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FACT SHEET

Agriculture and Natural Resources

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Sustainable Crop Rotations with Cover Crops

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Cover Crops Rotations after Cash Grain Crop

Cover crops offer many benefits for agriculture that include erosion control; reduced compaction and nutrient leaching; increased water infiltration; improved soil biodiversity; weed control and disease suppression; increased carbon sequestration and maximum nutrient recycling; improved air, soil, and water quality; and wildlife enhancement. Every cover crop species has its own niche and attributes for agricultural production. A wrong combination of cover crops may exert negative attributes, so a thorough understanding of cover crops selection and management is needed to minimize negative outcomes.

Legume cover crops are commonly used for nitrogen contribution because of their inherent capacity to fix atmospheric N (inert gas) into usable form to be used by succeeding crops. Common legume cover crops include cowpea, winter pea, crotalaria, red clover, sweet clover, hairy vetch, soybeans, and alfalfa. On the other hand, grass cover crops include cereal rye, annual ryegrass, Sorghum Sudan grass, oats, wheat, spelt, teff, triticale, and barley. Grass cover crops are widely used for soil erosion control, forages, improving soil structure and reducing compaction, carbon sequestration, recycling nutrients, and weed control. The Brassicas include oilseed radish, tillage radish, or forage radish, turnips, kale, mustard, and rape. They are good for reducing compaction, recycling nutrients, and weed control and disease suppression. Buckwheat is neither a legume nor grass but is a fast-growing summer cover crop and is excellent for nutrient recycling (e.g. phosphorus), honeybees, and allelopathy.

The following sections provide information about specific attributes of different cover crops grown after each cash crop.

After Wheat (Early July)

For nitrogen: cowpea, crotalaria, winter pea, red and sweet clover, hairy vetch, and soybeans.

For reducing compaction: Brassicas like turnips, oilseed or tillage radish, and annual ryegrass.

For recapturing excess nutrients: Brassicas like turnips, oilseed or tillage radish, cereal rye, annual ryegrass, buckwheat, and oats when planted with manures.

For organic matter: cereal rye, annual ryegrass, Sorghum Sudan grass, and oats.

In droughty soils: buckwheat, cowpea, and teff.

For hay crops: oats, cereal rye, triticale, field pea, Sorghum Sudan grass, teff.

For weed control and disease suppression: cereal rye, buckwheat, mustard, and oilseed and tillage radish.

Table 1. Biomass production and nitrogen contribution of selected cover crops.

Cover Crops	Dry biomass (ton/ac)	Nitrogen (%)	Carbon (%)	CN ratio	Biomass N (lbs/ac)
Legumes					
Alfalfa	4.8	3.72	41.9	11.3	400
Cowpea	3.2	1.97	42.6	21.6	141
Crimson clover	0.8	1.97	41.7	21.2	33
Hairy vetch	1.0	2.33	44.3	19.0	53
Jumbo Ladino clover	0.7	3.26	42.8	13.1	55
Medium red clover	0.9	2.77	43.7	15.8	53
Mammoth red clover	0.8	2.00	43.5	21.7	35
Mungbean	2.9	3.92	40.4	10.7	224
White clover	0.3	2.92	43.3	14.8	24
Winter pea	3.1	2.60	44.1	17.0	181
Non-legumes					
Corriander	0.5	1.52	41.4	27.3	18*
Cereal rye	1.4	0.89	42.6	48.1	26*
Annual ryegrass	1.3	2.11	43.2	20.5	62*
Oilseed radish	3.9	2.11	41.1	19.5	184*
Spelt	2.1	0.99	42.7	43.3	45*
Sorghum Sudan grass	12.2	0.68	43.3	63.3	185*

* indicates nitrogen recycling

Figure 1. Buckwheat used to attract beneficial insects and reduce surface compaction.
Photo courtesy of Rafiq Islam, OSU Piketon.

Figure 2. Oilseed or tillage radish used after wheat to reduce soil compaction or to loosen up soil.
Photo courtesy of Rafiq Islam, OSU Piketon.

