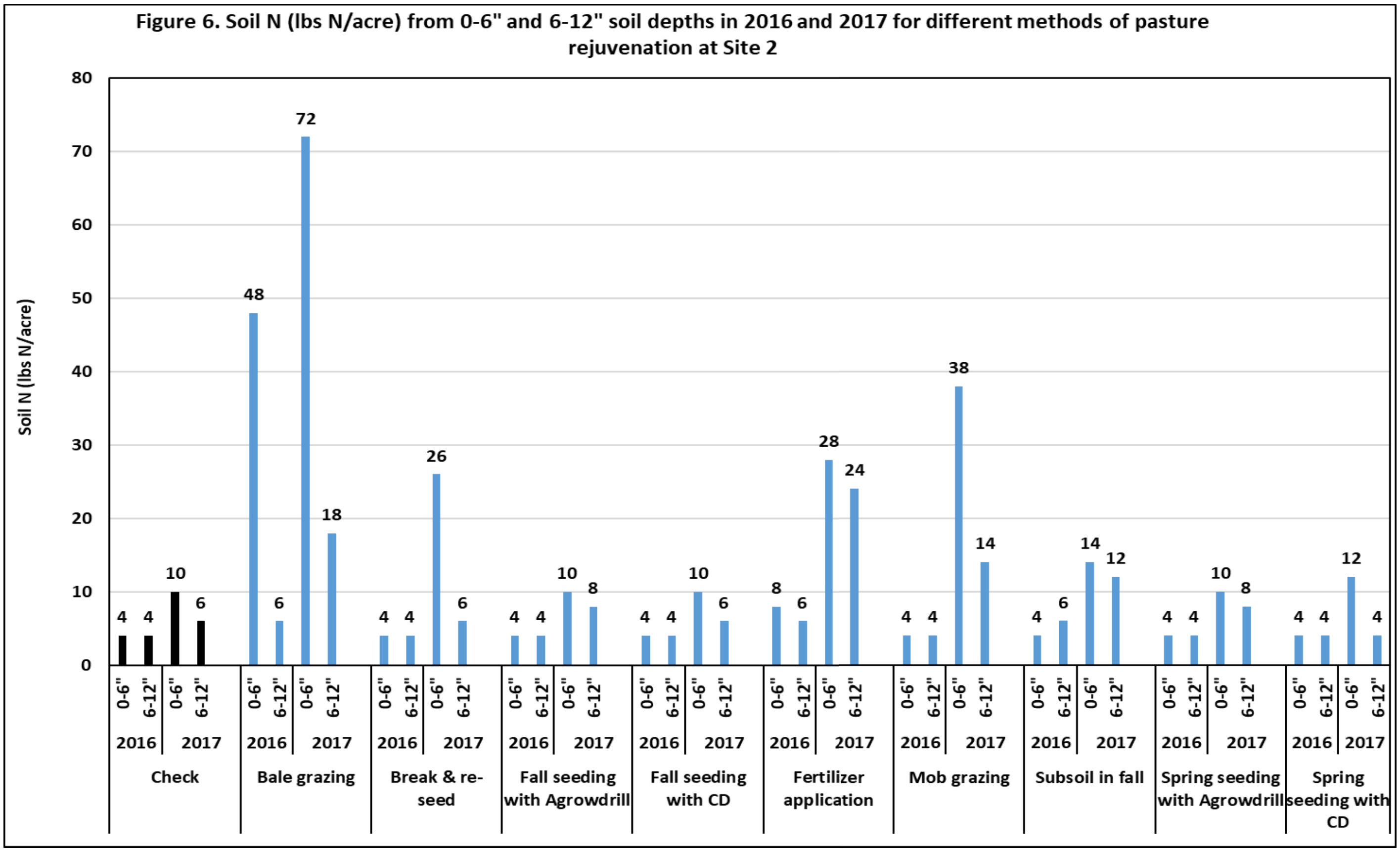


Figure 6. Soil N (lbs N/acre) from 0-6" and 6-12" soil depths in 2016 and 2017 for different methods of pasture rejuvenation at Site 2
Soil N (lbs N/acre)
0-6"
6-12"
2016
2017
Check
Bale grazing
Break & re-seed
Fall seeding with Agrowdrill
Fall seeding with CD
Fertilizer application
Mob grazing
Subsoil in fall
Spring seeding with Agrowdrill
Spring seeding with CD

