Cover Crops

Best Management Practices

FarmProgress

TABLE OF CONTENTS

IT BEGINS WITH YOU: INCORPORATING COVER CROPS

Cover crops are grasses, legumes or small grains grown between regular grain crop production periods for the purpose of protecting and improving the soil.

WHAT IS A COVER CROP?

Cover crops are the small grain or legume "green" crops that are seeded in early fall to protect and improve water quality during the "brown" winter months. This extended period between harvest and planting without living plants on the ground can leave soil, water and nutrients exposed and unprotected from erosion and leaching.

WHY IS IT A GOOD IDEA FOR FARMERS TO PLANT COVER CROPS?

Farmers are seeing the value of having a cover crop and more are incorporating them into their row-crop systems because they offer a way to improve soil quality, combat compaction, eliminate erosion and maximize soil nutrients. They may also increase crop production. By improving soil quality and the rooting of the corn or soybean crop, you get more consistent yields, rather than having large swings from one year to the next.

Putting more "green" plants into the "brown" months will help maintain natural cycles for water, carbon, nutrients and soil organisms now and in the future.

Even with these potential benefits to the soil and water, many farmers are hesitant to add cover crops to their farming system, but with good management, cover crops can help offset feed costs for cattle, hold precious nitrogen in place and add important organic matter to soils, increasing their ability to soak up water during heavy rains. The potential uses of cover crops are many, and new momentum for this practice has increased dramatically.

In natural ecosystems, most of the time the ground is not frozen and there are plants growing, recycling water and nutrients, and fixing carbon – at the very least, covering the soil. Research explains the benefits of using cover crops in annual cropping systems:

- Plants and plant litter protect soil from erosion by intercepting raindrops, slowing surface water flow, increasing infiltration, and holding soil with roots.
- Plants moderate soil and air temperatures by intercepting radiation, shading or mulching the soil surface, and transpiring water.
- Lastly, plants maintain soil productivity by preventing soil nutri-

ent loss, increasing soil carbon, improving water holding capacity, and maintaining soil structure.

In addition to holding soil in place and capturing nutrients, cover crops are also an "in-field" practice, an investment account for the farmer, as opposed to "out-of-field" practices such as wetlands, buffers, etc., which require a subsidy from the farmer. They also extend the grazing season and reduce the need for stored forages, or free up pastures to increase rest periods or make more hay.

Additionally, cover crops allow crop roots to go deeper, and can be grown in any farming system.

WHAT CROPPING SYSTEMS ARE COMPATIBLE WITH COVER CROPS?

Cover crops can be added to any farming system, but fit well with no-till, strip-till, or spring tillage-only systems. They fit best here because they give the cover crop a longer growth period.

Cover crop options such as clovers or brassicas are expanded when they are planted after mid-summer harvest of small grains such as oats or wheat. Small grain cereal crops like oats or winter-hardy rye, wheat and triticale can be planted in early September after corn harvest.

INTRO TO COVER CROP USES AND BENEFITS

Cover crop benefits reach far and wide – from soil erosion protection to returning nutrients, they offer ways to improve your bottom line.

ORGANIC WEED CONTROL

A major issue with growing row crops organically is weed invasion. Without herbicides, how do you control weeds? That is where the cover crops help.

For example, an aerial-applied seeding of a wheat and red clover cover crop mixture is helping to suppress weeds on 200 acres of certified organic cropland for a farming family in southeast Iowa. The 200 acres helps feed a 150-head certified organic dairy herd.

POSITIVE EFFECT ON WATER QUALITY

A Michigan State University Extension Team worked together to assess the amount of sediment and phosphorus that cover crops can reduce to improve Michigan water quality, finding that on average, cover crops will reduce sediment 1,840 pounds/acre from wind erosion and will decrease sediment 340 pounds/acre from water erosion. Cover crops are estimated to reduce phosphorus by 0.30 pounds/acre from wind erosion and 0.04 pounds/acre from water erosion.

Based on surveys and other resource materials, it is estimated that 1.1 million acres were planted in cover crops in 2011 when including wheat. About 400,000 acres of cover crops were planted excluding wheat. Seed dealer comments have indicated at least a doubling of cover crop seed sales over the last year.

COVER CROPS BOOST FERTILITY

While cover crops incorporated into a continuous no-till field crop rotation can produce enough nitrogen to complement or replace corn nitrogen fertilizer applications, they can also improve the health of the soil by sustaining soil microbes, earthworms and other organisms, says Rafiq Islam, who holds joint appointments with Ohio State University Extension and the Ohio Agricultural Research and Development Center.

"Cover crops improve the soil structure, support microbial efficiency and diversity, facilitate drainage, reduce soil erosion and nutrient leaching, store carbon, and suppress weeds and pathogens," Islam says. "They also break up soil compaction."

Another benefit is the increase in earthworm populations, which can be doubled through the use of cover crops, Islam said. Earthworms, which are a good indicator of soil health, enhance soil health through recycling nutrients and encouraging soil aeration, porosity and percolation.

HIGHER CORN YIELDS

In recent Kentucky experiments, winter cover used with no-till planting markedly increased corn yield. For instance, three-year average continuous corn yields were 8 bushels per acre greater when planted into a winter cover of rye and 25 bushels per acre greater when planted into hairy vetch than yields from plots without winter cover. The significantly higher yield in the hairy vetch cover plots was due primarily to the extra nitrogen that this legume provides.

Results from a four-year Iowa State University study on using cover crops between rows of corn reveals that higher yields, by as much as 10%, are possible using the soil-saving approach to farming.

The results are the best yet in the ongoing research, says Ken Moore, agronomy professor. Planting living mulch--or ground cover--between rows of corn is intended to perform several functions--maintain soil moisture, slow soil erosion and sequester carbon.

"Growing corn with a perennial cover crop promises to address many of the environmental concerns being expressed about corn production and will enable farmers to harvest stover for bioenergy as that market develops. It appears to be a win-win opportunity. These cover crop systems may eventually offer the farmer a profitable alternative that can ensure long term success."

BIOMASS PRODUCTION

Despite growing promise for biomass-based biofuels, there is a big question floating out there: How much crop residue can you remove from a field and still have left what you need for healthy cropland? While a lot of biomass proponents are hot about using switchgrass and other perennial crops, corn stover is also going to be a great resource, as work by Agco and Vermeer is showing. Iowa State University researchers may have an answer – living cover crops.

Two years into a study looking at methods of combining a living cover crop between corn rows, the researchers have found that corn yields can be maintained. They were testing between-row cover grasses as

part of research looking at ways to reduce soil runoff and keep crop nutrients in the soils while residues are removed to produce biofuels.

With U.S. government targets calling for 30% displacement of petroleum consumption with fuels made from biomass by 2030, researchers are studying ways to harvest more stover. Targets will require moving as much as 75% of stover to use as feedstock for biofuel production, but removing that much stover can cause more water runoff, creating a host of issues.

One approach to keeping soil in place would be to plant grasses between corn rows that would stay in the field year round – in effect growing corn in perennial sod. Sounds like a great idea, but farmers won't do it if the practice reduces yield. After two years of researching the idea, researchers say the system allows removal of up to 95% of stover while boosting the amount of carbon kept in the soil, increasing water use efficiency in corn and maintaining corn yield.

One cropping system the team examined in 2009, for example, increased harvest from about 195 bushels per acre using traditional methods to more than 209 bushels per acre with the new system. And they did that while improving the soil and harvesting almost all the stover.

Researchers looked at 36 different ground covers, mostly grasses, different tillage systems including no-till and strip-till and 50 different corn hybrids. In addition they tried a range of chemical treatments. One key they discovered is to find a grassy ground cover that is less active in the spring allowing the corn to absorb needed water and sunlight at the beginning of the growing season with less competition.

LET COVER CROPS DO YOUR TILLAGE WITH ROOTS

Some cover crops have notable uses as tillage tools.

