Fitting Pulses and Soybeans Into Your Crop Rotation

The Bean Report
Your source for soybean and pulse crop agronomy and research.

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THE RECOMMENDED PRACTICE to combat many agronomic issues is to diversify your crop rotation. But what is considered a "good" rotation and how do pulse and soybean crops fit in? We ask this question because soybeans are still relatively new to our cropping systems in Manitoba, peas are making a comeback and dry bean acres are expanding in some regions.

CROP SEQUENCE VS. ROTATION

First, it's important to define terms like sequence and rotation. A crop sequence is the order of crops grown throughout one phase of a longer-term crop rotation. An example of a four-year crop sequence in Manitoba may be spring wheat-soybeans-oats-canola. Many different sequences can make up a rotation.

Plenty of research has been conducted over the years on crop sequences and rotations. The tricky part is applying the results to your farm. This is mainly because specific crop sequences were tested under specific conditions across different studies.

The goal of this research is to generate principles that can be adopted and experimented with on your farm over time. The keywords here are "your farm" and "time." The ideal crop rotation will look different for everyone and the benefits or detriments of a given rotation will evolve over the long term.

CROP ROTATION PRINCIPLES

Here is a list of principles that have held true over time and apply to you right now:

Adapted from Dr. Dwayne Beck's list of crop rotation rules (Dakota Lakes Research Farm, South Dakota State University).

- Rotations that are not consistent in either crop sequence or crop interval will guard against shifts in pest species and minimize the probability of developing resistant, tolerant or adapted pest species. In other words, more diversity equals greater resilience against pest pressure.
- At least a two-season interval between growing a given crop or crop type is preferred. Some broadleaf crops require more time.
- Rotations should be sequenced to prevent volunteer plants of the previous crop from becoming a weed problem. This includes sequencing crop herbicide systems that are now available to farmers (e.g., Roundup Ready, Xtend or Enlist soybeans).
- The use of forage or flexible forage/grain crops and cover crops enhances your ability to adjust rotational intensity.
- Perennial plants grown in rotation offer greater long-term sustainability. Incorporation of perennials into a crop rotation is easier when livestock are a part of the system.
- Soil moisture storage is affected by surface residue amounts, the duration between crops, snow trapping ability of the stubble, rooting depth characteristics, soil characteristics, precipitation patterns and other factors.
- In drier regions, reduced- and no-till systems favour a more diverse array of crops.
- The desire to increase diversity and intensity needs to be balanced with profitability.

At MPSG's 2019 Soybean Management and Research Transfer (SMART) Day event, farmers were asked which factors are important to them when planning their crop rotation. From the list of eight considerations provided on the questionnaire, 88% of the 32 total respondents checked off weed pressure, 84% yield potential, 78% economics, 59% disease pressure, 56% residue management, 50% soil health and 41% market access and insect pressure.

Outside of this list, farmers also listed chemical residue and rotation, prevention of pest resistance, residual N and P levels, manure management, time to maturity of a crop and opportunities after harvest, intercropping opportunities, flood risk, past and present weather events and workload (i.e., planting and harvesting capacity). What ranks as most important clearly varies by farm.

BREAK INTERVALS AND SEQUENCES

A diverse crop rotation in Manitoba is considered to employ at least four different crops over a four-year period. Growing at least three different crop types over a three-year period is the minimum amount of diversity necessary to achieve crop rotation benefits.

Four years is the minimum break interval recommended between pea crops due to the potential impact of *Aphanomyces euteiches* root rot. If this disease is known to be present in your fields, a longer break period between pea crops (6–8 years) is recommended. According to crop insurance data in Manitoba, we see a yield benefit from growing peas every 4+ years and yield penalties from growing them more frequently (Figure 1). That is in line with what most farmers are already doing in Manitoba, according to our SMART Day questionnaire.

Recent research on soybeans has proven their flexibility within Manitoba crop rotations. Studies led by Dr. Yvonne Lawley at the University of Manitoba and Dr. Ramona Mohr at Agriculture and Agri-Food Canada (AAFC) – Brandon have looked at soybeans in rotation, including the impact of preceding crop on soybean performance and the impact of soybeans on subsequent crops.