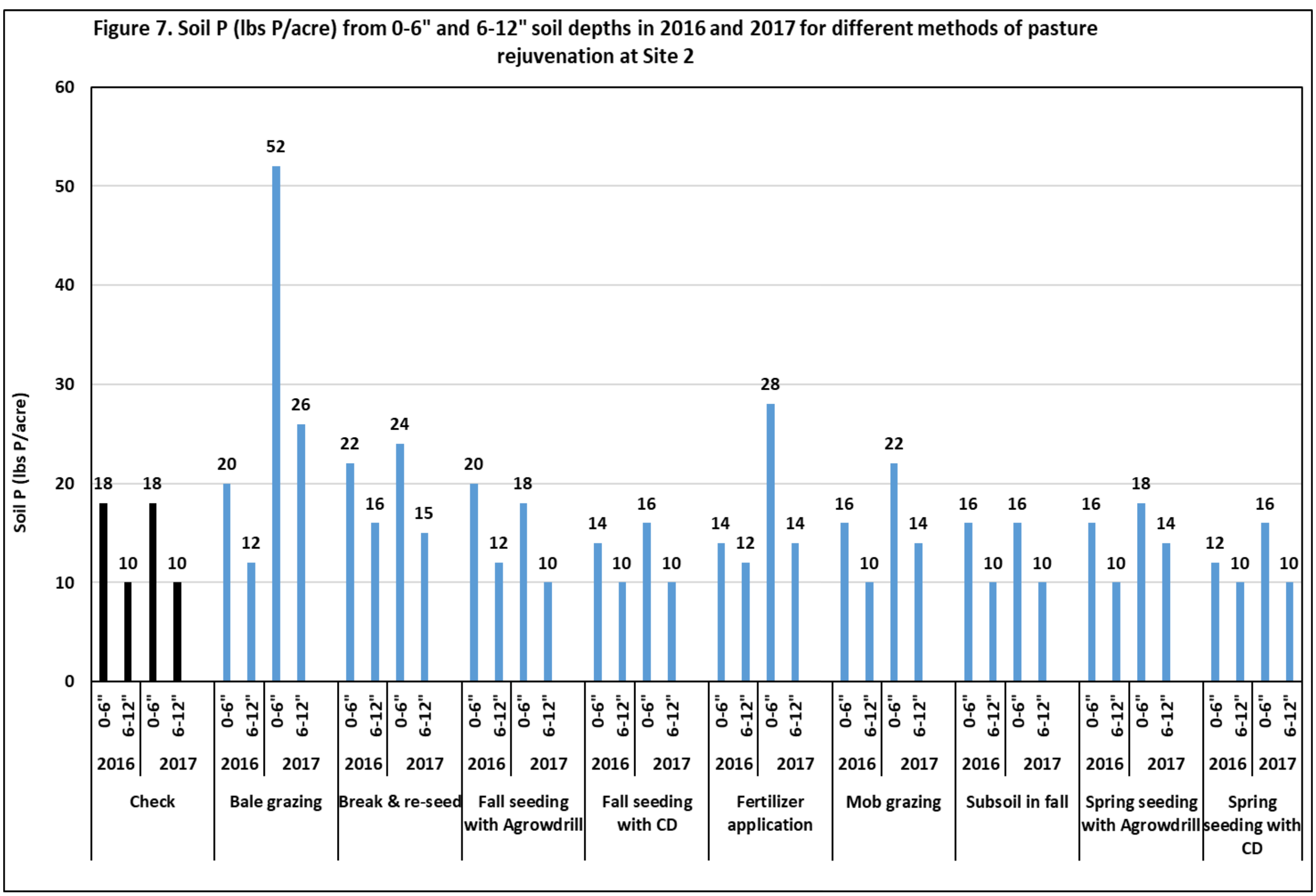
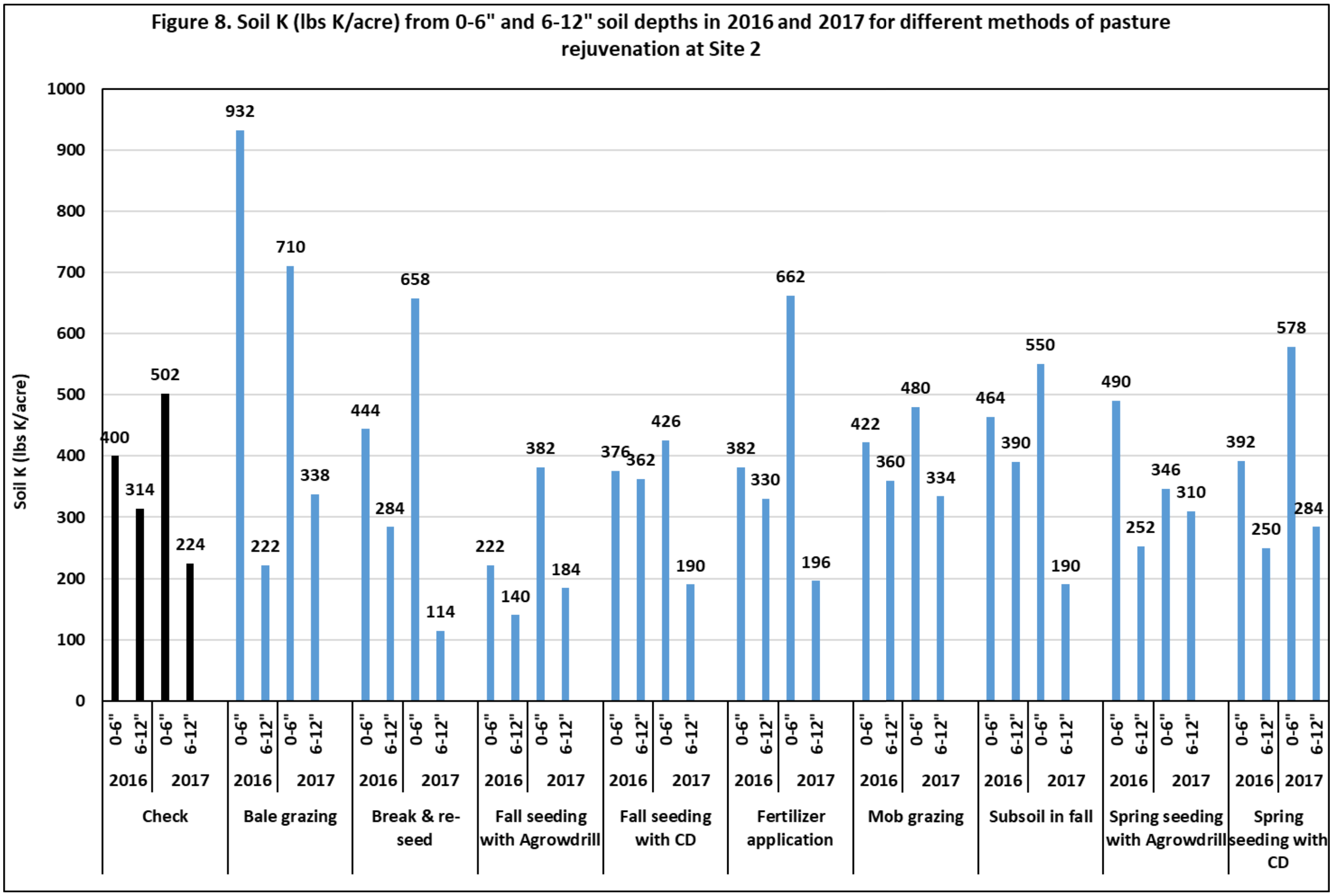


