Saskatchewan
Soil Conservation
Association

Soil Facts

Crop Rotations in Direct Seeding Systems

Crop rotations are crucial for sustaining crop production in Saskatchewan. Under direct seeding, crop rotations tailored to climatic zones and even specific farms can increase profitability and sustainability. A direct seeding system of crop production works so well because it more closely mimics the natural ecosystem than a tillage system. Lengthening crop rotations tries to reflect the diversity of species found in the "original" ecosystem.

Rotations impact and benefit almost all areas of crop production. The longer the cropping rotation, the greater the benefit. Several factors influence the design of a crop rotation.

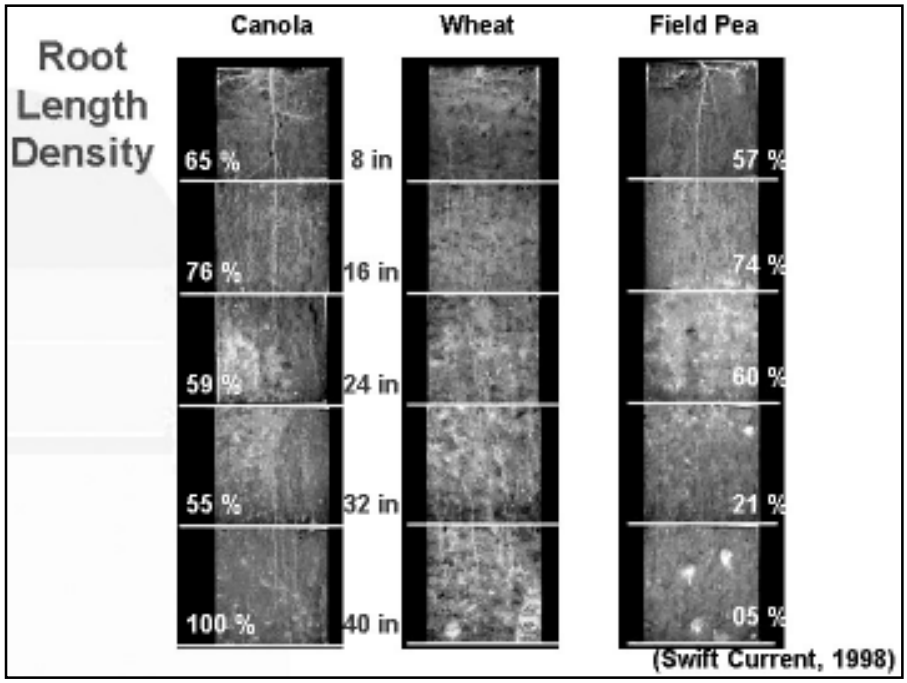

Figure 1. *Comparing the root length densities of canola, wheat, and field pea. (percent of wheat) [McConkey, Miller, Angadi, Gan]*

Water Management

A major limitation for diversity in a cropping system in Saskatchewan is the climate. The moisture available for growing crops across the province varies and has been delineated into soil climatic zones. Rotations need to be planned to make efficient use of moisture.

In the drier zones, fields are often left in fallow for one growing season to store water in the soil for subsequent crops. Although this is not efficient, because fallow will lose some of the moisture received between growing seasons, it does increase the soil moisture available the next season when a crop is planted. If growing season moisture is low, as it often is in the Brown Soil Zone, then there may be some economic benefit and risk reduction to fallowing. If fallow is used, it is critical the soil be protected from erosion using either a chem fallow or a green fallow system.. A chem fallow system leaves the stubble standing and controls plant growth with 2 to 3 applications of glyphosate during the growing season. Many producers in the drier soil zones have been able to produce a crop every growing season using a cereal – pulse – cereal – pulse rotation thereby eliminating fallow entirely.

When deciding how to set up a rotation to efficiently use moisture, consideration must be given to how deep different crops root and how much moisture is typically used by each. Agriculture & Agri-Food Canada researchers at Swift Current examined some of the water use parameters of typical crops grown in Saskatchewan. Rooting depth of these crops follows this order starting with the deepest and progressing to the shallowest: argentine canola=mustard > wheat=winter wheat > barley=chickpea=polish canola > flax=lentil > pea. (See Fig.1) They also found the water use of different crops is as follows starting at highest water use crops: argentine canola = mustard > wheat = winter wheat > barley = chickpea > flax = lentil > pea. Water use efficiency (WUE) is measured in terms of quantity of grain produced per quantity of water used. Peas are the most efficient water users, then cereals and lastly oilseeds. An ideal crop rotation alternates deep rooted crops with shallow rooted crops. The deeper rooted crops will pull up moisture and nutrients that the shallow rooted crops cannot reach. However, shallow rooted crops do not necessarily conserve the most moisture for the following crop. Crops which mature earlier allow more time to bank rainfall for the following crop. Crops that catch more snow can potentially recharge the soil profile better. Some stubbles with a heavier residue mat can reduce evaporation and save more moisture than other crops. The researchers found the

water conserving abilities of crops follows this order: cereals > oilseeds > pea > lentil > chickpea.