"The roots of oil seed radish can reach deep into the soil -- as much as 30 inches -- breaking up compacted soils (natural strip tillage), supporting microbial diversity, facilitating drainage and improving soil structure," says Rafiq Islam, an OSU Extension soil scientist. "If you grow a legume cover crop along with oil seed radish, you don't need to subsoil or deep plow. The crops work together as a natural biological plow."

SOIL EROSION PREVENTION TOOL

Past research has shown that fields with winter cover plowed under in the spring have 55% less water runoff and 50% less soil loss annually than do fields with no winter cover. More recent studies show soil losses from corn or soybeans no-tilled into a vigorous growth of rye or wheat to be 90-95% less than soil losses from corn and soybeans conventionally tilled.

Years ago, farmers who tried cover crops were those who were mainly sticklers for soil conservation. They did not want their fields exposed during the winter with no live cover where the soil would be an easy target for soil erosion, especially after soybeans, since the crop leaves such little residue.

On erodible soils, wind and water erosion are important concerns, especially after a season of extreme drought. “The most important benefit from cover crops is increased erosion control on these soils,” says Dan Gillespie, NRCS no-till specialist. “If you stop the soil loss, that is the first step to soil building.”

A mid-April storm in 2011 reminded many southern Iowa farmers why preventing erosion with cover crops is important. Up to 8 inches of rain, along with strong winds and tornadoes, hit southern Iowa on April 14, 2011, causing property and cropland damage. In many cases, crop inputs like corn seed and fertilizer washed away.

In Montgomery County, Iowa, district conservationist Tom Burkhiser, with USDA's Natural Resources Conservation Service, says a 20,000-acre area with mostly unprotected fields sustained soil losses in excess of 20 tons per acre. Alan Lange, NRCS district conservationist in Adair County, reported similar damage there. He says approximately 25,000 cropland acres lost more than 20 tons of soil per acre.

Farmers like Steve Berger of Wellman, Iowa, who planted cover crops in the fall, went mostly unscathed. Berger says 3 inches of rain fell that evening on his farm. When the sun came up the next morning, however, the cereal rye cover crop that he sprayed with a kill-shot just two weeks prior protected the soil from erosion.

Berger is a 30-year no-tiller. He added a cereal rye cover crop to his rotation 10 years ago. “Cover crops help to reduce soil loss and improve soil health,” he says. “A lot of ground in the area has been worked up as corn is planted, so there were several worked fields with significant soil erosion.”

Pete Hobson, who no-till farms in Pottawattamie County, Iowa, grew an annual ryegrass cover crop in corn residue last fall and just recently sprayed it in preparation for planting. He says those fields are free of erosion following more than 3 inches of rain on April 14 and more than an inch a week prior.

Hobson benefited most from drilling wheat into a field with soybean stubble in areas most susceptible to ephemeral gullies. “I sprayed the wheat with Roundup the Monday before, and it still kept those gully-prone areas from washing,” he says. “For me, it's less about the cover and more about the fibrous root systems that cover crops provide that help hold the soil in place.”

During heavy rains, cover crops provide an unintended benefit: keeping crop residue out of culverts. “We saw some problems with corn-

stalks and bean stubble plugging culverts," says Burkhiser. "Having cover crops on fields avoids that problem."

"Cover crop roots provide good soil structure, which allows water to infiltrate," he says. "Tilled soil leaves you with a muddy mess following heavy rains. It takes a long time to dry those fields out, and leaves you with a hard crust on top."

"It really comes down to, 'What is the soil worth to you?'" says Stewart. "Is the cost of planting a cover crop worth keeping the soil on your farm?"

RESTORE WINDSWEPT OR FLOODED FIELDS

While it can introduce erosion, storm damage is also an opportunity to seed cover crops such as radishes and turnips, says Sarah Carlson, director of research and policy for Practical Farmers of Iowa, located in Ames.

In Iowa the corn and soybean two-year rotation does not offer much time for trying out or adding a cover crop like tillage radish or turnips, says Carlson. In Indiana where many farmers still plant a 3-year rotation like corn, soybeans and wheat there is more time following wheat harvest in mid-July for farmers to be able to plant and successfully grow a sod-busting cover crop like tillage radish.

If your farm has ever been victim to a wind storm and you end up baling the laid down corn that isn't recovering or the corn that had a lot of green snap, and you end up having bare acres—but don't forget about cover crops. Early August is a perfect planting date for tillage radish, says Carlson, and with the good growing conditions in August and September the plant can produce tubers like the one in the accompanying picture.

Beans don't grow as tall and aren't as susceptible to wind damage. However, if for some reason you have a drowned out bean field or have to bale the soybean plants as forage, you should consider planting a cover crop in those fields, too, Carlson adds.

Chris Nelsen, Mission Hill, S.D., says cover crops may also help in restoring a flooded field.

When one of his fields flooded in 2011, he started the restoration process by planting a cover crop to break up the hardpan, recycle nutrients in the soil and provide organic matter for microbial action.

"I didn't want to do any fall tillage in that flooded field," Nelsen says. "That would make it susceptible to wind erosion all winter. It was severely eroded that way about 15 years ago. Two years ago I removed some wind-laid dirt, grass and sod from the ditches. I re-carved the field's drainage ways to promote in-field drainage. I needed to do something to prevent fallow syndrome.

"I used turnip, rapeseed, sugarbeets and radishes for this mix," Nelsen says. "My seed cost $16 per acre. I used pelletized gypsum as a carrier that cost $85 per ton and used an air-flow fertilizer spreader to distribute the seed. Overall, the cover crop cost $24.50 per acre. I added fertilizer with a spreader and used a soil finisher to work the seed in slightly. A nice rain right after I seeded resulted in a beautiful stand."

The cover crop mix rooted down as much as 14 to 16 inches into the soil, with smaller roots measuring at least an inch in diameter. The plants stimulated microbial activity in the soil until nighttime temperatures dropped below 15 degrees F.

"Once the roots freeze, they'll decompose. By spring there will be virtually nothing left of them," Nelsen says. "That will leave nice voids in the soil to help absorb spring moisture."

CUT YOUR NITROGEN COST

Worried about spikes in nitrogen fertilizer prices over the next few years? Cover crops incorporated into a continuous no-till field crop rotation can produce enough nitrogen to complement, or in some cases, replace nitrogen fertilizer applications, according to long-term Ohio State University Extension research.

Seven years of research found that cover crops, such as cow pea or winter pea, worked into a corn/soybean/wheat rotation, can produce enough N to support at least 150 bushels of corn per acre.

The findings indicate farmers can save money on spring N applications while reaping the environmental benefits of cover crops.

Ohio farmer Dave Brandt discovered giant oil seed radishes offer big benefits to his fertilizer bill. The cover combination of 1 pound per acre of radishes and 12 pounds per acre of peas reduces his fertilizer needs by 65% and cuts the herbicide bill by 25 to 30%. He uses a special planter to position the complimentary plants 4 inches apart so the radishes can draw nitrogen from the legumes as they grow.

In addition, oil seed radish stores massive amounts of reactive nitrogen and phosphorus, preventing any of it from leaching out of the soil or surface runoff and making it available to corn when it needs it.

Researchers also found that because oil seed radish does such a good job of improving the soil quality, it forces associated cover crops (legumes) to fix more nitrogen of their own, making even more of the natural fertilizer available, developing a mutually beneficial relationship.

RAISE ORGANIC MATTER IN ANY FIELD BY ADDING N

Organic matter can be raised to 2% or higher in fields where conservation tillage and cover crops are used for consecutive years.

In some pockets of the South, organic matter can be raised to 2% or higher in fields where conservation tillage and cover crops are used for consecutive years, more than enough, and well worth effort, to increase overall soil health. Extra nitrogen added to cover crops may also provide an extra boost.