Figure 7. Soil P (lbs P/acre) from 0-6" and 6-12" soil depths in 2016 and 2017 for different methods of pasture rejuvenation at Site 2
Soil P (lbs P/acre)
0-6"
6-12"
2016
2017
Check
Bale grazing
Break & re-seed
Fall seeding with Agrowdrill
Fall seeding with CD
Fertilizer application
Mob grazing
Subsoil in fall
Spring seeding with Agrowdrill
Spring seeding with CD



Forage Dry Matter (DM) Yield and Plant Composition (Table 9)

In both years (2016 and 2017), only 'Bale grazing' and 'Fertilizer application' showed far greater forage DM yield than Check. But in 2017, in addition to 'Bale grazing' and 'Fertilizer application', both 'Break & re-seed' and 'Mob grazing' also showed significant forage DM yield over Check. Across both years, the mean forage DM yield was highest for 'Bale grazing', followed by 'Fertilizer application' and 'Mob grazing', with their mean forage DM yields varying in excess of 704 to 2478 lbs/acre over Check.

In 2016, only 'Break & re-seed' and 'Spring seeding with Agrowdrill' appeared to show some higher proportion of grass plants in the total forage DM yield than Check. In 2017, both 'Bale grazing' and 'Break & re-seed' showed a higher proportion of grass in the total forage DM than Check.

In all cases, the proportion of legumes in the total forage DM yield was <50%. In 2017, both 'Bale grazing' and 'Break & re-seed' had the least amount of legumes in the total forage DM yield.

Forage Quality (Table 10)

Crude Protein (CP) - The forage CP in 2016 was very much similar for all methods, but in 2017, 'Bale grazing' by far had the highest forage CP over Check and all other treatments. In 2017, 'Bale grazing' increased forage CP by up to about 10% over Check and other methods. Other methods that showed significant forage CP improvement over Check in 2017 were 'Fertilizer application' and 'Mob grazing'.

Table 9. Forage dry matter (DM) yields and forage composition for different methods in 2016 and 2017
**, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

Rejuvenation Method	Total DM				Grass Plant		Legume Plant		Other Plant	
	2016	2017	Mean	DMY as % of check	2016	2017	2016	2017	2016	2017
Check	917	1345	1131	100	42.5	64.3	40.5	18.8	17	16.9
Bale grazing	2203	5015	3609	319	49	82.7	21.2	8.10	29.8	9.20
Break & re-seed	972	2698	1835	162	59.2	77.7	15.9	10.7	24.7	11.6
Fall seeding with Agrowdrill	1188	1362	1275	113	46.8	53.2	31.5	36.5	21.8	10.3
Fall seeding with CD	935	1878	1407	124	34.9	50.3	45.9	31.2	19.3	18.4
Fertilizer application	1644	3131	2388	211	33.7	52.6	40.7	38.7	25.5	8.70
Mob grazing	1380	2477	1929	171	48.7	55.1	10	39.0	41.3	8.90
Subsoil in fall	856	2144	1500	133	37.7	46.4	45.2	38.2	17.1	15.5
Spring seeding with Agrowdrill	923	2061	1492	132	54.2	49.7	10.2	41.5	35.5	8.90
Spring seeding with CD	756	2198	1477	131	38.9	62.7	20	26.4	41	10.8
Mean	*1177*	*2431*	*1804*		*44.6*	*59.5*	*28.1*	*28.9*	*27.3*	*11.9*
Significance	*	*			*	*	*	*	*	*NS*
LSD(0.05)	*658*	*772.4*			*8.02*	*10.3*	*20*	*17.5*	*1.9*	*13.2*
CV	*21.2*	*18.7*			*7.41*	*10.8*	*27.4*	*35.2*	*22.9*	*51.1*

Minerals (Table 10)
The amount of forage macro minerals (Ca, P, Mg and K) measured were not significantly different for the rejuvenation methods investigated here through out the study period.

