

Cover Crops in Missouri: Putting Them to Work on Your Farm

Sunlight powers agriculture and, fortunately, is free to all farmers. The challenge is to harvest as much sunlight as possible. Because commodity crops might be in the field for only four to five months, fields receive untapped sunlight for several months each year. To tap this free resource the rest of the year, consider planting cover crops (Figure 1). Cover crops protect the soil while improving soil health and providing living roots to feed the soil microbial community.

A multipurpose tool on a farm, cover crops can help you accomplish several goals:

- ✓ Keep soil from washing away.
- ✓ Keep expensive fertilizers in the field and out of the water supply.
- ✓ Produce nitrogen (with a legume cover).

Farmers are finding that cover crops also offer several other benefits:

- ✓ Reduce soil compaction.
- ✓ Improve soil moisture management.
- ✓ Allow more rain to soak into the soil.
- ✓ Control challenging weeds.
- ✓ Improve commodity yields over time.

The benefits provided by cover crops are valuable not only for sustaining food production capacity but also for regenerating soil. Many of these benefits are a result of the things cover crops do that we don't see: their roots grow deep, helping soil structure, storing soil carbon and improving overall soil health. These benefits come about partly through keeping green cover on the land for more of the year than would be possible with row crops alone, but also because cover crops add biodiversity to cropping systems. That extra diversity sometimes helps reduce disease in corn and soybean, creates a better balance of fungi and bacteria in the soil, and leads to more earthworms aiding porosity and rainfall infiltration. Because of all the benefits cover crops can provide, they are unlike almost any other crop input; although not a cure-all, they definitely



Figure 1. Oilseed radishes grown as a cover crop on a northeast Missouri farm. (Credit: Rob Myers)

increase the health of cropping systems. For maximum soil health benefits, consider combining cover crops with no-till or strip-till diversified crop rotations and possibly grazing the covers with livestock where feasible.

Cover crop options

Selection of a cover crop to use starts with considering the timing and purpose of its use. Virtually all cover crops appropriate for use in Missouri cropping systems are annual plants, which can be categorized as either warm-season or cool-season plants (Table 1). Warm-season plants, as the name implies, do best in warm weather and normally need fairly warm soil temperatures to start growing. Cool-season plants do best in spring or fall, and some will overwinter, the latter being called winter annuals.

In addition to considering the time of year the cover crop grows, it's also important to identify the main reasons for using the cover:

- To prevent erosion on a hilly Missouri field, particularly following soybean, use grass covers.
- To keep expensive nutrients in the field, plant vigorous grass covers or brassicas, such as oilseed radishes.
- To save money on nitrogen, take advantage of the biological nitrogen fixation of legumes, such as clovers and vetch.

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The traits of some of the more common Missouri cover crops are described below.

The common seeding rates mentioned are for planting just that one species of cover crop. If you are planting a mix of cover crops, cut back on seeding rates proportional to the amount of that species you want in the mix. For example, with a goal of equal amounts of each species, for a three-way mix, plant 35 to 40 percent the normal rate of each of species, and for a two-way mix, plant 55 to 60 percent of the normal rate of each species.

Rates for broadcast seeding, including aerial seeding, are higher because not all seed will germinate.

If a precision row crop planter is used, for some covers the rate will be less than the drilled rate, especially for members of the brassica family, such as radishes and turnips.

Crimson clover

A true winter annual legume, crimson clover establishes fast in the fall, has the potential to produce a fair amount of nitrogen, combines well with other cover crops, generally overwinters (except in poorly drained sites), and is reasonably easy to control in the spring. Plus, it's beautiful when blooming and a boost to pollinators in spring.

Crimson clover seeding rate

- Drill at 12 to 15 pounds per acre.
- Broadcast at 20 pounds per acre.
- Inoculate the seed.

Hairy vetch

Like crimson clover, hairy vetch is a winter annual legume, but with a much different growth pattern. It doesn't grow as much in the fall as crimson clover, but it generally overwinters well and by late April starts to grow with great vigor. If grown with another cover crop such as triticale or cereal rye, it will climb those plants and produce an impressive vegetative mat that helps suppress spring weeds. Hairy vetch is a strong nitrogen-fixing cover crop; to maximize the time for nitrogen fixation, use ahead of crops that will be planted later in the spring, such as sorghum (milo). Hairy vetch is generally not recommended on fields where wheat is grown, due to potential contamination of the wheat harvest from hairy vetch seed inadvertently collected during combining.