Dr. Lawley's two-year crop sequence trial (2013–2014) at Carman, Portage and Kelburn confirmed that the preceding crop had a minimal or inconsistent effect on soybean yield. Corn, wheat or canola as a preceding crop to soybeans produced consistent yields, whereas yield

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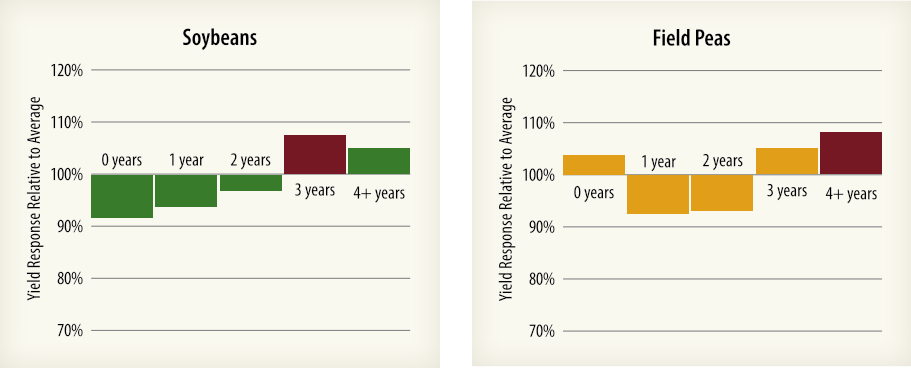

Figure 1. Average relative yield of soybeans and field peas grown after different break intervals between crops (2000–2010). Source: Manitoba Agricultural Services Corporation (MASC).

was penalized in the soy-soy sequence in one out of the five site years. Soybean N-fixation was highest in the corn-soy sequence and lowest in the canola-soy sequence. Arbuscular mycorrhizal fungi (AMF) colonization was greatest in the corn-soy and soy-soy sequences.

An additional study on crop rotation was launched by Dr. Lawley comparing continuous soy, corn-soy, canola-soy and wheat-canola-corn-soy rotations over a four-year period (2014–2017). To date, little to no differences in yield and soil health factors have been observed among rotation treatments. However, these results could change over time.

In Dr. Mohr's crop sequence study at Brandon and Morden, various combinations of soybeans, wheat and canola were tested over a three-year period. These sequences had a minimal impact on yield, root rot severity and seed quality. In a six-year rotation study (2011–2016) continuing certain combinations of soy, wheat and canola, root rot pressure increased under the canola-soy rotation compared to soy-wheat-canola rotation. By the final year, wheat and soybean yields remained consistent regardless of preceding crop, whereas canola yields benefited from greater crop diversity.

For more details on these or other related studies, visit our research database at manitobapulse.ca. Continuations of these studies have also been launched to learn about the long-term effects of soybeans in rotation. We will be staying tuned for the results.

According to our SMART Day questionnaire, farmers often listed more than one crop option when asked what they typically plant before soybeans. Cereal crops were listed in 72% of responses, canola in 47%, corn in 25%, soybeans in 16% and other crops like sunflowers and tall fescue were listed in 3% of responses. When asked how often they grew soybeans, most said every 2–3 years. According to MASC data, the best yields resulted from waiting at least three years before growing the next soybean crop (Figure 1).

WHAT IS UNIQUE ABOUT PULSES AND SOYBEANS?

N-P-K Nutrition

One benefit of pulse and soybean crops in rotation is their ability to fix atmospheric nitrogen (N) with the help of Rhizobium bacteria. This means they require less N-fertilizer than other crops. However, the ability of each crop to fix N varies. On average, faba beans can fix 84% of their total N-requirement, lentils and soybeans 58%, and peas 52%. Dry beans currently rely on N-fertilizer. However, this may be changing soon, thanks to ongoing research and inoculant products coming on the market.

The "N-credit" of pulses to succeeding crops is often promoted. Pulses can indeed increase the level of available N in the soil through microbial decomposition of roots, root exudates and old nodules. But the amount of N provided to the next crop is difficult to measure. The potential for an N-credit also depends on the crop type. Faba beans, lentils and peas can provide a small N-contribution to the next crop, whereas soybeans result in a neutral or negative N-balance due to the amount removed in harvested grain.

On the flip side, these crops are heavy users of phosphorus (P) and potassium (K) and efficient at extracting these nutrients from the soil. Due to low safe rates of seed-placed P and K for pulse and soybean crops, adequate amounts of these nutrients cannot be placed with the seed and must be balanced throughout the rotation (i.e., built up in crop years that can handle it, like cereals).

Growing Season Length

Field peas, certain dry bean market classes (navy, pinto and black beans) and lentils generally have a shorter growing season (~90–100 days to maturity). This offers flexibility at both seeding and harvest time. Peas and faba beans can be seeded earlier due to their frost tolerance, providing even greater flexibility. Early harvest of short-season crops that have ceased evapotranspiration allows for more significant soil moisture conservation and creates an opening for fall-seeded cover crops.

Pests

Except for a few common pathogens, pulse and soybean crops are hosts to a different range of diseases than other crops grown in Manitoba (Table 1). This means their presence in a rotation can reduce the impact of certain diseases. This is indicated by the missing checkmarks in Table 1.

Common pathogens like Fusarium, Rhizoctonia and Pythium root rot have potential to infect many crops, although they may not be an issue in all crops. Other diseases like Aphanomyces and Phytophthora root rot have a narrower host range, remaining exclusive to pulses and soybeans, respectively. A disease like Sclerotinia can infect many broadleaf crops, but its development is interrupted by cereals and corn.