Many growers balk at putting nitrogen on cover crops, especially with fertilizer costs rising. But some specialists think many are coming around and seeing the benefit, even if it is a tough sell to growers putting fertilizer on a crop you aren't going to harvest.

PLANT COVER CROPS IN A DROUGHT YEAR? YOU BET

With all the talk about what cover crops use to grow, some wonder if they can be grown in drought years. But experts say they may actually conserve moisture in a drought year.

Agronomists' advice for those with poor corn crops coming out of the drought in the fall of 2012 was to plant cover crops to capture the nitrogen. The theory was that if cover crops could get established in time, they could catch nitrogen before it leaches down below the tile zone. Otherwise, the nitrogen is likely to be lost to leaching during the winter and spring, especially if there are periods or warm, wet weather when soils are saturated.

Lisa Holscher, a watershed coordinator in west-central Indiana, provides proof that this theory was on target. She has circulated pictures from Indiana farmer Mike Bell, who established a cover crop relatively early in a cornfield where performance was well below par.

It is obvious that the cover crop growing over where the nitrogen was applied last spring and summer is much greener and taller. Obviously the roots of the cover crop have tapped into the nitrogen than the corn roots couldn't get to because the soil was too dry for uptake. As many expected, a large share of the nitrogen remains in bands close to where it was applied.

This visual proof indicates that the cover crop is capturing nitrogen. It will release it slowly once the cover crop is killed next spring. But the nitrogen won't be lost into the environment through leaching into tile lines and running of into waterways.

MOISTURE TRAPS

At the same time they are concerned about soaking up nitrogen, farmers are also wondering if the cover crops will suck up too much moisture from the soil and aggravate already excessively dry subsoil moisture conditions after a drought.

But, Kris Nichols, research soil microbiologist with the USDA Agriculture Research Service, Mandan, N.D., says cover crops are also beneficial for conserving moisture.

“Cover crops can be an important part of keeping moisture in the soil because they keep that soil covered,” she says.

Below the soil's surface, cover crops play a vital role in soil and plant health, too. “A green and growing cover feeds a whole web of soil organisms - much more than crop residue,” Nichols says.

Mycorrhizal fungi are an example. They are organisms made up of fine threads and filaments called hythae. Because these threads are so much smaller than plant roots, they have access to more soil and the nutrients or water it contains. For farmers who have been using cover crops for a few years and have built up their soil ecology, she says these same organisms will help reduce the amount of stress their plants succumb to during a drought.

"Many times during a drought, plants are not as much water stressed as they are nutrient stressed," she says. "The way plants get nutrients from the soil to their roots is through water. In times of drought, plants will sometimes give off their own water supply to create a water fill around the roots so nutrients can travel."

Plants growing in soils rich with mycorrhizae can take advantage of the fungi to help them obtain nutrients from the soil. Soil rich with living organisms also has a soil structure that is more conducive to water retention.

THINKING ABOUT A COVER CROP? START WITH A PLAN

Taking time to design your cover crop plan will increase the successful establishment of the crop and allow for improved staggering of fall harvest.

DEVELOP A COVER CROPPING PLAN

Taking time this winter to design your cover crop plan will increase the successful establishment of the crop and potentially allow for improved staggering of fall harvest. Fall is a busy time, even in a normal year – harvesting, handling grain, fall fertility and tillage concerns are priorities.

The best cover crop stands in the fall and spring are planted early, by mid-September, into a nice seedbed either tilled or no-tilled, and coinciding with rainfall. Corn silage, corn or soybean seed acres following a small grain are great options to take advantage of that perfect, early, nice seedbed planting opportunity.

YOU NEED TO ANSWER THESE QUESTIONS:

- Could a percentage of your land be planted to a shorter season corn hybrid or soybean variety?
- Could a percentage of your land be overseeded into standing corn or soybeans?
- Could a percentage of your land not have a cover crop?
- How can the percentages you plant be shifted to include more cover crops each year?

Additional factors to consider include proper crop selection for planting date and conditions, profitability, termination, harvest or grazing plans, and insurance requirements.

Weighing your options and deciding on a cover crop plan will improve your chances of a well-established, nutrient-holding, soil-improving fall cover crop. Read on to learn more about all of your options.

MOST POPULAR COVER CROP CHOICES

Now's the time to pick your cover crops and get them planted.

WHAT COVER CROP SHOULD I PLANT?

When buying cover crop seed, conservation specialist Mike Plumer says it pays to know what's in the bag.

Not all annual ryegrasses are created equal. There is a big difference in varieties. Some of the most cost effective seed options are not marked with any variety.

Additionally, variety mixes can be very inexpensive. However, each variety will grow differently. Plus, it can become a challenge when trying to select the proper mix of herbicides for burndown.

If the variety is stated on the bag, Plumer says that's a big step up. While it's not completely guaranteed, it's usually fairy accurate if the company is willing to mark it.

The gold standard of cover crop seed is certified. **Certification often refers to the production process and the quality standards of the seed. However, do not confuse certification – the process – with "variety." For example, a mix of different varieties of annual ryegrass can be certified, but that mix may be sold under a company brand name.**

Marked with blue tags on the bag, you know what you're getting with certified seed, and, more importantly, you'll know how to terminate it when the time comes.

COVER CROP CHOICE DEPENDS ON FIELDS

Roger Bender, Ohio State University Extension ag agent, says to pick the best option for their fields, farmers will need to determine what benefits are most important in each situation.

For instance, Bender points out, legumes such as Austrian winter peas, cowpeas, chickling vetch and crimson clover can fix nitrogen in the soil for use by the following crop. Brassicas like oilseed radish can loosen compacted soil, stockpile excess nutrients and hold down winter annual weed pressure. Grasses such as tall fescue, sudangrass, rye and wheat build soil organic matter, reduce compaction and recycle excess nutrients.

Besides offering advantages to the soil, cover crops provide financial incentives. Farmers should check with local soil and water conservation districts for information on available programs.

A PRE-SELECTION NOTE ON RYEGRASS, CEREAL RYE

Today, farmers often hear about annual ryegrass and cereal rye grain as popular cover crop choices. It's important to know the differences of each of these cover crops. Annual ryegrass is a versatile cover crop choice that will protect the soil, reduce soybean cyst nematode populations and hold nitrogen through the winter. Annual ryegrass – which is often referred to as "ryegrass" – has about 33% more roots than cereal rye and provides higher quality feed than cereal rye grain.

Annual ryegrass is lighter than cereal rye grain and farmers and custom applicators using high clearance, drills, spreaders for dry fertilizer

and airplanes can seed more acres before having to refill than if they choose cereal rye.

Annual ryegrass needs to be seeded in August into early and mid-September, depending on location and the weather, while cereal rye grain can be seeded later in the fall, often into October. That, of course, also depends on the weather and location.

Those who have grown annual ryegrass for some time say it can be controlled, but it takes careful attention to detail, spraying at the right time, often morning to mid-day, and not skimping on rates. Then it takes follow-up to make sure plants are dead. If not, they may begin the process of turning into weeds in crops where they are not wanted.

GRASSES

Annual/Italian Ryegrass

Annual ryegrass, also called Italian ryegrass, is a utility grass with a dense, deep penetrating root system. The extensive root system of this cover crop tolerates compacted soils and makes it an effective catch crop for excess nitrogen. It offers many benefits, including erosion control. This is not a crop with a shallow root system. Plant in fall as a winter cover or as a nurse crop for clover.

Reed Canarygrass

Reed canarygrass is a cool season perennial that forms clumps of sod. It can spread by seed or rhizomes. It is used for erosion control and is excellent at stabilizing waterways and the shorelines of ponds. However, it must be used in contained sites due to its invasiveness. Cultivars of variegated reed canarygrass have been selected for use as ornamentals. Prepare a firm and level seed bed. Avoid planting during hot summer weather. Plan ahead for the invasive nature of this cover crop, considering both containment and ultimate control. Reed canarygrass can out-compete native grasses in wetland habitats.