Hairy vetch seeding rate

- Drill at 15 pounds per acre.
- Broadcast at 20 pounds per acre.
- Inoculate the seed.

Cereal rye

Cereal rye is considered the queen of cover crops and is the No. 1 cover crop used in the United States. It is popular

Table 1. Examples of warm- and cool-season cover crops.

Warm-season cover crops (for summer planting)	Cool-season cover crops (for fall or early spring planting)	
buckwheat	annual ryegrass	crimson clover
cowpea	Austrian winter pea	forage turnips
foxtail millet	balansa clover	hairy vetch
pearl millet	black oats	oats
sorghum-sudangrass	brassicas, other	oilseed radish
sunflower	canola (rapeseed)	triticale
sunn hemp	cereal rye	wheat

because it is quite cold-hardy and can be planted later in fall than any other cover crop, and it provides excellent erosion control and incredible growth in spring. A potential drawback is that when rye is used on poorly drained soils that stay cool and wet in the spring, such as claypan soils, the decaying rye can sometimes slow corn establishment. Another caution is that the rapid spring growth of rye can take first-time users by surprise and create a slight risk of complications with spring planting. Fortunately, even 5-foot-tall rye can be killed with glyphosate or by rolling.

Cereal rye seeding rate

- Drill at 70 to 80 pounds per acre.
- Broadcast at 100 to 120 pounds per acre.

Triticale

A cross between wheat and cereal rye, triticale has some of the hardiness of rye but the shorter stature of wheat. Considered a good cover for erosion control and for grazing, it works well in combination with other cover crops, particularly legumes.

Triticale seeding rate

- Drill at 60 to 70 pounds per acre.
- Broadcast at 80 to 100 pounds per acre.

Oats

Widely available and normally spring-planted for grain, oats have the advantage of strong fall growth as a cover crop. Many first-time users of cover crops appreciate that oats will winterkill and require no special management in spring. However, the erosion control provided by oats in late winter and spring is less than that from overwintering cereals such as cereal rye, triticale and wheat.

Oats seeding rate

- Drill at 80 to 100 pounds per acre.
- Broadcast at 120 to 140 pounds per acre.

Oilseed radishes

Radishes have become a popular cover crop due to their rapid fall growth, deep taproot, good fall soil coverage (if planted early enough), and ability to scavenge soil nutrients that might otherwise leach out of the soil. Radishes normally winterkill in Missouri. They establish relatively easily when broadcast seeded, which is good because radishes often need to be aerial seeded in late August or early September to achieve adequate fall growth. Review the residual herbicides applied to the preceding commodity crop to make sure none will affect radish establishment.

Oilseed radish seeding rate

- Drill at 5 to 6 pounds per acre.
- Broadcast at 8 to 10 pounds per acre.
- In early seeding situations, such as after wheat or silage, row crop planters can be used, allowing seeding rates to be reduced to about 3 pounds per acre using grain sorghum meters, canola plates or radish plates.

Forage turnips

Like radishes, forage turnips are a member of the Brassica family that does best if planted in early fall. Although not quite as vigorous in growth as the best oilseed radish varieties, turnips are superior for grazing. Both the leafy top-growth and the tuber are good forage for grazing livestock. Turnip top-growth typically dies by late December. Turnips are often mixed with another forage species, such as cereal grass.

Forage turnip seeding rate

- Drill at 5 to 6 pounds per acre.
- Broadcast at 8 to 10 pounds per acre.

Annual ryegrass

Annual ryegrass is a completely different plant than cereal rye, with fine blades and smaller stature more like a turfgrass (ryegrass is often sold in turf mixes). Annual ryegrass is fast-growing and easier to establish by broadcast seeding than other grass cover crops. It needs to be planted earlier than cereal rye to get good fall cover. Ryegrass is conducive to interseeding applications in corn or soybean as it is relatively shade-tolerant. Annual ryegrass turns brown over the winter, but depending on planting date, location and winter conditions, will generally regrow in the spring. Where it does overwinter, timely herbicide application in spring is needed to terminate it. (For tips on herbicide termination of ryegrass, see the Oregon Ryegrass Growers Seed Commission guide listed under *Sources of more information*.) Use of a cover crop-specific variety will make spring termination easier. Annual ryegrass makes a good forage and, as a cover crop, is known for rooting deeply in the soil and providing good erosion control.