Generally, across the different rejuvenation methods, the forage macro minerals (Ca, P, Mg and K) had higher mean values in 2017 than 2016.

Detergent Fibres & Non-Fibre Carbohydrates (NFC) (Table 10)
The forage detergent fibres (ADF & NDF) and NFC values were similar for the methods of rejuvenation tested including Check in 2016 and 2017.

Energy (Table 10)
The forage total digestible nutrients (TDN) and other forms of energy (NE_L, NE_G & NE_M) measured here all showed similar forage values for the rejuvenation methods as well as Check in both 2016 and 2017 (except for NE_M in 2017). Even for the forage NE_M that showed some significant differences in 2017, most of the rejuvenation methods were still similar to some extent.

Table 10. Forage quality indicators of total forage dry matter (DM) for different methods in 2016 and 2017 at site 2.
**, indicates significance at P<0.05; NS, indicates not significant. CV stands for coefficient of variation*

Rejuvenation Method	CP 2016	CP 2017	Ca 2016	Ca 2017	P 2016	P 2017	Mg 2016	Mg 2017	K 2016	K 2017
Check	12.1	10.9	0.96	0.42	0.25	0.20	0.24	0.15	2.55	2.01
Bale grazing	12.9	20.6	0.7	0.76	0.22	0.28	0.16	0.17	2.56	3.33
Break & re-seed	11.7	13.8	1.01	0.65	0.24	0.25	0.23	0.16	3.17	2.38
Fall seeding with Agrowdrill	13.4	10.7	1.03	0.44	0.24	0.23	0.24	0.13	2.82	2.24
Fall seeding with CD	14.4	11.8	1.22	0.29	0.23	0.23	0.26	0.11	2.56	2.39
Fertilizer application	12.6	15.9	0.96	0.99	0.29	0.26	0.21	0.25	2.78	2.82
Mob grazing	13.6	15.3	1.09	0.98	0.21	0.22	0.22	0.18	2.96	2.73
Subsoil in fall	14.8	12.5	1.36	0.66	0.22	0.25	0.27	0.15	2.65	2.4
Spring seeding with Agrowdrill	14.0	11.8	1.12	0.41	0.23	0.26	0.28	0.14	2.88	2.25
Spring seeding with CD	14.3	12.9	1.13	0.46	0.23	0.26	0.26	0.16	2.70	2.81
Mean	*13.4*	*13.6*	*1.1*	*0.6*	*0.2*	*0.2*	*0.2*	*0.2*	*2.8*	*2.5*
Significance	*NS*	*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
$LSD_{0.05}$	*3.27*	*3.31*	*0.58*	*0.64*	*0.04*	*0.06*	*0.09*	*0.09*	*0.57*	*0.86*
CV,%	*10.9*	*13.9*	*25.0*	*46.8*	*9.13*	*11.5*	*18.1*	*25.7*	*9.39*	*15.3*

Rejuvenation Method	ADF 2016	ADF 2017	NDF 2016	NDF 2017	NFC 2016	NFC 2017	TDN 2016	TDN 2017	DE 2016	DE 2017
Check	35.7	38.1	54.1	62.9	23.0	15.4	60.5	58.0	2.67	2.56
Bale grazing	36.5	35.0	58.8	58.1	17.5	10.5	59.7	61.2	2.63	2.70
Break & re-seed	36.3	38.3	55.0	63.2	22.5	12.2	59.9	57.8	2.64	2.55
Fall seeding with Agrowdrill	35.5	34.5	55.1	58.4	20.7	20.1	60.8	61.8	2.68	2.73
Fall seeding with CD	36.6	36.0	54.6	61.6	20.2	15.8	59.5	60.2	2.63	2.66
Fertilizer application	37.5	34.1	58.0	53.9	18.6	19.4	58.6	62.2	2.59	2.75
Mob grazing	35.4	36.7	53.4	58.2	22.2	15.7	60.8	59.4	2.69	2.62
Subsoil in fall	35.7	34.8	53.0	59.0	21.4	17.7	60.5	61.5	2.67	2.71
Spring seeding with Agrowdrill	36.3	36.7	54.4	62.7	20.8	14.8	59.9	59.4	2.64	2.62
Spring seeding with CD	34.2	35.5	53.4	59.8	21.5	16.5	62.1	60.8	2.74	2.68
Mean	*36.0*	*36.0*	*55.0*	*59.8*	*20.8*	*15.8*	*60.2*	*60.2*	*2.7*	*2.7*
Significance	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
$LSD_{0.05}$	*4.94*	*2.91*	*10.7*	*7.95*	*9.68*	*6.51*	*5.28*	*3.11*	*0.23*	*0.14*
CV,%	*6.19*	*3.65*	*8.75*	*6.00*	*20.7*	*18.2*	*3.92*	*2.31*	*3.99*	*2.36*