Birdsfoot Trefoil

Birdsfoot trefoil is a perennial that adapts well to production on poorly drained, low-pH soils. Producing high-quality forage for cattle and sheep has traditionally been difficult on marginal lands in Pennsylvania and New York. Birdsfoot trefoil is a forage legume that is more tolerant of these adverse production conditions. It can reseed itself, is resistant to Phytophthora root rot and numerous alfalfa insects, responds well to fertilization, and does not cause bloat in animals. As a result, it is being grown more often in the northern United States and southern Canada, where production of other forage legumes is limited.

Kentucky Bluegrass

Most varieties of Kentucky bluegrass have been developed for use in lawns. Therefore, it is widely considered to be the most important lawn grass in the United States. Only three forage-type Kentucky bluegrass varieties, 'Park', 'Troy', and 'Ginger', have been released in the past 45 years. Turf-type varieties of Kentucky bluegrass need dethatching to remain productive and, in general, also require greater amounts of nitrogen fertilization and more extensive irrigation systems than forage-type varieties.

Forage Chicory

Chicory produces leafy growth which is higher in nutritive and mineral content (if managed properly) than is produced by alfalfa or cool-season grasses. It has a relatively deep taproot which provides for tolerance to drought conditions. Chicory provides both spring and summer forage with average growth rates from April through October of 50 pounds per acre per day. Forage chicory is a deep-rooted plant which grows best on fertile, well-drained soils. It will provide spring and summer growth which can supplement the grazing season during the traditional “summer slump” of the cool-season forage species.

Tall Fescue

Tall fescue is a deep-rooted, long-lived, sod-forming grass that spreads by short underground stems called rhizomes. In some areas, it has been used primarily for conservation purposes but is well suited as hay, silage, or pasture. Tall fescue is drought resistant and maintains itself under rather limited fertility conditions. It is also ideal for waterways, ditch and pond banks, and farm lots and lanes. It is the best grass for areas of heavy livestock and machinery traffic. Tall fescue can be part of a forage program, but it should not be the only species in the program.

Smooth Bromegrass

Smooth bromegrass is a leafy, sod-forming perennial grass that is best suited for hay or early spring pasture. It is deep-rooted and spreads by underground rhizomes. It matures somewhat later in the spring than orchardgrass and makes less summer growth than orchardgrass. Smooth bromegrass is the most widely used cool-season grass in North America. It is grown extensively in Canada and the north-central United States. Smooth bromegrass survives periods of drought and extremes in temperature.

Barley

Inexpensive and easy to grow, barley provides exceptional erosion control and weed suppression in semi-arid regions and in light soils. It also can fill short rotation niches or serve as a topsoil- protecting crop during droughty conditions in any region. Barley prefers cool, dry growing areas. As a spring cover crop, it can be grown farther north than any other cereal grain, largely because of its short growing period. It also can produce more biomass in a shorter time than any other cereal crop

Proso Millet

The major uses of proso millet are as a component of grain mixes for parakeets, canaries, finches, lovebirds, cockatiels and wild birds and as feed for cattle, sheep, hogs and poultry. Millet for birdfeed purposes is often grown under contract. Proso millet as livestock feed is similar to oats and barley in feeding value. It is commonly fed in ground form to cattle, sheep, and hogs. Whole seed can be fed to poultry.

German/Foxtail Millet

German or foxtail millet is an annual warm season grass that matures quickly in the hot summer months. It is one of the oldest of cultivated crops. Although German millet has a fairly low water requirement, it doesn't recover easily after a drought because of its shallow root system. Foxtail millet should not be fed to horses as the only source of

roughage since it acts as a laxative. If foxtail millet has been severely stressed it may accumulate nitrate at levels toxic for livestock. Several landraces of foxtail millet have been developed over time and include what is called Common, Siberian, Hungarian, and German Foxtail.

Pearl Millet

Pearl millet is a tall summer annual bunchgrass that grows 4 to 12 ft. tall. It is also often referred to as cattail millet because its long dense spike-like inflorescences resemble cattails. In studies in North Carolina, pearl millet was not as readily killed by mechanical methods (mowing and undercutting) as German or Japanese millet.

Oats

Oats provide quick, weed-suppressing biomass, take up excess soil nutrients and can improve the productivity of legumes when planted in mixtures. Stands generally fare poorly in hot, dry weather. This small grain is not particularly winter hardy. Spring-planted oats are used for green manure, while fall-planted oats provide winter-killed ground cover. Seed this cover crop in April for green manure, mid-August-September for winter cover. The root systems of oats are not effective at breaking up compacted soils.

Rye/Cereal Rye Grain

The hardiest of cereals, rye can be seeded later in fall than other cover crops and still provide considerable dry matter, an extensive soil-holding root system, significant reduction of nitrate leaching and exceptional weed suppression. Inexpensive and easy to establish, rye out performs all other cover crops on infertile, sandy or acidic soil or on poorly prepared land. It is widely adapted, but grows best in cool, temperate zones. The crop prefers well-drained soils but will tolerate heavy clays and acid soils.

Sorghum/Sudangrass

Sorghum-sudangrass hybrids are unrivaled for adding organic matter to worn-out soils. These tall, fast-growing, heat-loving summer annual grasses can smother weeds, suppress some nematode species and penetrate compacted subsoil if mowed once. These grasses are the most heat and drought- tolerant cover crops typically grown in the Northeast. Sudangrass growth is easier to manage because the stems are narrower, it can be sown earlier than sorghum-sudangrass, and suppresses weeds better.

Teff

Teff, the staple grain crop in Ethiopia, is a warm-season grass useful for suppressing weeds with a high plant population. Teff also produces a fine plant structure that doesn't leave soil clumpy for the next crop. Although buckwheat and sudangrass are the most common cover crop choices in the summer, teff holds some advantages over them. Teff tolerates dry conditions better than buckwheat or sudangrass. It also requires less maintenance. Teff is used to make high-quality hay. One cutting can be taken in late summer.

Triticale

Triticale is a crop species resulting from a plant breeder's cross between wheat and rye. The name triticale combines the scientific names of the two genera involved. They are winter-hardy and are often

found in rotation schedules with vegetable crops to prevent winter soil erosion. These small grains are good for reducing root rot in vegetables. In the spring, wheat, spelt and triticale grow more slowly than rye and are therefore easier to incorporate. Triticale's primary advantage over wheat and triticale is that it can be sown earlier to produce more fall growth. Triticale can be sown before the Hessian fly-free date.

Wheat

Although typically grown as a cash grain, winter wheat can provide most of the cover crop benefits of other cereal crops, as well as a grazing option prior to spring tiller elongation. It is less likely than barley or rye to become a weed and is easier to kill. Whether grown as a cover crop or for grain, winter wheat adds rotation options for underseeding a legume (such as red clover or sweet-clover) for forage or nitrogen. It works well in no-till or reduced-tillage systems, and for weed control in potatoes grown with irrigation in semiarid regions.

LEGUMES

Alfalfa

Mature plants may have from 5 to 25 stems with a height ranging from 24 to 36 inches. Varieties that can form new stems from rhizomes may be superior for living mulch systems because they can spread short distances to cover the soil after the grain crop has been harvested. Alfalfa yield may be higher than other forage legumes if the living mulch is grazed or mechanically harvested in the spring prior to crop planting. On the contrary, alfalfa may compete more for water and light than other less competitive species.

Austrian Winter Peas

Austrian winter pea can be grown alone or mixed with cereal rye, and can be planted successfully during September in the Puget Sound area. It is a poor competitor against winter weeds, and weed competition can choke out Austrian winter pea during mild winters. Gardeners who raise animals can graze them on the Austrian winter pea before turning the crop into the soil.

