Effect of swath grazing an annual polycrop mixture of brassica, legume, and grass species versus barley monocrop on forage yield and quality, soil organic carbon, cattle grazing capacity, and crop system economics in east-central Saskatchewan

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INTRODUCTION

- In SK, ~47% of cattle production costs are directly from grazing and winter feeding (Larson, 2013)
- Extensive fall and winter grazing systems, such as cereal swath grazing and corn grazing, can improve cattle production efficiencies (McCartney et al., 2004; McCartney et al., 2008)
- Increased total plant performance can arise from the diversity of species in a polycrop competing for resources in different ways compared to a monocrop (Crawford and Rudgers, 2012)
- Increased yield can lead to increases in carbon sequestration and soil organic matter, which play a role in:
  - Soil quality, forage biomass yield, and water quality (Lal, 2004)
  - Nutrient turnover and maintaining soil structure (Banwart et al., 2014)
- *However, limited replicated studies have been conducted to quantify the benefits of grazing polycrops for producers in western Canada.*

This polycrop study contributes to the mission of *Canada's National Beef Strategy* through alignment with the four pillars:

- ***Connectivity** and **Beef Demand:*** Producers may use polycrops as one production method contributing to sustainability of their operations. Beef produced with sustainable production methods connects positively with the public and creates a marketable product in demand.
- ***Productivity** and **Competitiveness:*** Polycrops may be used as an innovative tool on operations to increase productivity and reduce production costs, leading to a more cost competitive product.

MAIN RESEARCH OBJECTIVE

Determine the suitability of an annual polycrop mixture compared to a barley monocrop for swath grazing in western Canada

MATERIALS AND METHODS

- A 2-year (2017-2018 and 2018-2019) field study at the Livestock and Forage Centre of Excellence Termuende Research Ranch near Lanigan, SK
- A 13.2 ha (33 acre) field was divided into two fields (with three replicate paddocks in each) that were seeded in 2017 and 2018 to one of two crops (systems): annual polycrop mixture or barley (*Hordeum vulgare*) monoculture
- Each grazing season, dry pregnant Angus cows were randomly allocated to a replicate paddock
- Parameters evaluated and compared between crops: *forage yield and quality, forage dry matter intake and utilization, cow performance, soil organic carbon, and system economics*
- Statistical Analysis: Forage, cattle and economic data were analyzed using PROC MIXED while soil data was analyzed as an ANOVA using PROC GLIMMIX of SAS
- The annual polycrop mixture was composed of 40-10 forage peas (*Pisum sativa*) with Union Forage's "Ultimate Annual Blend" (below)

Species	2017	2018
Hairy Vetch (*Vicia villosa*)	30%	30%
Crimson Clover (*Trifolium incarnatum*)	10%	10%
Italian Ryegrass (*Lolium multiflorum*)	25%	30%
Sorghum (*Sorghum bicolor*)	15%	0%
Winfred Forage Brassica (*Brassica napus* ssp. *biennis*)	10%	10%
Hunter Brassica (*Brassica rapa* syn.B *campestris*)	5%	10%
Graza Forage Brassica (*Raphanus sativa* ssp. *maritimus*)	5%	10%

RESULTS

When comparing this polycrop mixture to the barley monocrop for swath grazing, differences ($P < 0.05$) were observed in:

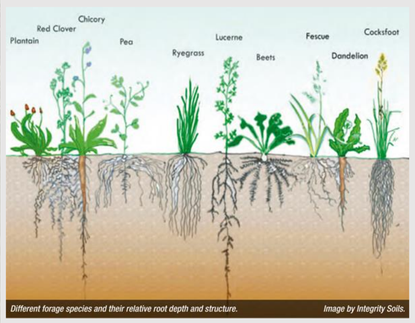
- ***Aboveground forage biomass yield*** ↓ in Polycrop
- ***Forage utilization by cattle*** ↓ in Polycrop
- ***Final cow body weight*** and ***body weight change*** ↓ in Polycrop
- ***Grazing days*** ↓ in Polycrop
- ***Forage quality***
  - *Crude protein* ↑ in Polycrop
  - *Neutral detergent fiber* ↓ in Polycrop
  - *Acid detergent fiber* ↑ in Polycrop
  - *Calcium* ↑ in Polycrop
  - *Phosphorus* no difference
  - *Sulphur* ↑ in Polycrop
  - *Nitrates* ↑ in Polycrop
- ***Soil organic carbon***
  - *Upslope landscape positions at 5-20 cm depth* ↑ in Polycrop
- ***Belowground root biomass***
  - *Upslope landscape positions* ↑ in Polycrop
- ***System economics***
  - *Crop production costs* ↑ in Polycrop
  - *Cost cow^{-1} day^{-1}* ↑ in Polycrop

Polycrop prior to swathing in 2017

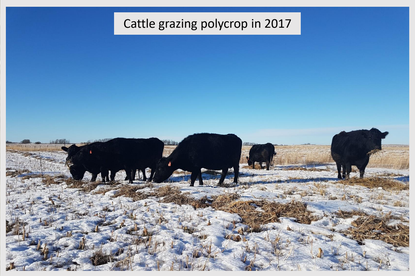
Barley prior to swathing in 2017

No differences ($P > 0.05$) were observed between both crop systems for:

- *Cow dry matter intake*
- *Body condition score* and *ultrasound rib and rump fat thickness*
- *Soil organic carbon*
  - Upslope landscape positions at 0-5 cm depth
  - Downslope landscape position at 0-20 cm depth
- *Belowground root biomass in downslope landscape positions*



Different root architecture of brassica species in polycrop



Cattle grazing polycrop in 2017

Cattle grazing barley in 2017

IMPORTANT IMPLICATIONS FOR PRODUCERS

- There was high weed pressure in this polycrop, especially in the 2nd year:
  - This likely contributed to lower aboveground biomass yield, forage utilization, final cow body weight, and total grazing days in the polycrop
  - ***If using a polycrop for grazing, weed control is very important!*** *Herbicides cannot be sprayed in most polycrops as a means of weed control. Therefore, pick a field without a prior history of weed problems. Ensure your seeding rate and species selection will compete with weeds.*

- ***Feed test, feed test, feed test!!!***
  - You cannot manage, what you do not measure. Feed test for nutritive value and to determine if your forage will meet the physiological demands of your cattle. If your forage does not meet nutritional demands, you should be prepared to supplement.
  - *High levels of sulphur and nitrates were observed in this polycrop*
    - *Sulphur toxicity can occur at 0.5% level in a forage-based diet*
    - *Excess nitrates in forages relate to decreased cattle performance, at levels of 0.5 to 1%*
  - *Calcium was higher in the polycrop than the barley*
    - This may mean using a different mineral program when feeding polycrops to achieve a Ca:P ratio >1.5:1

- ***Polycrops have the potential to increase soil organic carbon** over a short period of time in areas with low carbon levels, such as lower soil depths and degraded upslope landscape positions.*
  - Increases in soil organic carbon are related to higher root biomass inputs

- ***Polycrops cost more to produce***
  - Seed costs are higher for polycrops than barley
  - *Cost cow^{-1} day^{-1} was higher* in this polycrop, due to weed pressure and lower yield
    - **There is no silver bullet** when it comes to managing forages for a beef cattle herd. Yield performance of this polycrop led to increased grazing costs in this trial

- ***Always have a Plan B forage source!***
  - Weather can be unpredictable
    - A freeze-thaw cycle in early December 2017 led to ice crusting of the polycrop swaths, resulting in inaccessible feed for the cows. These cows were removed from the field and provided with a different feed source.

With proper management, there is potential for the use of annual polycrop mixtures for grazing in western Canada, with opportunity for gains in soil organic carbon.

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