Annual ryegrass seeding rate

- Drill at 12 to 15 pounds per acre.
- Broadcast at 20 to 25 pounds per acre.

Fitting cover crops into your rotation

For a corn-soybean rotation

Two fairly simple sets of options for beginning cover crop users with a corn-soybean rotation are described below. Option 1 is a sequence of cover crops with corn and soybean where most of the cover crops will winterkill, making management easy. Option 2 puts more emphasis on covers that overwinter and have a higher level of erosion control but also need more attention to terminate in spring.

Residual herbicides can restrict which cover crops can be used in a field. Check how the herbicides in your field will affect the cover crops you plan to use. You might need to change the herbicides you are using on your corn and soybean to allow the following cover crops to be used.

Option 1, an easy management approach

Before soybean. Use a mix of oilseed radishes and oats after corn and before soybean. If the radishes and oats can be planted by mid-September after corn harvest, then drill the mix as early in September as feasible (either get the seed premixed or place radish into small seed box and oats into large seed box on drill). Where corn is harvested later, such as in northern Missouri, you might need to aerially seed the cover crop mix into standing corn when the corn leaves start to turn color and the canopy starts to open. Timing is important — light needs to reach the soil to allow the radishes to successfully establish. Be aware that aerial seeding is less reliable than using a grain drill and is highly dependent on timely rainfall.

Oats-radish mix seeding rate

- Drill a combination of 50 pounds per acre of oats and 3 pounds per acre of radishes.
- Broadcast or aerial seed at a 20 percent higher rate: a combination of 60 pounds per acre of oats and 3.6 pounds per acre of radishes.

The mix of oats and radishes will scavenge leftover soil nitrogen from the corn and help reduce erosion in fall and early winter, but does not require termination in the spring and thus simplifies spring soybean planting. Using a two-way cover crop mix increases the odds that at least one cover will establish. Although erosion control and weed suppression are not as good with an oats-radish mix compared to cereal rye, the corn residue combined with fall covers will provide significant erosion suppression in a no-till system. The radishes have the potential to reduce problems from certain soybean pests, such as cyst nematodes or sudden death syndrome.

Before corn. No-till drill a mix of oats and crimson clover right after soybean harvest. The oats will provide some erosion protection through midwinter and can help with the crimson clover establishment; in most years, crimson clover will overwinter if planted early enough. The clover can provide a modest amount of nitrogen fixation in the spring, especially if corn planting is delayed until late April (be sure to inoculate the clover to achieve nitrogen fixation). Crimson clover is easy to terminate in spring with a herbicide tank mix, typically glyphosate with 2,4-D; mowing after flowering starts; or using a roller-crimper. Be aware that crimson clover does not overwinter well in poorly drained fields.

Oats-crimson clover mix seeding rate

- Drill a combination of 50 pounds per acre of oats and 7 pounds per acre of crimson clover.
- Broadcast or aerial seed a combination of 60 pounds per acre of oats and 8.4 pounds per acre of crimson clover.

Option 2, an approach providing additional erosion control

Before soybean. Drill cereal rye in the fall right after corn harvest, and terminate it shortly before soybean planting, or at the time of soybean planting if the spring is not too dry. The use of cereal rye before soybean is a well-proven cover crop approach and often gives the soybean a yield boost as well as helping with weeds and erosion, but be sure to have a plan for terminating the rye in spring. In a dry spring, terminate the rye well before soybean planting; in a wet spring, the rye can be allowed to grow right up until soybean planting time.

Cereal rye seeding rate

- Drill at 70 to 80 pounds per acre.
- Broadcast at 100 to 120 pounds per acre.

Before corn. Either drill a two-way mix of triticale and crimson clover right after soybean harvest, or for a bit more diversity, aerial seed a three-way mix of triticale, crimson clover and oilseed radishes into standing soybean (the radishes need to be planted earlier than the other two covers, thus the earlier aerial seeding into standing soybean). The timing of aerially broadcasting cover crops into standing soybean is crucial. This seeding needs to be done when the soybean leaves are starting to turn yellow and light is starting to reach through the soybean canopy to the soil surface. If the cover crop is aerial seeded while the soybean leaves are still green, not enough light will reach the cover crop seedlings. If it is aerial seeded after the soybean leaves have started falling and begun to form a mat on the soil surface, the cover crop seed will end up on top of the soybean leaves and fail to establish.