Crimson Clover

Crimson clover also starts growth slowly, and performs best if planted in late August or early September. October planting dates are successful in milder climates. Crimson clover does not compete as well with the cereals, and is often grown alone or with annual ryegrass. It is easier to turn under and less likely to become a weed than the vetches. Crimson provides a good source of nitrogen.

Fava Bean

Fava bean is a good legume for October plantings because it grows

faster during the fall and winter than the other legumes. If planted too early, excess fall growth will reduce crop hardiness, increasing the risk of winterkill. Fava beans can be grown alone or mixed with cereal grains. Seed may be difficult to find.

Berseem Clover

A fast-growing summer annual, berseem clover can produce up to eight tons of forage under irrigation. It is a heavy N producer and the least winter hardy of all true annual clovers. This makes it an ideal winterkilled cover before corn or other nitrogen-demanding crops in Corn Belt rotations. As a winter annual in California, irrigation usually is needed to allow berseem to achieve its full potential. Its peak growth period during the West Coast's rainy season and its highly efficient water use compare favorably to alfalfa as a high-producing forage and green manure.

Field Peas

Field peas are used in spring plantings as a source of organic matter and nitrogen, which improve overall soil health. Peas are a modest nitrogen-fixer on vegetable ground, but are the only choice in spring. In late summer, peas can be interseeded with oats to provide ground cover over the winter.

Hairy Vetch

Hairy vetch is hardy enough to survive most winters and can add significant amounts of nitrogen to the soil if allowed to grow long enough. Hairy vetch performs poorly on compacted soils. Do not use in rotation with small grain because the hard seed of vetch will germinate in later years and contaminate the grain. Hairy vetch is slow to establish and often needs a nurse crop. Wait a minimum of three years before another legume crop is planted because hairy vetch supports root rot and lesion nematodes.

Kura Clover

Kura clover is a long-lived rhizomatous plant, although seedling vigor is poor. Once established, kura clover is persistent and can survive extreme environmental conditions (drought, short-term flooding, cold). Spring and late summer are the best times for kura clover seeding. Kura clover has high protein and low fiber content so bloat is a serious concern when grown in pure stands for grazing.

Medics

Medic is an annual legume crop that is well adapted to alkaline soils. They are considered drought tolerant and are adapted to areas where annual rainfall is as low as 12 inches. Medics can provide ground cover that will meet farm program residue compliance regulations, protect the soil from erosion, provide additional seasonal grazing for livestock, or be used as a hay crop.

Mungbean

Mungbean seeds are sprouted for fresh use or canned for shipment to restaurants. Sprouts are high in protein, calcium, phosphorus and certain vitamins. Because they are easily digested they replace scarce animal protein in human diets in tropical areas of the world. Self-pollination occurs so insect and wind are not required. Mature seed colors

can be yellow, brown, mottled black or green, depending upon variety. They do poorly on heavy clay soils with poor drainage.

Red Clover

Medium red clover is a widely grown legume for both forage and soil cover purposes. As temporary soil cover it is equal but not superior to medium red clover. Medium red clover is a short-lived perennial used to supply nitrogen. Unlike other legumes, it fixes a lot of nitrogen even in high-nitrogen soils. Mow medium red clover during the summer of the first year. It can be seeded between established rows, reducing soil compaction in well-traveled areas.

Cowpea

Other common names for this plant include blackeye, crowder, and southern pea. Cowpea is a fast growing, summer cover crop that is adapted to a wide range of soil conditions. Having a taproot that can obtain moisture from deep in the soil profile, it does well in droughty conditions. Vigorous cowpea varieties compete well against weeds.

Soybean

Soybean is one of the best economic choices for a summer legume cover crop. It is an erect, bushy plant that grows 2 to 4 ft tall, establishes quickly, and competes well with weeds. When grown as a green-manure crop, late maturing varieties usually give the highest biomass yield and fix the most nitrogen. Some new viney forage are available or are being developed that have the potential to produce more biomass than traditional soybean varieties.

Velvetbean

Velvetbean is a vigorously growing, warm-season annual legume native to the tropics but well adapted to southern conditions. It performs well in sandy and infertile soils. Velvetbean is an excellent green manure crop, producing high amounts of biomass that decomposes readily to provide N for subsequent crops.

Sunn Hemp

Sunn Hemp is a tall, herbaceous, warm-season annual legume that has been used extensively for soil improvement and green manuring in the tropics. It can tolerate poor, sandy, droughty soils but requires good drainage. While forage of some Crotalaria species is toxic to animals, Sunn Hemp forage is not. Sunn Hemp should also not to be confused with the weed species, and some regions do not have growing seasons long enough for Sunn Hemp.

Subterranean Clover

Subterranean clovers offer a range of lowgrowing, self-reseeding legumes with high N contribution, excellent weed suppression and strong persistence in orchards and pastures. Fall-planted subclovers thrive in Mediterranean conditions of mild, moist winters and dry summers on soils of low to moderate fertility, and from moderately acidic to slightly alkaline pH. Seeded with perennial ryegrass, tall fescue or orchardgrass, subclovers add feed value as they improve productivity of the grasses by fixing nitrogen. In California, subclover is used in pasture mixtures on non-irrigated hills. Perennial ryegrass is preferred for pasture through early summer, especially for sheep.

Sweetclover

Yellow and white biennial sweetclover are the important strains of sweetclover. In general, the adaptations and uses of biennial yellow and biennial white sweetclover are the same. Yellow sweetclover has much greater ability to establish itself in dry seasons and on dry seedbeds than white sweetclover. Sweetclover should be seeded during the early spring months. Use red clover or alfalfa on land destined for future production of animal hay as sweetclover forage is not desirable for animal feeding.

White Clover

Although variety and management affect root distribution, the majority of white clover roots are located in the upper 8 inches of the soil profile. White clover is usually divided into three types, small, intermediate, and large. The latter two types are usually seeded from improved commercial seed. It is often used in high traffic areas to minimize soil compaction and improve soil health. White clover tolerates wet conditions.

Woollypod Vetch

Specialty vetches such as woollypod and purple vetch are faster growing alternatives to hairy. Requiring little or no irrigation as a winter cover in these areas, they provide dependable, abundant N and organic matter, as well as excellent weed suppression. Many growers of high-value crops in California rely on one or more vetch species as a self-reseeding cover crop, beneficial insect habitat and mulch. It is a good choice as an overwintering cover before or after tomato crops. Woollypod does well on many soil types—even poor, sandy soil—and tolerates moderately acidic to moderately alkaline conditions.

BRASSICAS

Black Mustard

Brassica and mustard cover crops are known for their rapid fall growth, great biomass production and nutrient scavenging ability. Most Brassica species release chemical compounds that may be toxic to soil borne pathogens and pests, such as nematodes, fungi and some weeds. There is also growing interest in their use in row crop production, primarily for nutrient capture, nematode trapping, and biotoxic or biofumigation activity.

Brown Mustard

Mustard is a name that is applied to many different botanical species, including white or yellow mustard brown or Indian mustard—sometimes erroneously referred to as canola—and black mustard. In Washington, a wheat/mustard-potato system shows promise for reducing or eliminating the soil fumigant metam sodium.

Spring Mustard

In the Northeast, yellow mustard is used as a spring-planted cover crop before regular season vegetables. It is used particularly for reducing root rot. It also adds organic matter, breaks up hardpan, and suppresses weeds in the following crop. After seeding, roll the ground to improve seed-to-soil contact but do not break up soil aggregates.

Fall Mustard

In the Northeast, mustard is used as a fall-planted cover crop that winter-kills. This crop thrives in the cool conditions of fall and can give 100% ground cover. It adds organic matter, breaks up hardpan, and suppresses weeds in the following crop. Use for disease control after onions and lettuce on the muck. Mustards attract flea beetles and diamond-back moths, but the risk is lowest in the fall.