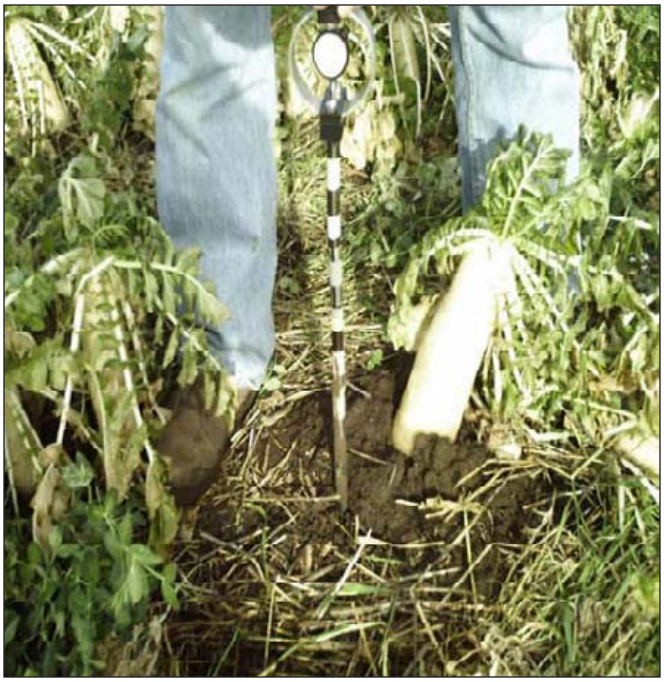

Figure 3. Crop rotation: wheat-oilseed or tillage radish with manure-corn-cereal rye-soybean. *Photo courtesy of Rafiq Islam taken at Dave Brandt Farm, Fairfield County.*

After Wheat

Cowpea, winter pea or crotalaria are ideal summer cover crops to be winter killed for providing nitrogen to succeeding grain crop. If there is a dry summer, cowpea will be best to be planted by 4th week of July because it is more drought-tolerant, fast growing, and can accumulate 140 pounds of nitrogen per acre. If it is wet summer, then winter peas will be good to be planted by 4th week of July. Winter pea will be frost killed (if planted after August) in January while cowpea will die with the first killing frost by the end of October. If Austrian winter pea starts to flower in the fall before it frosts, the Austrian winter pea will not survive the winter but it will accumulate around 180 pounds of nitrogen for the next crop. Legumes have their maximum biomass nitrogen accumulation before flowering. In the spring, corn can be planted no-till without any nitrogen fertilization assuming adequate amounts of nitrogen will be released from decomposition of cowpea or Austrian winter pea residues. A wheat/soybean cover crop rotation also works well if cheap soybean seed is available (bin run or leftover soybean seed). After wheat harvest, oilseed or tillage radish or annual ryegrass may be used to recapture excess nutrients and reduce soil compaction and is especially useful where manure has been applied.

In sustainable agricultural systems, planting an early maturing soybean crop will allow another cover crop to be incorporated into the crop rotation.

After Early Soybeans

Cereal rye, annual ryegrass, wheat, oats, or spelt as grasses can be planted to accumulate soil organic matter, recycle nutrients, and reduce soil compaction. Brassicas (oilseed or tillage radish or turnips) recycle nutrients, reduce compaction, and promote weed and disease suppression. Fall planted winter pea is a nitrogen source for corn (up to 80 pounds of nitrogen) by the next spring. No-till corn may be planted into live winter pea, allowing it to continue to grow, and then spraying and killing the peas within one month of corn emergence. Cowpea should not be planted after soybeans because they will not germinate and the seed will freeze with the first frost.

Late Soybeans and Corn

Cereal rye may be planted after late maturing soybeans and corn, and will still have time to get established before winter. Cereal rye needs a little N broadcast (or manure) to help it quickly establish. A spring or fall application of N to the cover crop can be used to improve cover crop growth and can be subtracted from the N needed for the following crop. Cereal rye is winter hardy, produces large amounts of organic matter, and helps control diseases and nematodes. Wheat may also be planted late after corn or soybeans but growth may be slower.

After Corn Silage

Cover crop choices include cereal rye, annual ryegrass, oats, winter pea, oilseed, or tillage radish and turnips. Winter pea will produce nitrogen for the next crop. The choice depends on the calendar: Winter pea can be drilled by early or mid September. If a cover crop is planted after mid September, use one of the grass cover crops and apply a moderate amount of manure (or N fertilizer). For livestock producers, the cereal rye, annual ryegrass, oats and oilseed or forage radish and turnips may be grazed.

Cover Crops for a Specific Purpose

Farmers sometimes want to plant cover crops for a specific purpose including the following:

Cover crops for organic matter (high C:N): Sorghum Sudan grass, cereal rye, annual ryegrass, triticale, oats, wheat, spelt, and barley.

Cover crops for nitrogen (low C:N): cowpea, winter pea, red clover, sweet clover, hairy vetch, alfalfa, soybeans, and mung beans.

Require no herbicide to kill: oats, cowpea, winter pea, crotalaria, oilseed or tillage radish, turnips.