Rejuvenation Method	ME 2016	ME 2017	NE_L 2016	NE_L 2017	NE_M 2016	NE_M 2017	NE_G 2016	NE_G 2017	RFV 2016	RFV 2017
Check	2.22	2.13	1.37	1.31	1.35	1.27	0.77	0.70	106	88
Bale grazing	2.19	2.24	1.35	1.39	1.33	1.38	0.75	0.80	99	99
Break & re-seed	2.20	2.12	1.35	1.30	1.33	1.26	0.76	0.76	103	88
Fall seeding with Agrowdrill	2.23	2.27	1.37	1.40	1.36	1.40	0.78	0.82	104	99
Fall seeding with CD	2.18	2.20	1.34	1.36	1.32	1.34	0.75	0.77	103	92
Fertilizer application	2.15	2.28	1.32	1.41	1.29	1.41	0.72	0.82	97	108
Mob grazing	2.23	2.18	1.38	1.34	1.36	1.32	0.79	0.74	107	97
Subsoil in fall	2.22	2.25	1.37	1.39	1.35	1.38	0.78	0.80	108	98
Spring seeding with Agrowdrill	2.19	2.17	1.35	1.34	1.33	1.32	0.76	0.74	104	90
Spring seeding with CD	2.28	2.23	1.41	1.38	1.41	1.36	0.83	0.78	109	95
Mean	*2.2*	*2.2*	*1.4*	*1.4*	*1.3*	*1.3*	*0.8*	*0.8*	*104.0*	*95.4*
Significance	*NS*	*NS*	*NS*	*NS*	*NS*	*	*NS*	*NS*	*NS*	*NS*
$LSD_{0.05}$	*0.19*	*0.11*	*0.12*	*0.07*	*0.17*	*0.10*	*0.16*	*0.09*	*25.3*	*15.5*
CV,%	*3.92*	*2.26*	*4.25*	*2.52*	*5.88*	*3.35*	*9.40*	*5.67*	*10.9*	*7.27*

Discussion

Cow-calf producers know that grazing on productive pastures can be very profitable. However, over time, the productivity and livestock-carrying capacity of seeded hay fields and pastures may decline, largely a result of reduced stand vigor, consequence of drought, pests, weeds, the invasion of unpalatable or less productive species, overgrazing and poor soil fertility. The improvement strategies implemented in this study considered the seeding of new pastures, the regeneration of existing ones, and even the fertilization of existing pastures to demonstrate practical, sustainable forage production and low cost options with maximal success.

Soil Component (infiltration, compaction, SOM, moisture and soil nutrients)

One evaluation alternative for the implementation of these strategies is through the concept of soil quality proposed by Karlen et al. (1997): "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation". This concept is determined by inherent and dynamic characteristics of the soil (Karlen et al., 2003), and is found valid when indicator parameters are present (e.g., air capacity, permeability, penetration resistance) that allows for evaluation of the level of soil quality (Reynolds et al., 2009; Horn and Fleige, 2009). In the present study, at both sites, in an effort to improve soil quality in order to make soil function and sustain plant and animal productivity, and enhance water uptake and retention (without breaking and re-seeding the existing pastures), bale grazing has consistently played a great role in all these.

Bale grazing improved SOM by up to 3.80% over other methods (including check), though bale grazing only appeared to show less compaction in the surface soil (0-6"), and not the subsurface soil (6-12"). Mob grazing, and to some extent Manure + subsoil in fall (site 1 only) also showed greatly improved SOM. Subsoil in fall, Manure + subsoil in fall, and Break & re-seed also consistently played significant roles in improving infiltration rate and reducing soil compaction over the study period.

The improvement in SOM by bale grazing in this study was not unexpected, as various studies in the same environment (Omokanye, 2013, 2014) and elsewhere [based on producers experience as indicated by Jerry Lindquist (Henke, 2017)] have reported similar observations. The SOM is critical for plant growth, and storing water. As observed here, previous studies by Omokanye (2013, 2014) also reported higher SOM in the surface soil (0-6") than the subsurface soil (6-12"). In addition to the roles played by bale grazing in improving soil function, it is important to note that the combination of Manure + subsoil in fall may also be a strategy to enhance soil health, through improved SOM and infiltration rate, and reduced compaction. The observation from the present study with respect to SOM supports the fact that winter feeding through bale grazing on pasture is an excellent way to add organic matter to the soil. Later in the study (2017), Bale grazing, Subsoil in fall, Manure + subsoil in fall, and Break & re-seed all showed up to 34% higher soil moisture content in the surface soil (0-6") than Check. The higher soil moisture value obtained over Check could be due to improved SOM and infiltration rate, and reduced compaction, which all helped to retain moisture for those methods of rejuvenation. As earlier indicated by Newport (2013), 2% SOM will hold 32,000 gallons of water (or 21% of a 5.5 inch rain), 5% SOM will hold 80,000 gallons of water (or 53% of a 5.5 inch rain) and every 8% SOM will hold 128,000 gallons of water (or 85% of a 5.5 inch rain).

In terms of soil nutrients (particularly N, P, K and S) at both sites, it is evident from this study that Bale grazing, Manure + subsoil in fall, Mob grazing and Fertilizer application have all shown great potential for improving soil N, P, K and S, compared to other methods including Check (see Figures 2-3 & 6-8 for soil N, P & K). This study also shows that at both sites in both years (2016 and 2017), the surface soil (0-6") N, P and K was mostly higher than subsurface soil (6-12”). The consistently higher soil nutrients (particularly N, P and K) obtained in this study for both sites after Bale grazing, Mob grazing, Manure + subsoil in Fall, and Fertilizer application, compared to Check and other methods, indicate that for the purpose of improving soil nutrients as part of soil quality/health improvement, there were significant benefits. Therefore any of these methods would have potential to directly influence soil health on an old forage stand. As seen for Manure + subsoil in fall at site 2, it is evident that manure would be a valuable source of plant nutrients.