Triticale-crimson clover mix seeding rate

- Drill a combination of 35 pounds per acre of triticale and 7 pounds per acre of crimson clover.
- Broadcast or aerial seed a combination of 42 pounds per acre of triticale and 8.4 pounds per acre of crimson clover.

Triticale-crimson clover-radish mix seeding rate

- Drill a combination of 25 pounds per acre of triticale, 5 pounds per acre of crimson clover and 2 pounds per acre of radishes.
- Broadcast or aerial seed a combination of 30 pounds per acre of triticale, 6 pounds per acre of crimson clover and 2.4 pounds per acre of radishes.

The time frame to aerially seed into soybean can be as short as a week; aerial seeding cover crops into standing corn is a bit easier, with a planting time frame of a few weeks. In either case, timely rain will be crucial for establishment of the cover. The use of earlier-maturing soybean on seeded fields might allow earlier cover crop planting and, possibly, use of a grain drill instead of aerial seeding.

For a rotation including wheat

Use of wheat in the rotation expands the selection of cover crops that can be used. Southern Missouri farmers normally double-crop beans after wheat harvest, but many others in the state might want to consider options for soil-improving cover crops to follow wheat. One of the more popular options after wheat in the central Corn Belt latitudes has been to drill oilseed radishes in mid-August, which allows an excellent stand with great fall growth. Even greater soil improvement benefits can come from drilling a mix of several cover crops that will provide biodiversity. If the drilling can be done in midsummer with adequate moisture, a mix of warm-season covers such as sorghum-sudangrass, sunflower, sunn hemp, cowpea and buckwheat can work well.

Some farmers have combined warm-season and cool-season covers into a blend of eight to 12 cover crop species for drilling after wheat. Ideally, the cool-season covers will emerge in early fall as the warm-season covers' growth declines. Use of such a multiway blend after wheat can be one of the faster ways to build organic matter and enhance soil health in a commodity crop system, especially if combined with no-till and compared to a rotation of using just corn and soybean with conventional tillage and no covers. Some multiway cover crop blends can also be excellent for grazing livestock.

One cover crop to generally avoid in wheat rotations is hairy vetch, due to its tendency to have hard seed and reappear year after year, which makes it hard to clean out of the wheat. Likewise, cereal rye might not be the best option for a rotation that includes wheat due to its potential to volunteer in the wheat field.

Cover crops and vegetable operations

The most common cover crop approaches for vegetable operations in Missouri involve the use of either warm-season cover crops, such as buckwheat or foxtail millet, following early harvested vegetables, or of fall-planted cover crops to protect and improve the soil. Because tillage or mowing is more likely to be used to terminate cover crops in vegetable operations, a wider range of covers can typically be used and a multiway blend of cover crops is worth considering. For organic vegetable crops, nitrogen fixation can be maximized by planting winter annual legumes — such as crimson clover, hairy vetch or Austrian winter peas — and letting them grow until late May or early June. Be sure to use the correct inoculum with any legume to allow nitrogen-fixing root nodules to form.

Planting cover crops

According to a 2014–15 national cover crop survey, the most common planting method for cover crops on commodity crop farms is drilling, second is aerial seeding, and third is broadcasting cover crop seeds with light tillage incorporation. An increasing number of farmers planting cover crops on a large scale are using row crop planters, both to be able to use lower seeding rates, thus reducing seed costs, and to cover more ground. New equipment approaches for seeding continue to be developed, ranging from using high-clearance broadcast seeders to putting a broadcast seeder on a combine or on tillage equipment. Vegetable producers often rely on broadcast seeding with light incorporation.

A general guideline is that the larger the seed, the less likely that broadcasting will establish the crop, at least without some form of incorporation. Small seed — such as clovers, radishes, canola or ryegrass — generally works best for straight aerial or broadcast seeding due to its ability to find cracks and crevices in the soil where it can more easily come in contact with moisture. For most reliable establishment, consider using a drill or other planter or at least incorporating the seed with tillage equipment. When incorporating seed with tillage, limit the tillage depth, as most cover crop species can only emerge reliably from ½ to 1 inch deep in the soil.

Another important consideration in planting cover crops is to review the recent herbicide history of the field. Some spring- or summer-applied herbicides will have residual effects lasting into late summer or fall and might affect certain cover crops, particularly broad-leaved cover crops. Oilseed radishes and other brassicas are particularly sensitive to some common residual corn and bean herbicides. (For more information on herbicide carryover effects, see the MU Extension slideshow listed under *Sources of more information*.)