Reduce compaction (deep rooted): Sorghum Sudan grass, annual ryegrass-5-6', oilseed or tillage radish-3-30', sweet clover-deep taproot, cereal rye and oats-30".

Quick forage or can be grazed: oats, forage radishes, turnips, cereal rye, annual ryegrass, teff for dry fields, Sorghum Sudan grass, and barley.

Start up or enhance no-till: oilseed or tillage radish, turnips, Sorghum Sudan grass. Sorghum Sudan grass can result in massive thatch at planting, so chop it well before cold weather sets in to increase decomposition. Sorghum Sudan grass should be mowed twice, once in early summer to maximize root growth (five times more root growth after first mowing) and once in late summer to increase organic matter decomposition.

Prevent soil erosion: Grasses have fibrous root systems to bind soil, and the best grass cover crops include cereal rye, annual ryegrass, oats, wheat, and barley. Other cover crops include buckwheat with a shallow fibrous root system, cowpea, and winter pea.

Recapture excess nutrients (nitrogen, phosphorus): oilseed or tillage radish, turnips, annual ryegrass, cereal rye, oats, wheat, Sorghum Sudan grass, and buckwheat, sweet clover, winter pea, cowpea, red clover, hairy vetch. In general, legumes need P for N fixation but are poorer scavengers of P in the soil. Since legumes acidify the soil, they tend to make P more available when P is limiting. In general, grass cover crops store and supply more P than legumes because they have a finer root system and more surface area than legumes with a taproot. In mixed legume-grass pastures, the legume cycles N to the grass and the grass cycles P to the legume.

Natural herbicides or allelopathic effects for weed suppression: cereal rye, oilseed or tillage radish, mustard, oats, barley, buckwheat, Sorghum Sudan grass. Annual ryegrass, cereal rye, Sorghum Sudan grass may be used for controlling soybean cyst nematodes.

Attract beneficial insects: buckwheat, sweet clover, and red clover.

Tolerate wet soils: sweet clover, red clover, annual ryegrass, cereal rye, wheat, and oats.

Tolerate heat and drought: cowpea, hairy vetch, mung beans, sweet clover, Sorghum Sudan grass, buckwheat, barley, teff.

Cold tolerant: Cereal rye, wheat, spelt, triticale, winter pea, and sweet clover.

Nurse crop: Oats and cereal rye.

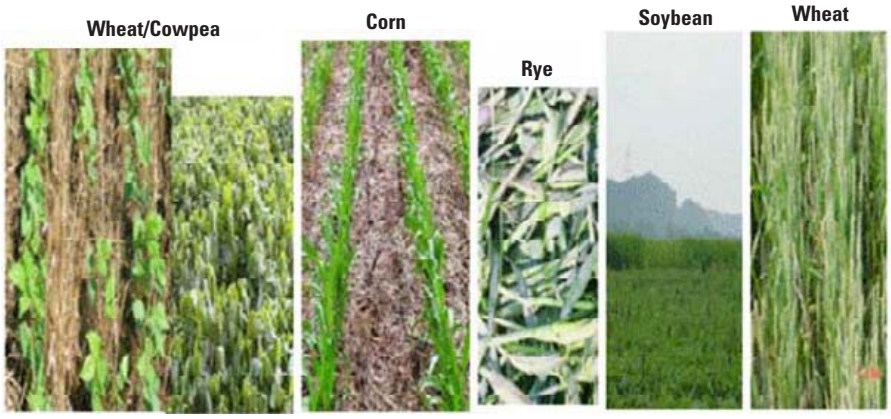

Figure 4. Crop rotation: wheat-cowpeas-corn-cereal rye-soybeans back to wheat. *Photos courtesy of Rafiq Islam, OSU Piketon.*

Planting and management

Broadcast seeding: sweet clover, red clover, cereal rye, annual rye, oilseed or tillage radish, turnips.

Low cost to establish: Sorghum Sudan grass, oats, cereal rye, sweet clover, red clover, wheat, barley, oilseed or tillage radish.

Require little management: turnips, oilseed or tillage radish, oats, cowpeas.

Require high management: Annual ryegrass and cereal rye may be hard to kill; seed heads need to be managed because they may become a weed in wheat, attracts insect pests, and may dry out the soil in the spring. Annual ryegrass and cereal rye need to be killed early if planting corn. Hairy vetch-hard seed can become a weed in wheat.

Susceptible or attract pests or diseases: annual ryegrass, cereal rye, hairy vetch, wheat, oats.