Producers consistently having problems with delayed seeding because of wet conditions, need to include crops which use more water. On the other hand, producers in drier conditions who are consistently experiencing poor yields, need to introduce more crops and adopt techniques which use less water.

Economics & Marketing

Another limitation to crop rotations is economics. Because the market price for both products and inputs vary, the market outlook often plays a major role in determining the crop sequence on any particular piece of land. Usually agronomic principles and markets are considered together to decide on a profitable solution to how much diversity can be worked into the rotation from year to year. Rotations need to be flexible.

Crop Residue

One of the benefits of rotating crops is to manage crop residue for good crop establishment the following growing season. The amount of straw and residue produced by each crop must be considered. The ideal is to produce enough straw to have a residue cover to maintain moisture but not so much that there will be problems seeding through it. Some straw types decompose faster than others. There are also different colors of residue that can affect soil temperature in the spring. This can be especially important in late cool springs. Alternating cereal and broadleaf crops will usually provide good general residue management.

Fertility

Another benefit of crop rotations is to make efficient use of plant nutrients in the soil. One specific example is the nitrogen produced by legumes in the rotation. Producers can decide which crops will most respond to the extra N fixed by pulse crops. Crops such as hard red wheat, which sometimes see a premium for protein, might economically benefit from N released throughout the growing season as the pulse residue is broken down. Another big advantage to pulse residue is that it contains more N than other straws so microbial degradation does not tie up much soil or fertilizer N during decomposition.

Weed Control

Weed control options often increase with longer crop rotations in a number of ways. First, some crops are more competitive and may yield well even in weedy situations. They can be alternated with less competitive crops such as lentils. Second, crops which do not provide as many weed control options can be rotated to facilitate weed control . Whether or not a crop will be preharvested is another crop rotation issue. A benefit to longer rotations is that they offer more herbicide options thereby avoiding the build up of resistant weed populations. Longer rotations also make it easier to control volunteers. Herbicides with 10 month plus residues can reduce the flexibility of rotations. However,

Direct seeded canola in cereal stubble.

some herbicides can also provide extended weed control with a rigidly planned rotation.

Logistics

A further benefit to a well planned crop rotation is that it enables workload, labour, and machinery investment to be spread out over a longer time span. It may even enable the producer to crop more acres. One prime example of this is the use of fall seeded crops. Because fall seeded crops are often ready to harvest earlier, one combine can cover more acres at harvest.

Disease Control

Probably the biggest benefit to rotating crops is to control crop diseases. Pesticides are available to control many crop diseases but often the additional yield does not justify the expense. Canadian plant pathologists have reported that environment such as weather conditions usually have a bigger impact on disease than tillage system under a well planned rotation. Many crop diseases survive over winter on crop residue. In direct seeding, many of these residues do take longer to break down so a good crop rotation is crucial to successful direct seeding. (See Fig. 2).

Canola: A standard rotation for canola is one crop every four years. Seedlings are at the greatest risk from seedling disease when they are planted into cool soils. Pythium attacks canola seedlings in wet conditions and rhizoctonia in dry conditions. These fungi are prevalent in Saskatchewan soils so rotation will not have a big impact on seedling diseases. However, if the seedlings get off to a vigorous start, there is a reduced risk of seedling disease. Since producers are now seeding more of their canola acres early, they can help reduce the risk

Figure. 2. *Crop Rotation and Disease Risk*

Crop	Adequate Rotation (years)	Risk Of Shortening Rotation	Major Economic Diseases
Canola	1 in 4	moderate	Seedling Disease Complex
	1 in 4	Moderate w/ resistant varieties	Blackleg
Flax	1 in 3	low	Rust
	1 in 3	Very high	Fusarium Wilt
	1 in 3	high	Pasmo
	1 in 3	Very high	Seedling blight & root rot
Lentil	1 in 3	Moderate with resistant variety	Aschochyta
	1 in 3 to 4	high	Anthracnose
Chickpea	1 in 4	high	ascochyta
	1 in 4	high	Seed & root rots (Kabuli)
Field Pea	1 in 4	moderate	Mycosphaerella (Ascochyta) Blight
Barley	1 in 4 is a pulse	moderate w/ seed treatments	Seedling blight
	1 in 3	Moderate – high	Net Blotch
	1 in 3	Moderate	Spot blotch
	1 in 2 to 3	High (more risk -AB)	Scald
Wheat	1 in 3	high	Septoria Leaf & Glume Blotch (weakly infect barley, rye & some grasses)
	1 in 3	high	Tan spot (grasses rye & barley)
	1 in 3	Moderate except where no disease then high	Fusarium Head Blight (barley, oats, rye, corn, triticale, canary seed, and some forage grasses)
Wheat, Barley, Oats		Low -Need to be blown in	Rusts
Cereals	1 in 3	moderate	Common Root Rot, Seedling Blight, Prematurity Blight
Canary Grass	1 in 3	high	Septoria leaf mottle