The findings with using Bale grazing, in particular, as a reliable rejuvenation strategy in this study further reaffirms the benefits of bale grazing in adding nutrients to the soil, as earlier reported in various studies across Western Canada including the Peace Country region (Jungnitsch *et al*., 2011; Omokanye, 2013 & 2014; Picard, 2010). With Bale grazing, through the residual feed/feed litter and manure accumulation, N is captured on the Bale grazing site and gradually becomes available, through litter decomposition and soil nutrient mineralization, for subsequent pasture production. As observed in the present study, Picard (2010) also reported that soil N, P and K levels increased dramatically in the surface soil of the soil profile within one year after Bale grazing. The present study as well as those of Omokanye (2013 & 2014) and Picard (2010) showed that those soil nutrients remain elevated in the surface soil profile but seem to be stabilizing or dropping with increasing years of forage growth and harvest, either as hay or pasture. As reported earlier for Bale grazing in the Peace Country of Alberta, residual soil N appeared to be moving through the surface soil to the subsurface soil profile within a few years after Bale grazing, indicating a potential for soil N leaching within the system. In the present study, generally, soil nutrients leaching from surface (0-6”) to subsurface (6-12”) soil profile tended to be very minimal.

The present study has also shown that Manure + subsoil in fall, Mob grazing and dry Fertilizer application would reliably improve soil nutrients, particularly in the surface soil profile (0-6”). This therefore, in addition to Bale grazing, provides producers with a wide varieties of strategies they can use for improving their soil nutrient conditions. These other methods may not have more lasting effects than Bale grazing.

Forage Production Component

Forage DM Yield

By increasing forage production on grazing land, higher stocking rates can be used and animal performance may improve, and increasing production on hay land reduces the cost of unit of production, which means reduced winter feed costs per cow (BCRC, 2016).

In this study, over the 2 years of data collection at both sites, the top 4-5 forage DM yielders were Bale grazing, Manure + subsoil in fall, Break & re-seed, Mob grazing and fertilizer application, with up to about 220% higher mean forage DM yield. Two years (2017) after the rejuvenation methods were implemented, Bale grazing (at both sites), Manure + subsoil in fall (site 1) and Fertilizer application (site 2) showed greater improvement in forage DM yield producing 1.5-2.0 tons DM/acre.

The higher forage DM yield produced across the years or in any particular year, could be attributed in part to some or most of the following parameters discussed above: improved soil physical conditions such infiltration rate, soil moisture and compaction; and soil nutrients (N, P, and K in particular). Overall, there is no doubt that Bale grazing would greatly produce far more DM yield than other rejuvenation methods tested here, at least within a few years after Bale grazing has been carried out.

Using Break & re-seed rejuvenation as a method to renew pastures does work well when conditions are favorable (e.g. weather and soil) and with the right management decisions (e.g. right forage mixture, seeding equipment and seeding date, history of site). However, Break & re-seed is a complex and costly challenge for producers. In this study, we did not get the anticipated results from Break & re-seed as a means of pasture renewal, in terms of forage DM yield at both sites. The Break & re-seed treatment was tilled and seeded in 2015, which was a dry year. The amount of rainfall and grasshopper infestation were thought to be responsible for the poor establishment of seeded forage mixture for Break & re-seed treatment. The forage DM yield reported here for the Break & re-seed treatments were only from areas in the field where pasture establishment was better.

In this study, when dry Fertilizer application (at site 2 only) was done as a method of forage stand rejuvenation, the result was impressive compared with Check and some other methods investigated. The resulting benefit from Fertilizer application was 727 lbs forage DM/acre in 2016 and 1786 lbs forage DM/acre in 2017 over Check, indicating that the residual effect of fertilizer can last for a few years after application. As observed in the present study, research has indicated that fertilization can bring the productivity of a stand back to its original level without the expense of re-seeding (BCRC, 2016). Given the high fertilizer prices and poor margins in the cattle industry in recent years, many producers are hesitant to increase input costs. This is because higher yields do not necessarily translate into lower costs or increased profits (BCRC, 2016).

Seeding into existing pastures using no-till drill equipment as done in this study (Spring vs Fall using Agrowdrill and conventional drill) did not improve forage DM yield to a large extent over Check at both sites. The forage yield advantage from the no-till drill and seeding times was only up to 563 lbs DM/acre at site 1 and 853 lbs DM/acre at site 2. The failure could be attributed again to dry weather, and in particular the effect of competition from the existing vegetation.

Taking into consideration unpredictable weather conditions (rainfall in particular), competition of existing stands with newly seeded pasture using no-till drill (without spraying out the old forage stand), the high cost and loss of productive time that could be associated with forage stand termination and re-establishment, and the fact that one may not get the expected results because of various factors as noted in the present study, it is evident that Bale grazing could be identified as one of the best options for sustaining a forage stand.