Kale

Kale provides a strong, winter hardy crop with the potential to provide cover for two years. Like all brassicas it's very hungry and needs a lot of fertilizer so is not ideal for set aside where you can't use artificial nutrients. Most seed merchants now treat the seed to protect against flea beetle.

Forage Radish

The true radish or forage radish does not exist in the wild and has only been known as a cultivated species since ancient times. Cultivars developed for high forage biomass or high oilseed yield are also useful for cover crop purposes. Common types include oilseed and forage radish. Drilling gives a much better stand, so broadcasting should be reserved for when the soil is too wet to drill. After seeding, roll the ground to improve seed-to-soil contact but do not break up soil aggregates.

Arugula

Arugula is a fall-seeded, overwintering Brassica. It is useful for suppressing weeds and minimizing surface compaction. Arugula provides less ground cover but more biofumigation potenial than turnips or rape. When using conventional tillage, control the first flush of weeds before seeding to ensure a weed-free seedbed. Roll after seeding to improve seed-to-soil contact but do not break up aggregates. Arugula is reported to reduce the populations of Northern root knot nematodes on tomatoes.

Rapeseed

Rapeseed is used as industrial oil, but besides its use as an oil crop, these species are also used for forage. Rapeseed has been shown to have biological activity against plant parasitic nematodes as well as weeds.

Turnip

Turnips are used for human and animal food because of their edible root. Turnip has been shown to alleviate soil compaction. While they usually do not produce as much biomass as other brassicas, they provide many macrochannels that facilitate water infiltration. Turnips grow quickly and are good at reducing surface compaction while providing winter cover and fall weed suppression.

Winter Canoloa

Canola is a cool-season crop, adapted to long, wet, cool springs. It performs best on well-drained, deep silt loam soils. Canola varieties have been developed as both spring and winter types. Spring types are somewhat sensitive to high temperatures during the summer and are best adapted to cooler regions.

OTHER NON-LEGUME BROAD LEAVES

Buckwheat

Buckwheat is the speedy short-season cover crop. Buckwheat is not particularly drought tolerant, and readily wilts under hot, dry conditions. Its short growing season may allow it to avoid droughts, however. Buckwheat is a short season annual with a delicate, fibrous root system. Since it establishes quickly, it is useful for weed suppression. It also mellows the soil while improving aggregate stability. Classic uses include ground cover after early vegetables, cover before planting strawberry beds, and bringing idle land into production.

Flax

Flax is an alternative cash crop, especially in areas of Wisconsin and Minnesota where allocated acreages for other cash crops are limited or where other crops are not adapted. At one time the flax acreage was concentrated on the clay soils in eastern Wisconsin. However, flax is adapted and has been successfully grown in other areas of the state. In Minnesota, flax acreage is concentrated in the northwestern part, however flax has been grown successfully in nearly all counties.

Marigolds

Marigold is not only grown as an ornamental, cut flower, and landscape plant, but also as a source of pigment for poultry feed. The pigment is added to intensify the yellow color of egg yolks and broiler skin. Finely ground blossom meal, often enriched with an extract, or the extract itself, usually saponified for better absorption, is added to the feed. Marigolds are grown for this purpose in various locations in the western hemisphere, primarily in Mexico and Peru, by and for various companies who produce feed additives.

COVER CROPS GO OUT IN DIFFERENT WAYS: AERIAL VS BROADCAST

The biggest post-harvest activity this fall is likely seeding cover crops.

PLANTING TECHNIQUES

On his farm in Pierceton, Ind., farmer Jamie Scott says aerial seeding can do amazing things. Scott typically drills as much as he can, which is about 200-400 acres, but as the clock ticks down, he calls in for air support. Establishing the cover crop by October is paramount, he notes.

Depending on the size and type of seed being planted, planes can carry enough seed to plant 12 to 100 acres each trip. Helicopters carry smaller loads but can land and reload closer to the planting site. A nearby grassy summit can be used as opposed to flying back to a runway.

The trips to and from the runway and the turns across the field while planting all influence the price per acre; the plane needs about a half-mile to turn around.

Some cover crops are applied aerially or with specially modified spray rigs into standing corn and soybeans. Others are being broadcast as the combine goes through the field with a seeder mounted on either the corn platform or the grain header.

Some farmers have a good crop of annual ryegrass already growing from seeding it off the corn head and under the residue in early September. Seeding cover crops this way is considered broadcasting.

Still others are doing light tillage after corn or soybean harvest. Then they are seeding cover crops. In at least one case, the farmer is seeding cover crops from a vertical tillage tool. He has the seeder rigged up to seed the cover crop and work it in lightly with the vertical tillage tool and trailing basket.

This particular farmer has tried cereal rye, but he has also tried other mixes, including a blend of oats and forage radishes.

AERIAL IS COST-COMPETITIVE

Cost of aerial seeding is competitive with the cost of drilling or broadcasting the seed on the ground. For example, two aerial applicators, one from Wells, Minn., and the other from Ankeny, Iowa, quoted a range of $8.50 to $12 per acre. They recommend using 50-pound seed bags for hand loading at the runway.

Final price is determined by the number of total acres being planted, location to a runway, runway size and type of seed being planted.

Keep soil moisture in mind if you are planning to fly-on the seed – seeding a cover crop in very dry fields is risky.

SOME COVER CROPS GOT AN EARLY START

One Indiana farmer who used aerial application in some cases to get cover crops started earlier in standing corn says he has good results with aerial applicators.

He seeded 20 pounds per acre of crimson clover, annual ryegrass and radishes into different corn fields over a period of a week or more. The earlier the seeding occurs, the quicker the start for the cover crops. A quick start is important so that there is enough growth to protect the soil and help the cover crop make it through the winter, or get big enough to get some rooting depth into the soil in the case of crops that don't survive the winter.

This farmer says he probably could have applied only 15 pounds if he was making a ground application, but he's happy with the results from the aerial application. He applied a mix of about 50% annual ryegrass, 30% crimson clover and 30% forage radishes.

COVER CROP SEEDING OPTIONS YOU CAN CONSIDER:

1. If you've already flown on your cover crop, then following fall harvest you should observe the soil-to-seed contact. Where that needs to be improved, and where it is appropriate, you can pack or roll the seed to push it into the soil. That will improve soil-to-seed contact. Then hope for rainfall to sustain growth.

2. If you are planning to overseed using an airplane or highboy and you have a shorter season corn hybrid or soybean variety to harvest first, you might want to wait to no-till drill the cover crop seed into the ground following grain harvest. That will improve soil-to-seed contact. To save soil moisture, do not disturb the soil and just plant the cover crop seed directly.

3. If you are planning to overseed using an airplane or highboy and have a while until grain harvest happens (one month or more) then timing with moisture will be critical. If rain is in the forecast, then fly the cover crops on. Or, if your fields already have enough soil moisture, then go ahead and fly the cover crop seed on. However, if you are very dry (no rain since sometime in July) and there is not any rainfall in the forecast, then re-think flying the cover crop seed on. If you can irrigate, then the problem is solved and you should plan to do that.

4. If you will be planting the cover crop after grain harvest this fall--and your soil is dry and only limited rainfall is in the forecast---DO NOT till the soil before planting the cover crop seed. By drilling the seed directly you will improve the chances of cover crop establishment by saving any soil moisture there is in the top couple inches of the soil.

BEST TIME TO PLANT COVER CROPS

To be successful, several farmers and researchers have concluded that planting must coincide with moist conditions or rainfall. Agronomist Tom Kaspar at the USDA National Laboratory for Agriculture and the Environment at Ames, Iowa, suggests planting in late August for aerial seeding into standing soybeans, and mid-to-late September for aerial seeding into standing corn.

“You should seed legumes a couple weeks earlier because they are small-seeded and need more time to establish before a hard freeze,” says Kaspar.

WHAT IF A COVER CROP IS PLANTED, BUT DOESN'T GERMINATE?