Source: Kutcher AAFC Melfort

of seedling diseases by using vigorous seed, planting shallow and using seed treatment.

A four-year rotation is very effective for reducing the risk of blackleg development and the associated yield loss. Varieties susceptible to blackleg need at least a four-year rotation. For a short period, rotations can probably be tightened but only with highly resistant varieties. However, the risk of shortening the rotation is that new strains of blackleg may develop for which there is no resistance.

Since sclerotina stem rot can infect many broadleaf crops, including canola, and because the sclerotia bodies can survive many years in soil, crop rotation is not nearly as effective in reducing risk of sclerotina. However, a four-year or longer rotation of canola can help reduce the sclerotia bodies.

Pulse Crops: The ascochyta blights are among the most important diseases affecting the three major pulse crops (lentils, field peas, and chickpeas). The pathogen is specific to each of these crops. The traditional lentil rotation has been three years to reduce the risk of ascochyta infection. Buffer strips of 50m from previous year's lentil stubble is recommended to reduce the risk of wind blown infection. Recent introduction of resistant lentil has reduced the damage done by ascochyta. In field pea, the disease is often referred to as mycosphaerella blight. There are no resistant pea varieties so a four-year rotation is important. In chickpeas a minimum four-year rotation is recommended due to lack of genetic resistance and the extreme severity of the disease in this crop. Even with recommended rotations foliar fungicides are often necessary in chickpea.

Anthracnose is another disease of lentils for which a 4-year rotation is recommended due to lack of resistance. To control anthracnose, avoid seeding in a field adjacent to residue from the previous year.

A four-year rotation in field pea can reduce the risk of seedling blight. Because field peas are often seeded early when soil conditions are cool and wet, seed treatments can protect the developing seedling.

Cereals: The common rotation recommendation for each cereal species is three years. Fusarium head blight can infect all of the cereals and some of the forage grasses grown in western Canada. It can cause yield loss and mycotoxin production. Although the recommended rotation is at least three years, in areas where the disease is a serious problem, other control measures are required. Warm moist conditions during and after flowering are conducive to infection resulting in yield loss and down grading. In areas where it is not yet prevalent, following the recommended rotation and using fusarium-free seed can delay spread of the disease.

The incidences of common root rot, seedling blight, and prematurity blight in all the cereals can be reduced somewhat by a two-year rotation. Incidence of ergot is mainly dependent on conducive environmental conditions and the presence of forage grass hosts.

Barley: A three-year rotation will provide some protection against net blotch. There are some resistant varieties now available and 6-row barley generally has greater resistance than 2-row. There is little resistance to spot blotch in available barley varieties so a rotation of one cereal in three years is recommended. Although the disease may be reduced somewhat if another cereal such as wheat is grown. To protect barley from scald, a Three-year rotation that does not include brome grass is recommended.

Wheat To protect wheat crops from septoria leaf and glume blotch and tan spot, a Three-year rotation is recommended. However, since high levels of inoculum of these two diseases are found on the prairies, rotation provides only partial protection.

Canary Grass: Canary grass is subject to septoria leaf mottle and the recommended rotation is three years.

Fall Seeded Cereals: Winter wheat and fall rye are at risk of a viral infection, wheat streak mosaic, spread by wind blown mites. These mites will not survive if green cereal plants are removed at least 10 days before fall seeding.

Flax: Flax has a very good fit in rotations because foliar flax diseases are not found in other crops. There are some common root diseases but with the use of seed treatments the effect of these can be minimized. The recommended rotation for flax is three years. This rotation can help alleviate the residue borne disease inoculum for fusarium wilt and pasmo and is effective for flax rust. Flax rust is the only significant type of rust that originates locally although there hasn't been an outbreak for many years. There is some research that has shown that flax should not follow canola as yield is often reduced.

Summary

In conclusion, the benefits of crop rotations can be increased with more diversity. Biennial and perennial crops, while not mentioned, provide great opportunities for increasing diversity in a rotation. The number of crop species grown in Saskatchewan is limited by climate, particularly moisture. The key to successful rotations is maintaining flexibility.

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