Climate-Smart Specialty Grains and Oilseeds: Covering America from Coast to Coast

Background
Interest in cover crop use has increase in the past decade with several well-known soil benefits arising from their use. Coupled with a resurgence in new markets and consumer production awareness adoption is being accelerated.
Aspirations to increase cover crop adoption face several hurdles, with cover crop seed supply being an obvious and significant hurdle. While many species of plants can be used as a cover crop, cereal grains such as rye, oats, and buckwheat, as well as oilseeds such as flax and winter camelina, are staple ingredients in cover crop seed mixes. This project will accelerate the production of five key specialty grain and oilseed commodities that are commonly used as cover crop seed.
The increased adoption of cover crops will put a strain on the current supply of cover crop seed, making an expanded seed supply necessary to advance the practice. This project strives to alleviate potential seed shortages by bolstering supplies through an incentive program designed to increase seed supply and introduce climate smart production system practices.

Producer Incentives and Premiums
Through this project, farmers in the Midwest and Northern Great Plains have the option to raise five crops in a holistic manner, incorporating multiple conservation practices.
Producers interested in participating in the program will have the option of growing rye, oats, flax, buckwheat, or winter camelina under a contract with Millborn Seeds, who is committed to purchasing the commodity grain/seed. To be eligible for a commodity premium payment, participating producers must commit to at least two out of three climate-smart practice options:

1. Reduced Tillage or No-till
2. Nutrient Management Plan
3. Conservation Crop rotation

Each acre of specialty grain or oilseed production must be accompanied by an equal number of acres of a multispecies cover crop or forage planted on the same operation. Adoption of these practices will be supported by an incentive payment.

Adoption of Conservation Practices
AgSpire landowner advisors will be assisting with practice adoption, verifying that practices have been implemented according to NRCS practice standards.
Each participant will have at least one farm visit annually by an AgSpire landowner advisor, focused on the adoption of a comprehensive suite of climate-smart practices, promoting a holistic approach to farm management, rather than individual practices. Implementation of multiple synergistic practices can maximize the potential of enrolled acres to provide greenhouse gas benefits, while offering numerous other

environmental benefits including better soil health, a reduction of nutrient runoff and leaching, reduced erosion, increased water, and air quality, while increasing farm resilience by reducing dependencies on outside inputs.

Project Activities

All fields enrolled in the program will have a composite soil sample collected and tested for organic matter, available phosphorus, exchangeable potassium, magnesium, calcium, hydrogen, Soil pH, Buffer index, CEC, percent base saturation of cation elements, and carryover nitrate before and after the commodity crop. Sampling will be coordinated through AgSpire and the producers. In addition, 25% of all fields enrolled will have a soil carbon measurement taken using EarthOptics C-mapper basic system before and after the crop year. On 10% of fields evaluated with EarthOptics methods, deep soil core samples will be taken to evaluate the potential for soil carbon capture beyond 30 cm in depth.

Roughly 10% of project acres will have a biochar treatment applied. Contracted growers will be offered the opportunity to participate in the biochar initiative associated with the program. Most of the biochar applications will occur when the multispecies cover crop is planted, as a seed treatment for the cover crop, after the harvest of the specialty grain and oilseed crops.

Buckwheat

Buckwheat (*Fagopyrum esculentum* Moench) is an annual broadleaf, flowering plant of the Polygonaceae family native to northern Asia. Seeds are brown, irregularly shaped with four triangular surfaces. Plants grow rapidly, beginning flowering about three weeks after planting, flowering continuously before gradually reducing as the plant matures. Plant heights and rate of maturation depend heavily on planting date. Earlier planted crops produce plants that can reach 3 – 4 feet in height and complete their life cycle in 11-12 weeks. Crops planted later in the season produce plants that are shorter and mature in 9-10 weeks.