Sarah Carlson, research and policy director for Practical Farmers of Iowa, says if your cover crop seed (winter rye, winter wheat and usually hairy vetch) does not germinate this fall, you will have unprotected soils this fall and winter but these seeds can still germinate in the spring right after snowmelt and provide soil protection during spring rains. “The goal is to have a cover crop in the fall and the spring but sometimes Mother Nature changes our plans and we must be patient,” notes Carlson.

Despite the benefits of cover crops, there are still some challenges growers face in incorporating them into their no-till system. A few include finding available seed, crucial timing of planting cover crops following wheat, planning ahead for planting cover crops, and knowing the right cover crops combination.

So what works best? In a corn/soybean/wheat rotation, harvest corn in the fall, plant cereal rye over the winter and roll it over in May in preparation for soybean planting. Cereal rye helps control weeds. After soybean harvest grow wheat, then plant another cover crop following wheat, such as winter pea or cow pea.

ADD GRAZING AND ADDITIONAL FORAGE WITH COVER CROPS

Looking to cut feed costs? Turn livestock out on cover crops in the fall, or harvest for feedstuffs.

Cover crops can provide yet another benefit – extend the grazing season and reduce the need for stored forages, or free up pastures to increase rest periods or make more hay. There are many different strategies of how farmers are doing this.

Wade Dooley, farming near Albion in central Iowa, has grazed winter wheat and winter rye in the past. He seeded 20 acres of winter rye following corn silage, seeding the rye in mid-September. And 30 acres of winter wheat were broadcast-seeded with a highboy into standing soybeans at the leaf yellowing stage — also in mid-September.

In November, 65 head of cow-calf pairs (1,200- to 1,500-pound cows) and four bulls were put into the rye, plus 70 additional acres of cornstalks. The calves were weaned, and the bulls were removed after Thanksgiving. The rye and cornstalks were grazed for one month with corn silage, but no additional feed was provided. The cows were then moved into the winter wheat, and half a day later it snowed. The cows were fed hay and corn silage in this field the remainder of winter.

GRAZE WHEAT, RYE IN SPRING

As soon as the snow melted, the wheat (which had been insulated under the snow), started growing and the cows started grazing it. They grazed the wheat until the rye was 6 inches tall. They then moved to the rye and adjoining 70 acres of cornstalks with no cover crop, until the rye had been eaten down.

Dooley then moved the cows back to the winter wheat field to allow the rye to grow back again. He rotated the cows back and forth between the rye and the wheat three times a month for two months, after which the rye regrowth no longer seemed to be palatable to the cows. The winter rye field was planted to soybeans and the winter wheat field was planted to corn.

For the first time, Dooley had extra hay in the spring. That's because he fed no hay in the fall and reduced hay feeding in spring when the cows were grazing cover crops.

During the spring grazing, he fed the cows the same as he normally would: corn silage and hay as needed. But he moved to every-other-day corn silage feeding earlier than he normally would have, as the cows did not seem as hungry. They also ate considerably less hay than usual. The only difference was he added the cover crop as a feed source.

PRACTICE PAYS OFF IN SEVERAL WAYS

Dooley says this saves on feed costs, keeps cows cleaner during mud season (with no bedding cost) and spreads out the manure nutrients with no labor or fuel needed.

Another advantage, Dooley notes, is fields with cover crops held up under the weight of a manure spreader, while the spreader sank in wet fields with no cover crops, forming huge ruts.

This could be a function of two things: The plants were actively taking up water, leaving the soil drier, and the living plants and roots provided better soil structure to support weight. This could help dry out the soil for planting in wet springs, but it could also become a problem in areas and years when water is scarce.

WHAT ABOUT FALL GRAZING?

Another farmer who grazes winter rye is George Schaefer, who farms with his brother Steve at Kalona in southeast Iowa. In the past they have drilled rye following corn harvest, but the fall of 2009 they had the rye aerial-seeded into standing corn as part of a Practical Farmers of Iowa and Iowa Learning Farm research project, comparing side-by-side treatments of a winter rye cover crop and no cover crop.

If the rye gets significant fall growth, they will graze it in the fall along with cornstalks. In the spring they graze the rye when it gets about a foot tall (assuming the field is in a location that can be grazed). This spring they grazed rye for about a month.

The Schaefers warn that if you are replacing spring pasture with rye grazing, some of the pastures should be hayed for the grass to not get overly mature by the time you get to grazing it in your rotation. This was especially a problem this spring with all the moisture their farm received (18 inches in June), as the mature grass, which did not get mowed, got trampled on the ground, retarding regrowth. This is also an advantage, though, to either make more hay in the spring or give pastures more rest.

PREPARE FIELDS FOR PLANTING

The brothers also say any cover crop fields that get grazed must be tilled before planting corn or soybeans, as the field will have hoof marks that make it difficult to get a good no-till stand. On the Schaefers' organic fields, this is especially true, as grazing the cover crops would delay the time until boot stage, when they would be able to shred the cover crop before organic no-till beans.

Cover crops such as rye can also be harvested and stored as forage if fencing is lacking or the location makes the field unsuitable for grazing. The brothers did this on some fields this year. Ideally, the rye should be harvested in the flag leaf to flowering stage, but waiting for this stage in the spring could delay planting of the main cash crop, such as corn or beans. Perhaps planting a shorter-season corn following harvest of the rye forage would work, says George.

MULTIPLE-SPECIES COVER CROPS AND GRAZING PROFITABILITY

Near Bismarck, North Dakota, Richter Farms compared these three cropping systems:

- a multispecies cover crop, grazed and planted to corn
- manure applied to land with no cover crop and then planted to corn
- land with no manure or cover crop planted to corn

The short story is the cover-crops grazing-corn system netted $62 per acre for the corn alone, the manure-corn system netted $50 per acre for the corn alone, and the straight corn system netted $14 per acre for the corn alone.

Add to the cover-crops system $66 net income from grazing, and that method really begins to shine.

That doesn't include uncalculated values for gains such as increased recovery time from grazing on native rangeland or improved soil health, says Jay Fuhrer, district conservationist for Burleigh County, North Dakota, where the Richters farm. Fuhrer has helped farmers in the area account for the value of cover crops and grazing management for many years now.

In addition to showing an economic advantage for the multispecies cover crops, the demonstration showed no significant difference in soil moisture in May following the cover crop. Measurements on the ground without a cover crop showed it held 3.11 inches of moisture, while the ground where a cover crop had been grown and grazed held 3.07 inches of moisture in the top 4 feet of soil. This can be important anywhere, but especially in a 15-inch annual rainfall zone like the Bismarck area.

One advantage for the cover crop system is it required one herbicide application versus two after peas in the other systems, saving $12 per acre on the 2007 corn crop.

Yields and test weights on the corn crops were similar. The manure field had the highest yield at 87 bushels and a test weight of 55.5 pounds. The cover crop field had a yield of 83 bushels and a test weight of 56.5 pounds. The conventional field had a yield of 74 bushels and a test weight of 55.5 pounds. All income figures were based on a then-average corn price of $3.50 per bushel.

In 2008, the cover-crop system again showed an advantage in herbicide usage per acre. For corn, that system only used $32, with applications in May and June.

The other two systems needed a third application in July, increasing their herbicide costs to $48. All three systems used $51 in commercial fertilizer and $33 in seed costs. Otherwise, except for $12.50 in manure application costs, the budgets were the same.

The only other difference was the amount of nitrogen remaining in the soil after corn harvest. November 2008 soil tests showed 61 pounds of nitrate remained in the soil on the cover-crop ground, versus 27 pounds of nitrate on the ground that had no cover crop and no manure application.

Fuhrer and the Richters calculated the grazing advantage for 141 stocker calves with an in-weight of 580 pounds, an average gain of 52 pounds per calf and an average daily gain of 3.1 pounds per day. They used the sale price of $1.09 as the gross value of gain and calculated a per-acre gross income of $111. Then they subtracted the actual costs for seed, planting and herbicide, which were $45 per acre, to get their $66 net profit figure for grazing value.