Typical Cover Crop Rotations

1. **Corn**-cereal rye-**soybeans**-Austrian winter peas (in northern Ohio, it would need to be planted after early maturing soybeans, harvested in early or mid-September).
2. **Corn**-cereal rye-**soybeans-wheat**-cowpea (or winter pea, crotalaria, hairy vetch).
3. **Wheat**-Brassica (oilseed or tillage radish or turnips)-**corn**-cereal rye-**soybeans-wheat**-cowpea-**corn**-cereal rye-**soybeans**.
4. **Corn silage**-winter pea-**corn silage** (cover crop for nitrogen).
5. **Corn silage**-cereal rye or annual ryegrass-**corn silage** (cover crop for forage, soil cover, or manure application).
6. **Alfalfa hay**-**corn silage**-Austrian winter peas-**corn silage**-cereal rye-**soybeans-wheat**.
7. **Corn**-cereal rye-**corn**-cereal rye-**soybeans**-Austrian winter peas.
8. **Soybean**-cereal rye-**soybean** OR **soybean**-cereal rye-**soybean-wheat**-Brassicas.
9. **Corn**-cereal rye-**soybean-wheat**-cereal rye-**soybeans**-Austrian winter pea (maximizes corn production on poorer soils or lower management).

Starting up No-till with a Continuous Living Cover Crop Rotation

1. **Wheat**-Sorghum Sudan grass-**soybeans**-Austrian winter pea-**corn**-cereal rye-**soybeans-wheat**-Brassica (oilseed or tillage radish or turnip) back to corn or soybeans.
2. **Wheat**-sweet clover (or other legume)-**corn**-cereal rye-**soybeans-wheat**-Brassica (oilseed tillage radish or turnip).

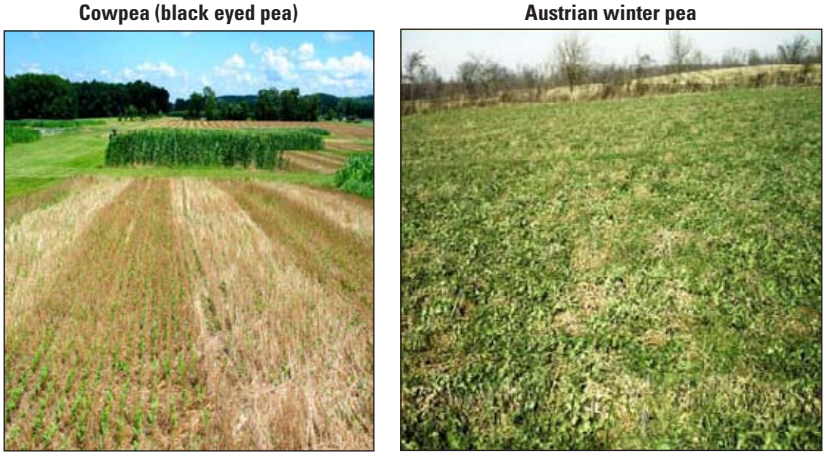

Figure 5. Cowpea and Austrian winter pea used as legume cover crops for nitrogen. Cowpeas after wheat can supply up to 140 pounds N and Austrian winter pea can supply up to 135 pounds N. After soybeans, Austrian winter pea can supply 80 pounds N if allowed to flower in the spring. Note the dark color of the corn crop in the background from cowpeas planted the previous year with no N fertilizer. *Photos courtesy of Rafiq Islam, OSU Piketon.*

Figure 6. Red clover and hairy vetch used as legume cover crops before corn. *Photos courtesy of Rafiq Islam, OSU Piketon.*

Figure 7. Annual ryegrass growth (12-14 inches) 45 days after 6,000 gallons of swine manure was applied. *Photo taken by Chris Bruynis from Dave Schilling Farm, Nevada, Ohio.*

Figure 8. Oats planted after wheat and harvested for forage in late October on Gary Wilson Farm, Jenera, Ohio. *Photo taken by Gary Wilson.*

Summary

Cover crops offer many benefits to producers that increase farm profitability and environmental sustainability. Each cover crop has a niche or special purpose. Legume cover crops are typically used to produce homegrown nitrogen. Grass cover crops are used to increase soil organic matter, recycle excess nutrients, and reduce soil compaction. Brassica crops are grown to loosen the soil, recycle nutrients, and suppress weeds. Some other cover crops are grown to suppress insects, disease, weeds, or attract beneficial insects. Therefore, cover crops should be considered an integral part of any farming system that wants to efficiently utilize nutrients, improve soil quality, and increase farm profitability.

Acknowledgments

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References

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