Cover crop seed can be obtained from companies that specialize in cover crop seed sales, from other farm seed suppliers, or sometimes from a local ag co-op or retailer. Be sure to purchase good quality seed in varieties appropriate to your region.

Terminating cover crops

According to the cover crop survey previously cited, commodity crop farmers report primarily using the following methods for terminating cover crops:

- Herbicides — 59 percent
- Cover crops that winterkill — 23 percent
- Tillage — 10 percent

Conversely, horticulture producers are most likely to use tillage instead of herbicides to control cover crops.

When using herbicides to terminate cover crops, it is important to consider the following conditions in addition to herbicide rate:

- Time of the day for spraying — early in the day is best
- Weather — sunny is better than cloudy
- Growth state of the cover crop
- Adjuvants needed, if any

Because spring conditions might provide limited opportunities for timely spraying of a cover crop, you will need to pay close attention to management and, optimally, have a sprayer readily available for timely herbicide application.

Making money off of cover crops

People often assume that cover crops are too expensive and are used only by farmers who get government incentive payments to plant them or who are focused on conservation. In reality, less than half of farmers who use cover crops have ever received a cover crop incentive payment and few (9 percent) get regular incentive payments, according to the 2014–15 cover crop survey. More importantly, many farmers are finding cover crops can help their economic bottom line. Three years of national cover crop surveys have shown that corn and soybean farmers have, on average, received yield benefits ranging from 4 to 10 percent in soybean and 2 to 9 percent in corn. In those three years (the 2012, 2013 and 2014 cropping seasons), the highest yield increases after cover crops came in the drought year of 2012, which proves their value for risk management.

Of course, not all fields show a yield benefit, especially in the first year, but the benefits increase year by year. A farmer who uses cover crops for at least three to four years will see increases in soil health and yield accumulating over time. Cover crops can also improve the bottom line by eventually allowing reductions in certain input costs, such as a lower nitrogen fertilizer rate or one less herbicide or pesticide application. The cover crop survey reports that farmers have paid a median price of \$25 per acre for cover crop seed, but careful planning can keep seed costs modest and pay dividends in improved net profitability over time.

Grazing of cover crops is another key strategy for boosting farm profits. A number of cover crops have the potential to extend the grazing season. Most common are cool-season cover crops that can grow late into the fall and be grazed in November and December; forage turnips, cereal rye, triticale, winter wheat and annual ryegrass are popular for this purpose. The cereal grasses will overwinter

in Missouri and can also provide for early spring grazing at a time when other forage and hay might be in short supply. Rate of cattle weight gain on cereal rye, wheat and annual ryegrass has been shown to exceed a pound of gain per day if sufficient fall growth has been achieved before grazing begins.

Sources of more information

The U.S. Department of Agriculture's (USDA) National Institute of Food and Agriculture (NIFA) supports a Sustainable Agriculture Research and Education (SARE) program that maintains extensive information on cover crops, having funded hundreds of research and education projects involving cover crops. Much of the cover crop information is organized in a "topic room" at <http://sare.org/covercrops>. SARE's detailed reference book *Managing Cover Crops Profitably* can be read online, downloaded as a free PDF, or purchased on the SARE website. The reports and analyses of the national cover crop surveys cited in this guide, which were funded by SARE and carried out by the

Conservation Technology Information Center (CTIC), are also available from the SARE Cover Crops Topic Room.

The Midwest Cover Crops Council is a group of university extension staff and researchers, agency representatives, farmers and crop consultants who share information on cover crops. It has online cover crop selection tools and a pocket-size *Midwest Cover Crops Field Guide* available on its website at <http://mccc.msu.edu>.

The USDA's Natural Resources Conservation Service (NRCS) is another good source of information on cover crops and soil health, both through its technical staff in state and field offices, and through its website at <http://nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health>.

The Oregon Ryegrass Growers Seed Commission's annual ryegrass management recommendations guide, which contains tips on herbicide termination, is available at <http://ryegrasscovercrop.com/resources/publications>.

The University of Missouri Extension Weed Science program's slideshow *The Effects of Herbicide Carryover on Cover Crops* is available at http://weedscience.missouri.edu/extension/pdf/cover_crop_carryover_slideshow.pdf.

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