Planting

Buckwheat is not frost tolerant, with crop quality and vigor declining considerably when exposed to cold early season frost events. Buckwheat should be planted in mid-to late July in the upper Midwest. Planting later in the season helps prevent frost damage and pushes flowering into periods when night temperatures have started to cool down. Research shows that nighttime temperatures have a significant impact on the percentage of flowers that are aborted. Cooler temperatures during flowering reduce the percentage of aborted flowers consequentially increasing yields.

Buckwheat needs to be planted around 1 inch deep at seeding rates of 50-55 lbs. per acre depending on seeds per pound and quality. Planting in narrow rows utilizing a no-till grain drill helps preserve soil moisture, control weeds while minimizing trips over the field. Buckwheat is susceptible to compaction and caution needs to be taken when no-till planting takes place.

Fertility

Nitrogen and phosphorus are the primary nutrients that can be deficient in fields due to their mobility in the soil profile. Fertilizer applications need to be based on yield potentials of the field and recent soil test results. All nutrients require a 0-6" soil test except nitrogen. Soil tests from 2 foot in depth are very important in prescribing the correct amount of nitrogen to be applied to the crop. If a 2-foot soil test is not available, it is important to subtract 30 lbs. of nitrogen from the recommended volume. Previous legume crop nitrogen credits also need to be accounted for while calculating the rate of nitrogen applications. An overabundance of available nitrogen significantly increases the possibility of lodging.

		Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm		
Total N * Recommended	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121+
80	40	30	20	10	0	60	40	30	0

*Total N includes soil test nitrate-N to 2 feet in depth, previous crop N credits, long-term no-till N credit of 30 pounds of N/acre if field has been in no-till continuously for six years or more, and supplemental fertilizer N. Fertilizer P application will not result in economic benefit for flax growers. The 2 foot nitrate test is extremely important for optimal N recommendations and to promote N-use efficiency, greater farm profitability and environmental stewardship.

Pests

Buckwheat is frequently used as a summer cover crop because of its rapid growth and ability to out-compete weeds. Because of its competitive nature, it can be grown without the use of post-emergence herbicides. Controlling weeds that might come up ahead of buckwheat seedlings by using a burn-down herbicide, such as glyphosate, or by tilling just prior to planting. No post emerge herbicides are currently labeled for use in buckwheat. Buckwheat is relatively pest free, with no widespread insect of fungal infestations. Prolonged wet conditions can promote seedling and/or root rot diseases, but these occasions are rare.

Harvest

Most Northern Plains grower's swath buckwheat, which begins when 75% of the seeds and plants are brown. Direct combine when 80%-90% of the plant and seeds are brown. It is normal for buckwheat to still have a few green leaves, green seeds, and a few flowers when harvest begins. The timely harvest of Buckwheat is important because if left in the field to dry and frost occurs, shattering and header loss become major problems during harvest.

Flax

Flax (*Linum usitatissimum* L.) is an ancient crop domesticated 7,000 years ago in the Fertile Crescent region of the Middle East. It is grown for seed, oil, and the lignin stored in its shoots. Egyptians used linen, derived from flax, to wrap their dead in for embalming. Flax is widely recognized as a foundation crop of modern civilization. Flax is an annual herbaceous plant that is grown in northern climates due to its rapid maturity rate under cool, short season growing conditions. It is adapted to a variety of soils but performs best on well-drained sandy loam soils. It does not do well in poorly drained soils and can be retarded by surface crusting occurring in heavy soils. Flax grows to a height of 16 – 36 inches and is a self-pollinating crop, not requiring the presence of pollinators to propagate.

A shallow tap root system relies on moisture and nutrients in the top 2 inches of the soil surface, requiring moderate levels of nutrients compared to most cultivated crops. Settlers pushing west across America and the Canadian Prairies generally planted flax after braking virgin soil because if its low nutrient requirements.

Planting

Cropping sequences and rotations have a significant impact on flax yields. Flax performs poorly on canola and mustard (*brassica*) stubble with a phytotoxic response to the presence of canola stubble and volunteer canola seedlings. It is highly recommended flax does not follow canola in a crop rotation. Flax does well when following a legume or cereal grain crop.