Forage Quality Indicators

In the present study, taking into consideration that mature beef cattle require 11% CP, the resulting forages were mostly adequate for mature beef cattle (except on a few instances at site 1) in both years. At site 1, Fall seeding with Agrowdrill and Spring seeding with Agrowdrill were only able to meet the CP requirements of a dry gestating cow either in mid or late pregnancy. The lower forage CP obtained for Fall seeding with Agrowdrill and Spring seeding with Agrowdrill at site 2 is difficult to explain.

At site 1, except for Break & re-seed (in 2017), Fall seeding with CD (in 2016 & 2017) and Spring seeding with Agrowdrill (in 2017), all methods of rejuvenation had adequate forage Ca for mature beef cattle according to NRC recommendations (NRC, 1996, 2000). At site 2, in 2016, all methods exceeded the Ca needed by mature beef cattle. But in 2017, five (Check, Fall seeding and Spring seeding) of the 10 methods fell short meeting the Ca requirements of mature beef cattle.

At both sites the P and Mg requirements of mature beef cattle were not met by all methods tested in both years.

However, at both sites in both years (2016 & 2017), all methods had met and far exceeded the K requirements of mature beef cattle as suggested by NRC (1996, 2000).

Because of the inability or inconsistencies of any particular methods examined in this study to meet the complete macro mineral requirements of mature beef cattle, it therefore suggests that some form of mineral supplementation is needed for cows on pasture or when hay is being fed during fall, winter and early spring.

Except in a few instances at site 1, all methods of rejuvenation as well as Check had enough TDN for a dry gestating cow in mid pregnancy in 2016. In 2017, all methods had adequate TDN according to NRC (1996, 2000) recommended values for dry gestating cows in mid pregnancy, and only Manure + subsoil and Mob grazing met the 60% TDN needed by a dry gestating cow in late pregnancy. However, at site 2, most methods had enough TDN for dry gestating cows in mid and late pregnancy in both years. None of the methods at either site in any year was able to meet the TDN requirement of a lactating beef cow as suggested by NRC (1996, 2000).

In terms of the requirement for net energy for maintenance (NE_M), all methods were well within the 1.19-1.28 Mcal/kg for mature beef cattle, as well as the 1.08-2.29 Mcal/kg needed by young beef cattle as recommended by NRC (1996, 2000). But in terms of net energy for gain (NE_G) needed by growing and finishing calves, all methods including Check were within the suggested 0.53-1.37 Mcal/kg at site 2, but not at site 1. At site 1, in 2016 only, Fall seeding with Agrowdrill and Spring seeding with CD just fell short of meeting the required NE_G by growing and finishing calves.

Conclusion

Producing high quality forage and maintaining productive forage stands is a major challenge that Alberta's beef producers encounter, as rejuvenation is a complex and costly challenge. With the high cost and loss of productive time associated with forage stand termination and re-establishment, producers are anxious to identify all options for sustaining a forage stand. In the present study, of the different methods investigated and in terms of soil health improvement (soil compaction, infiltration, soil moisture and nutrients particularly N, P and K), compared with Check, it is evident that Bale grazing, Manure + subsoil in fall, Mob grazing and Fertilizer application (positive effects on infiltration and compaction) have all shown great potential for improving soil conditions for pastures.

The top forage DM yielders were Bale grazing, Manure + subsoil in fall, Break & re-seed, Mob grazing and Fertilizer application. Their performance in terms of forage DM yield could be attributed in part to improved soil physical conditions such infiltration rate, soil moisture and compaction; and soil nutrients (N, P, and K in particular). Overall, Bale grazing produced far more DM yield than other rejuvenation methods tested here. Fertilizer application produced a yield advantage of up 1786 lbs forage DM/acre in 2017 over Check, indicating that the residual effect of fertilizer can last for a few years after application. Fertilizer application could be used to bring the productivity of a stand back, without the expense of re-seeding.

Manure is a valuable source of plant nutrients and organic matter and, when used as a fertilizer, will improve forage production and soil quality as seen with Manure + subsoil in fall method of rejuvenation. Forages offer an opportunity for manure application, though not all of the nutrients in manure are immediately available to the crop. The availability of manure nutrients depends upon the nutrient composition of the manure, method of manure application and weather conditions at the time of application. Nutrient availability must be estimated when determining the manure application rate.

Because of the inability or inconsistencies of any particular methods examined in this study to meet the complete macro mineral requirements of mature beef cattle, it therefore suggests that some form of mineral supplementation is needed for cows on pasture or when hay is being fed during fall, winter and early spring.

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MUNICIPAL DISTRICT & COUNTY REPORTS

Clear Hills County Report

After the very wet fall of 2016, the County welcomed a much drier crop year in 2017. Many acres of crop were harvested this spring that had been left out in the fields from the previous fall, which put some producers behind schedule as far as seeding. Approximately 90% of crops were harvested this fall.

The County completed 1393 weed inspections in 2017. Some Scentless Chamomile was found in a few areas, as well as a bit of Toadflax. Canada Thistle was the most predominant, with Perennial Sow Thistle showing up later in the season.

All County ditches were inspected and a great deal of spot spraying was done where needed by our spray crews. We will continue with this approach for the upcoming season. A contract sprayer will be used for any large areas of weeds that are encountered in our ditches. 12 miles of right of way was sprayed for brush control.