There are two important disclaimers for this table:

1. it is a listing of soybean and pulse diseases only and
2. some of the diseases in this table are listed only at the genus level, meaning certain diseases may not infect all check-marked crops at the species level. In other words, this table was created on the cautious side when depicting common pathogens among crops.

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Table 1. Pulse and soybean pathogens common to different crop types grown in Manitoba.

Disease	Soys	Dry Beans	Peas	Faba Beans	Lentils	Chickpeas	Wheat	Oats	Barley	Corn	Canola	Sunflowers	Flax
FUNGAL DISEASES													
Fusarium spp.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rhizoctonia solani	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pythium spp.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aphanomyces euteiches		✓	✓	✓*	✓	✓							
Phytopthora root rot (*P. sojae*)	✓												
Ascochyta blight (*Ascochyta* spp.)			✓	✓	✓	✓							
White mould (*Sclerotinia sclerotiorum*)	✓	✓	✓	✓	✓	✓					✓	✓	✓
Septoria brown spot (*Septoria glycines*)	✓												
Downy mildew (*Peronospora* spp.)	✓		✓										
Powdery mildew	✓		✓	✓	✓								
Rust (*Uromyces* spp.)***	✓**	✓	✓	✓	✓								
Septoria leaf blotch (*Septoria pisi*)			✓										
Anthracnose (*Colletotrichum* spp.)	✓	✓		✓	✓								
Frogeye leaf spot (*Cercospora sojina*)	✓												
Pod and stem blight (*Diaporthe/ Phomopsis* spp.)	✓											✓	
Phomopsis seed decay (*P. longicolla*)	✓												
Chocolate spot (*Botrytis* spp.)				✓	✓	✓							
Phyllosticta leaf spot	✓												
Alternaria			✓	✓								✓	✓
Charcoal rot (*Macrophomina phaseolina*)	✓**									✓		✓	
Stemphylium blight					✓								
Septoria leaf spot					✓								
BACTERIAL DISEASES													
Bacterial blight (*Pseudomonas/ Xanthomonas* spp.)	✓	✓	✓				✓			✓			
Halo blight		✓											
Bacterial wilt		✓											
NEMATODE DISEASES													
Soybean cyst nematode	✓	✓											

* Crop species has partial resistance to pathogen. ** Not yet identified in Manitoba. *** Rusts that infect pulses and soybeans are distinct from one another.

These crops also have a different and narrower range of insect pests than other crops. Refer to MPSG's new and updated insect and disease scouting calendars for field peas, dry beans and soybeans at manitobapulse.ca.

Soil Quality

Past research has linked pulses to improved soil quality. This means physical properties such as improved soil workability, reduced soil hardness and increased soil moisture retention. Pulses have also been shown to improve biological factors such as an increased soil microbial population and diversity, and greater colonization of roots by AMF, which helps mycorrhizal crops access and take up soil P.

IN THE RESEARCH PIPELINE

Several new studies on crop rotation involving pulses and soybeans have been launched recently across western Canada (Table 2). ■

Table 2. New studies on crop rotation involving pulses and soybeans launched recently across western Canada.

Research Lead	Project Info	Duration	Funder
Dr. Yvonne Lawley, University of Manitoba	**Frequency of soybean in Manitoba crop rotations** • Continuation of a previous rotation study • Continuous soybeans compared to other rotations, including canola, corn and spring wheat. • Two other companion projects looking at rhizobium survivability and disease pressure.	2018–2023	Integrated Crop Agronomy Cluster (including MPSG)
Dr. Ramona Mohr, Agriculture and Agri-Food Canada	**Economic and agronomic performance of emerging cropping systems for western Canada** • Continuation of a previous rotation study. • Crop rotations involving soybeans and corn grown in non-traditional areas.	2018–2023	Integrated Crop Agronomy Cluster (including MPSG)
Kristen MacMillan, MPSG/University of Manitoba	**Effect of preceding crop type and residue management on dry bean productivity** • Pinto beans seeded into wheat, corn, canola, pinto bean and oat stubble.	2017–ongoing	MPSG – Agronomist-In-Residence program
Dr. Charles Geddes, Agriculture and Agri-Food Canada	**Management of glyphosate-resistant (GR) kochia in western Canadian cropping systems** • Impact of crop diversity (two and four-year rotations), crop life cycle and integrated cultural controls on GR kochia	2018–2023	Integrated Crop Agronomy Cluster (including MPSG)
Dr. Yantai Gan, Agriculture and Agri-Food Canada	**Optimizing systems productivity, resilience and sustainability in the major Canadian ecozones** • Nutrient use efficiency, system resiliency and long-term soil health using contemporary crop rotations.	2018–2023	Integrated Crop Agronomy Cluster (including MPSG)

For more information on these studies, visit the Western Grains Research Foundation (WGRF) website (westerngrains.com).