Fertility

Seedbed preparation is important to the establishment of a good stand of flax. A smooth, firm seed bed is ideal for flax establishment. Flax does well in reduced tillage and no-till operations. Improved soil organic matter, soil moisture and an increase in arbuscular mycorrhiza are all soil health attributes associated with reduced tillage. Mycorrhizal fungi increase the surface area of the relatively small root system associated with flax, improving the crops' ability to absorb immobile nutrients in the soil.

Flax responds well to nitrogen fertilizer applications on fields with low soil N. Caution needs to be taken when applying fertilizer near the seed during planting. Nitrogen can "burn" seedlings and has a negative impact on establishment and yield production. Banding of nutrients between rows has shown the best yield responses. Potassium and sulfur deficiencies are not as common as those of N and P and are usually only associated with specific soil types. Iron and zinc deficiencies have much more of a negative impact on flax crops in comparison to potassium and sulfur. Although flax is sensitive to low levels of iron and zinc, fertilizer applications of these micronutrients have not shown yield benefits.

		Soil Test Potassium, ppm			
Total N * Recommended	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
80	70	54	32	10	0

*Total N includes soil test nitrate-N to 2 feet in depth, previous crop N credits, long-term no-till N credit of 30 pounds of N/acre if field has been in no-till continuously for six years or more, and supplemental fertilizer N. Fertilizer P application will not result in economic benefit for flax growers. The 2-foot nitrate test is extremely important for optimal N recommendations and to promote N-use efficiency, greater farm profitability and environmental stewardship.

Pests

Flax is not competitive and will be out competed by weeds if allowed. There are several herbicides that can be used to control both grass and broadleaf weeds in flax. Though there are herbicide options, most are only registered in Canada, limiting selection for producers in the United States. Planting in narrower rows and higher populations can help flax compete with weeds. Flax should be rotated a minimum of three years between subsequent flax crops. Extending rotation periods between flax crops aids in weed, disease, and insect management.

Harvest

Flax can be direct harvested or swathed and threshed. Due to flaxes lignin levels in the stems, it can be difficult to cut. Ensuring that sickle bars are clean and sharp is important to an even consistent harvest. Desiccation can help advance crop maturity while killing any weeds that may interfere with harvest.

Oats

Oats (Avena sativa) wild ancestor, A. Sterillis, grew naturally in the fertile crescent of the near East. Considered a weed of primary cereal domesticates of the region oats did not become domesticated until they spread westward to cooler, wetter areas favorable for its growth and reproduction. Domestication eventually occurred around 3,000 years ago in regions of the Middle east and Europe.
Oat production is second only to rye in worldwide cereal production. Most oats are grown for animal feed.

Planting

Plant early in the spring. Oats tolerate and are adapted to cool seedbeds and grow well in early season soils. Early planting enables more tiller production, larger panicles and avoids high-temperature stress later in the season that can reduce seed size. Late season diseases can also be avoided by planting early.
In fields with wild oat problems, waiting until the first flush of wild oats has occurred and been controlled is a recommended practice. However, this practice will likely result in reduced yields. Oats emerge through elongation of the coleoptile and the first internode, resulting in the crown being closer to the soil surface in relation to other small grains, up to the three-leaf stage. This helps oats survive in cold air temperatures. Oats need to be planted between 1.5-2.5 inches, taking care not to plant deeper than 3 inches. The seeding rate should be 1 million pure live seeds per acre, which is around 60-90 lbs./acre depending on the variety.

Fertility

Nitrogen and phosphorus are the primary nutrients that can be defiant in fields due to the mobility in the soil. Fertilizer applications should be based on the yield potential of the field and a recent 2-foot soil test. Soil test results from 2 foot in depth are very important in selecting the correct amount of nitrogen fertilizer used in the crop. If a 2-foot soil test is not available, it is important to subtract 30 lbs. of N from the recommended amount of nitrogen fertilizer. Previous crop nitrogen credits also need to be accounted for while calculating the rate of nitrogen applications. If too much nitrogen is applied the possibility of lodging increases dramatically.

		Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm			
Total N * Recommended	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
120	60	45	30	20	0	60	40	30	15	0

*Total N includes soil test nitrate-N to 2 feet in depth, previous crop N credits, long-term no-till N credit of 30 pounds of N/acre if field has been in no-till continuously for six years or more, and supplemental fertilizer N. Fertilizer P application will not result in economic benefit for flax growers. The 2- foot nitrate test is extremely important for optimal N recommendations and to promote N-use efficiency, greater farm profitability and environmental stewardship.

Pests

Grass weeds can be problematic in oat fields due to the lack of herbicide options to control the grass in the oat crops. Although no herbicides are labeled for grass control in oats, there are several selections for the control of broadleaves. Calisto, 2,4-D, Aim, Dicamba, Buctril and Stinger are viable herbicides options for broadleaf control in oat fields. Follow all label instructions and keep detailed records of all herbicide applications.

If grasses have a history in the field, prolonging planting until after the first flush of weeds has taken place in the spring and treating with a burndown can be an effective management practice. This is a viable option for weed control, but oat production will be negatively affected due to the later planting date. High populations can also be a best management practice option for grass weed control. Although a viable weed control option cation needs to be taken to ensure that competition does not induce elongation, creating a tall, top-heavy crop susceptible to lodging.

High populations can also increase the potential for diseases, reducing air movement in the crop. Air movement dries the crop after moisture evens, reducing the time fungal pathogens have for propagation and infestation. Oats can be affected by several fungal diseases such as stem rust and leaf spot, but crown rust is the most detrimental. Knowing the disease history of the field and region benefits in selecting less susceptible varieties. Proper variety selection is the most important strategy to avoid disease pressure. If an outbreak does occur there are several fungicides such as Headline, Tilt, Priaxor, and Trivapro labeled for fungal disease control in oats.

Harvest

Oats are generally swathed and dried down in windows until they are threshed by a combine with a pickup head attachment. Direct combining is an option although swathing helps prevent loss from shattering. Harvest takes place when the kernel moisture is around 35%. Threshing needs to occur as soon as the grain reaches 15%-20% moisture or weathering will occur, reducing the premiums that can be received at market. Oats need to be stored between 12% and 14% moisture.

Rye

Rye (*Secale cereale* L.) is a cool season, annual grass, native to southwestern Asia. Rye was the first cereal crop domesticated by humans around 13,000 years ago. It proceeded to migrate west across the Balkan Peninsula and eventually into and across Europe. It is found throughout North America, Asia, and Europe and as far north as the Arctic Circle.

Rye is adapted to many different soils and climatic conditions and does not persist as a wild, introduced pest. It thrives at high altitudes and has the best winter heartiness of all the cereal crops, surviving temperatures as low as -20°F if the plants are well rooted before the ground freezes. It tolerates pH between 4.5 – 8.0 and tolerates heavy clay and light sandy and infertile or drought-affected soils better than any of the other cereal crops.

Planting

Sow in early fall, though cereal rye will germinate through mid-fall, after the soil has lost its heat from the summer months. Seedbeds should be smooth, firm, and weed free. Seeds need to be planted 1 to 1.5 inches in depth with an average seeding rate around 50-60 lbs./acre.

Fertility

Nitrogen and phosphorus are the primary nutrients that can be defiant in fields due to the mobility in the soil. Fertilizer applications should be based on the yield potential of the field and a recent 2-foot soil test. Soil test results from 2 foot in depth are very important in applying the correct amount of nitrogen fertilizer. If a 2-foot soil test is not available, it is important to subtract 30 lbs. of N from the recommended amount of nitrogen fertilizer. Previous crop nitrogen credits also need to be accounted for while calculating the rate of nitrogen applications. If too much nitrogen is applied the possibility of lodging increases dramatically.