We will be hosting our 24th annual Agricultural Trade Show on April 14,2018 at the Dave Shaw Memorial Complex in Hines Creek. For information on the show, sponsorship, or being an exhibitor, contact the County at 780-685-3925, or email greg@clearhillscounty.ab.ca or sarah@clearhillscounty.ab.ca

Greg Coon, Agricultural Fieldman

Municipal District Of Spirit River No. 133 Report

The spring of 2017 posed a variety of challenges towards agriculture producers within the Municipal District of Sprit River #133. Copious amounts of rain and snow fell mid-April, just as farmers were gearing up to hit the fields. About 90% of fields in the MD were seeded, and produced an average, if not above average crop considering the wet spring conditions. The summer of 2017 was fairly dry compared to the 2016 summer, but properly managed crops didn't notice the difference in moisture. Turning the clock to ahead to fall, about 98% of crops seeded were harvested which is amazing news. Producers were blessed with wind and sun, which helped make harvest operations go as smoothly as possible, as opposed to 2016 when nearly 25% of crops were left out under the snowy and cold conditions of winter.

Field surveys showed very little insect or disease pressure towards our high quality peace country crops. Wheat midge had been an issue in a few areas of the Peace, and select farmers' fields obtained the threshold, where it is economically feasible to spray. Our municipality mowed all ditches with a "First Pass Cut" and nearly 75% of the municipality received a full ditch cut. Mowing the ditches helps control the amount of herbicide spraying we require, in exemption for spot spraying of field scabious, scentless chamomile and toadflax. We have found ditch mowing is also a useful key for not only weed control, but overall vegetation and brush control also, as well as greater aesthetics towards the area. Wind and extreme heat events made for very difficult spraying conditions. There appeared to be an upward fluctuation of Scentless Chamomile within the area, some of which was in crop. Producers are reminded the best way to control Scentless Chamomile is picking the weed, and competing against it with grasses. The farmers and ranchers within the municipality exhibit great cooperation and diligence in weed control along roadsides and within fields and pastures. With the introduction of club root within the Peace, the municipality will be doing many more field surveys and showing much more attention when scouting canola fields. Producers should always remember to be leery of where they purchase their equipment from, and be extra careful before introducing the equipment to their land. More information on club root scouting, effects and control measures can be found on our website.

Agricultural Service Board Report submitted by Riley Nooy, Agricultural Fieldman

Municipal District Of Fairview #136 Report

Well, another year has gone by with plenty of accomplishments for 2017 for the Agricultural Department. Our Weed Inspectors have done a total of 1038 field inspections, and 59 Clubroot and Blackleg inspections in our municipality. They have also done 12 grasshopper surveys, 30 grasshopper collections for identification purposes, and 4 Bertha Armyworm trap collections by request for the Alberta Pest Surveillance Branch. We are also contracted to do the Town of Fairview yard and lot inspections of which 792 were accomplished. Inspections are done in the Hamlets of Bluesky and Whitelaw once a week also.

We managed to mow all the municipal ditches once and went back to a few roads that had re-growth from where we originally started. We will begin our mowing program on the north and west side of Highway # 2 in 2018. Our roadside spraying consisted of a total spray of all our municipal road ditches on the north and west side of Highway # 2. We also had done Toadflax control especially on the east side of our municipality along with selective brush spraying along our ditches, especially areas where we brushed in the winter season. I had also sprayed 80 miles of roadside shoulder spray in selected areas given to me by the public works department. The 2018 season will see us spraying ditches on the south side of Highway # 2 in 2018.

A few things to mention is that the ASB has purchased a fencing stapler that is operated on a rechargeable battery and a CO2 cartridge. It looks much like a roofing nailer and can take up to 2-inch staples. It will be part of our rental and we will include staples although the cost will be charged back to the user. We have several rental items and you can check it out on our website.

Also, as many of you producers know, Clubroot has been found in Big Lakes County and in the M.D. of Greenview. It is the producers right to be sure any equipment that comes on to your property is washed and sterilized. Any wheeled vehicle could carry the pathogen in any soil that is accumulated on the vehicle or machinery. Be aware of where that equipment came from before allowing them access to your land. Also, when you purchase cereal seed, be aware of it's origin and possibly have the owner have it tested for Fusarium prior to your purchase.

On another note, the M.D. of Fairview # 136 honors a farm family every two years and we will be looking for your input in nominating one for 2018 but the nominee has to own land and be actively farming in our municipality. There are nomination forms available at our office and on our website.

We, the M.D. of Fairview # 136 Council and Agricultural Service Board would like to say thank-you to PCBFA for their dedication and efforts on hosting the many informative workshops and research plot demonstrations and the intense work and time they put in to be able to deliver these informative opportunities to not only our municipality but many of them in the Peace Region. We are very pleased with all they do for our producers and by seeing the high attendance at the workshops, I believe the producers are taking home some very valuable information. I have personally seen a great majority of the same producers attend workshops or field days and of course many new faces so I believe there is huge value in what PCBFA delivers. The M.D. of Fairview looks forward to what you have in store for us in 2018 and are happy to be part of PCBFA funding not only for the Forage Association but the Environmental Stream also that you deliver on our behalf.

May 2018 be a very successful year to PCBFA and all producers in the Peace Region!

Fred Sawchuk, Agricultural Fieldman

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