Nitrogen

- Areas of low productivity (yields below 40 bushels/acre): Total available N = 100 lbs./acre
- Areas of medium productivity (yields 40 to 60 bushels/acre): Total available N = 150 lbs./acre
- Areas of high productivity (yields greater than 60 bushels/acre): Total available N = 200 lbs./acre
  *(Total available N = soil test nitrate 2 feet + previous crop credit + fertilizer N)

Phosphorus

- Low productivity: Apply 25 lbs. of P_2O_5 at seeding with the seed up to an Olsen soil test of 15 ppm.

Potassium

- All productive ranges: Apply 30 lbs./acre K_2O if soil test K is less than 100 ppm.

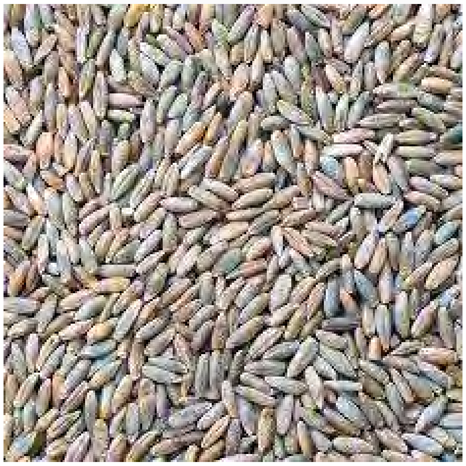
Pests

Rye is extremely competitive and can suppress weed growth to the point of not needing herbicide to raise the crop. Grass weeds can be problematic in rye fields due to the lack of herbicide options. There are several herbicide selections for the control of broadleaves in rye fields. If grass-like weeds have a history in the field, waiting until the first flush has taken place and treating the field with a burndown herbicide before planting can be an effective management practice.

Planting at higher populations is also a best management practice option for weed control. Although an option, caution needs to be taken when planting higher populations. Competition between plants induces elongation, creating a tall, top-heavy crop susceptible to lodging. Higher populations also increase the potential for diseases because of the lack of air movement in the crop. Air movement is important in drying the crop after moisture events, reducing the possibility of fungal diseases. Although less susceptible to disease than most cereals, it can still become infected with ergot, stem or stalk smut, anthracnose and various strands of rust.

Harvest

Rye is generally swathed and dried down in wind rows until its threshed by a combine with a pickup head attachment. Direct combining is an option although swathing helps prevent loss from head shattering which rye is prone. Direct combining needs to take place around 22% moisture. Swathing can take place as soon as the kernels are in hard doe stage and can no longer be crushed between the thumb and finger. Threshing (combining) needs to occur as soon as the grain is swathed. Rye needs to be stored between 12% and 13% moisture.



Winter Camelina

Winter Camelina (*Camelina sativa*) originated in frigid Siberian climates, adapting to survive in some of the coldest environments on earth. This has allowed camelina to naturalize itself in many temperate regions of the world. For a long time, it was known as a weed across North America and was thought of as a nuisance. Only recently has it been recognized as a valuable oilseed and beneficial cover crop. Camelina has both a spring and winter biotype, like wheat. Winter biotypes have vernalization requirements that need to be met before entering their reproductive phases. Both biotypes are well adapted to early season frost and have been reported to continue growing down to temperatures of 12°F. Camelina is well suited for poor growing conditions, producing well in low fertility and moisture conditions in comparison to most conventional cultivars.

Planting

Winter Camelina does best when seeded as soon as the previous crop is harvested to establish a good stand before dormancy over winter. Planting rates are generally 3-5 lbs./acre of pure live seed when drilled, increasing 1.5 to 2 times for a broadcast rate. Plant ¼ inch deep, or less, into a firm seed. Planting depth and seed soil contact is very important due to camelina's small seed size. If planted too deep, seedlings do not have enough stored energy to emerge, significantly reducing stands.

It is also important to know the field's chemical history. Camelina is very susceptible to imidazoline (Arsenal, Chopper, Contain, Stalker) and sulfentrazone (Spartan, Shutdown, Ambition) which are popular active ingredients in multiple pre, and post emerge herbicides used in crop production. Research is ongoing, studying the effects of herbicide carryover in camelina establishment. Read and follow all label guidelines for plant back restrictions for canola or rapeseed if camelina is not listed on a label.

Fertility

Camelina responds well to nitrogen, sulfur, and phosphorus fertilizer applications the same as its brassica family relatives. Very few fertilizer-response trials have been conducted on camelina. Historically camelina has been viewed as a nutrient scavenger, requiring little, if any additional fertilizer. Early research does indicate that adequate nutrients are required to produce a quality yield though. Soil testing is recommended to ensure there are no nutrient deficiencies that could rob yield. Follow University Extension, USDA-NCRS guidelines, and local information to implement a fertility plan.

Pests

Weed control in camelina can be complicated because very few herbicides have been approved for use in the crop. Selecting fields where prior management has limited weed pressure and weed seed production was kept to a minimum are important to production quality. Perennial weeds such as field bindweed, Canada thistle, and skeleton weed are especially problematic in camelina fields.

Although camelina is susceptible to sclerotinia stem rot, Rhizoctonia, and downy mildew. It is highly resistant to blacklegs and other common brassica diseases. This makes it a good addition to crop rotation to increase years between susceptible brassica crops, reducing disease outbreaks.

Harvest

Camelina is normally direct-combined but can also be swathed. Harvest normally occurs between June and July when the seeds are 10 % moisture or less using a canola moisture curve. The crop needs to be monitored closely once ripening begins to avoid seed shatter. Combine settings like those used for canola or alfalfa work well with camelina harvest. Cut as high as possible to reduce the volume of green stems that pass through the combine. Camelina is a small seed and care needs to be taken to ensure seed loss is minimize and does not leak out of the combine during harvest. Seed is susceptible to spoilage and needs to be stored at 8% moisture or below.

Additional Information

	Flax	Buckwheat	Winter Camelina	Oats	Rye
Full seeding rate lbs/acre	30	50	3	70	50
Seeding Depth, inches	.25-.75	.5-1.5	.25-.5	.5-1.5	.75-2.0
Nitrogen recommendation	80 lbs – STN -LC	80 lbs – STN -LC	35-50	120lb - STN - LC	100-200
Phosphorous Recommendation	0	0-40	25-30	0-60	24-40
Potassium Recommendation	0-77	0-60	0	0-90	50
Micros			S -20 lbs		
Reduce erosion	F	P	F	G	G
Increase soil organic matter	F	P	F	G	G
Scavenge nutrients	F	F	F	G	G
Promote biological nitrogen fixation	N	N	N	N	N
Suppress weeds	P	F	P	G	G
Rooting depth/Plant water use	SM	SL	ML	MM	MH
Minimize/Reduce Surface soil compaction	F	F	P	G	G
Minimize/Reduce subsoil compaction	P	P	F	F	G
Seed Size (Large or fine)	F	L	F	L	L
Crop Type	CB	WB	CB	CG	CG
Winter Survival	N	N	S	N	Y
Salinity Tolerance	P	P	P	F	G
C:N Ration	H	L	L	M	H
Mycorhizal fungi association	H	N	N	H	M
Seeds/lb	80,000	19,000	400,000	16,000	18,000
Legend					
Rooting Depth/Water Use:		Ratings			
SL=Shallow rooted/Low water Use		G=Good			
SM=Shallow rooted/Medium water use		F=Fair			
SH=Shallow rooted/High water use		P=Poor			
ML=Medium rooted/Low water use		L=Low			
MM=Medium rooted/medium water use		M=Medium			
MH=Medium rooted/High water use		H=High			
DL=Deep rooted/Low water use		Y=Yes			
DM=Deep rooted/Medium water use		N=No			
DH=Deep rooted/High water use		S=Sporadic			
Shallow = 6-18 inches					
Medium – 18-24 inches					
Deep = 24+inches					
Crop Type:					
CG=Cool season grass					
CB= Cool season broadleaf					
WG=Warm season grass					
WB=Warm season broadleaf					