The multispecies cover crop used in the Richter Farms demonstration was typical of mixtures used by these progressive growers in the Northern Plains.

It included a mixture of warm-season grass, warm-season broadleaf and cool-season broadleaf. Often their mixtures also include a cool-season grass.

- Millet, 8 pounds — warm-season grass
- Cowpea, 10 pounds — warm-season broadleaf
- Soybean, 15 pounds — warm-season broadleaf
- Turnip, 0.5 pound — cool-season broadleaf
- Oilseed radish, 1 pound — cool-season broadleaf
- Sunflower, 1 pound — warm-season broadleaf
- Sweet clover, 1 pound — warm-season broadleaf

CUT FEED COSTS

Cover crops are quality fall forage option because they remain palatable and protein rich long after the first freeze, says Eric Mousel, cover crop and alfalfa specialist with Millborn Seeds.

"The right cover crop mixture can provide cattle with as much as 22% protein. Cover crops are also much more palatable than mature grasses because they do not produce nearly the amount of cellulose that grass does," Mousel said. "Cellulose takes a long time to break down in the rumen. As grasses mature this time of year the amount of cellulose in the stem increases, decreasing the available nutrients in the plant."

John Braun, Warner, S.D., began planting cover crops in prevented plant acres five years ago to help absorb additional moisture and prevent nitrogen leaching. The fact that cover crops provide his cattle with inexpensive, high quality forage in the fall is an additional benefit he says.

"Feeding them on cover crops in the fall saves us money. If you figure that it costs about $1 per head per day to feed a cow once she's off pasture, every day she's on a cover crop adds up," Braun says.

"They are such a good quality, low-cost feed. When cattle producers turn calves out on cover crops, they can expect to see weaned calves gain between 2 to 3 pounds per day," Mousel says.

On a 500-pound steer, Mousel calculates that cover crops add up to about a 25 cents cost of gain and a $1.25 profit per pound of gain. Grazing cows on cover crops is a savings of anywhere from 50 cents to $1.50 per head per day, he says.

When working with cattle producers considering cover crops as a fall forage bloat is one concern many have. Any cattle that have an abrupt change in their diet can become ill. Offering grass hay to include a higher percentage of dry matter in their diet or slowly introducing the cattle to the cover crop are both ways to minimize the risk.

TIPS FOR KILLING COVER CROPS IN THE SPRING

If grazing or harvesting isn't your top choice, kill off crops for "mulch" benefit

TIPS FOR KILLING COVER CROPS IN SPRING

How do you handle cover crop fields in the spring, so you can plant corn or soybeans in that field? Sarah Carlson, research and policy director for Practical Farmers of Iowa in Ames, provides the following answers and guidelines for cover crop management.

RECOMMENDATIONS FOR SPRING KILLING OF COVER CROPS

1. If spring conditions are dry, plan to kill the cover crop sooner than later.

2. If planting corn, kill the cover crop 8 to 10 days prior to corn planting.

3. If planting soybeans, cover crop can be killed closer to planting. Some farmers are no-till drilling soybeans into a living cover crop and then using a "burndown" 1 to 2 weeks following planting to kill the cover crop. Caution: try this new method on a few acres as you get started.

4. Herbicides are not the only method for killing a cover crop. Using cattle to graze off the cover in the spring or mowing it then followed by tillage can kill the cover crops.

5. If using tillage only, don't let the cover crop get taller than 6 inches high.

6. If using herbicides use the legal, labeled rate and pay attention to the weather conditions prior to spraying.

WILL HERBICIDE CARRYOVER HURT FALL-SEEDED COVER CROPS?

The question about whether corn or soybean herbicide programs will pose a problem for seeding fall cover crops arises again, particularly in areas of severe drought where corn is harvested earlier than normal and the desire to plant a cover/forage crop is strong. So here's a best-

guess assessment from Bill Curran and Dwight Lingenfelter, Penn State Extension weed specialists.

If you look at the rotation crop restrictions for corn and soybean herbicides in the Agronomy Guide, you'll see that many products limit rotation to alfalfa and/or clover as well as some of the small grains. This is a good place to start when thinking about rotation to fall cover crops.

However, these tables are inadequate. Cash crop rotation restrictions center concern for herbicide residues accumulating in forage or feed, not carryover injury. If the crop is not going to be harvested and consumed by livestock or humans, then the primary concern is carryover injury and achieving an acceptable stand that provides the benefits of a fall or winter cover.

While few cover crops are listed in these Agronomy Guide tables or on herbicide labels, look for close plant relatives to get an idea of how certain species may succeed. For example, there's no listing for the legume hairy vetch or the mustard daikon radish. But by looking at the alfalfa or clover restrictions or at annual mustards such as canola you can “guesstimate” which herbicides may cause potential injury to related cover crop species.

In general, products with a four month or less rotation restriction for the species of interest, close relative, or sensitive species (i.e. clovers) should pose little problem.

Corn products of concern for fall cover crops are atrazine or simazine, particularly for legumes, brassicas, or annual ryegrass. Both persist longer on higher pH soils (pH 7 or greater) or soils recently limed, so watch surface pH in particular.

Herbicides with shorter half-lives (time required for 50% of the active ingredient to dissipate) are always less of a concern. In addition, species sensitivity can play a role if only a small amount of residue is necessary to cause injury.

So, look at what herbicide programs you are using and the potential for carryover injury to fall cover crops before seeding something this fall.

TYPICAL HERBICIDE RATES, SENSITIVE SPECIES, HALF- LIFE, AND POTENTIAL FOR CARRYOVER INJURY TO SENSITIVE CROPS

(carryover potential based on half lives and soil availability).

Herbicide	Typical rate/acre	Sensitive species	Half life (days)	Carryover potential
Accent	2/3 oz	brdlfs+grass	21	Low
Assure/Targa	8 oz	grass	60	Low
Atrazine	1 lb	brdlfs+grass	60	Moderate
Authority	4 oz	brdlfs	32-302	Moderate
Balance Pro	2 fl oz	brdlfs+grass	50-120	Moderate
Callisto	6 fl oz	brdlfs	5-32	Moderate
Classic	2 oz	brdlfs	40	Moderate
Dual II Mag	1.67 pt	brdlfs+grass	15-50	Low
FirstRate	0.33 oz	brdlfs	8-33	Low
Harmony	1/8 oz	brdlfs	12	Low
Harness	2 pt	brdlfs+grass	10-20	Low
Impact	0.75 fl oz	brdlfs+grass	14	Low
Laudis	3 fl oz	brdlfs+grass	14	Low
Outlook	16 fl oz	brdlfs+grass	20	Low
Peak	1 oz	brdlfs	9-152	Moderate
Permit	2/3 oz	brdlfs	9-27	Low
Prowl H2O	3 pt	brdlfs+grass	44	Low
Pursuit	4 fl oz	brdlfs+grass	60-90	Moderate
Raptor	5 fl oz	brdlfs+grass	20-30	Low
Reflex	1.5 pt	brdlfs	100	Moderate
Resolve	2 oz	brdlfs+grass	2-4	Low
Select	10 oz	grass	3	None
Sencor	0.33 lb	brdlfs+grass	14-60	Low
Sharpen	3 fl oz	brdlfs	7-35	Low
Simazine	1 lb	brdlfs+grass	60	Moderate
Stinger	5 oz	brdlfs	40	Moderate
Valor	2.5 oz	brdlfs	12-20	Low

TERMINATION TIPS

Watching a cover crop grow to mammoth proportions in the spring can lead to a mammoth disaster, says conservation specialist Mike Plumer, who spent 34 years with the University of Illinois before retiring.

Before the burndown window nears, Plumer says the farmer needs to understand why the cover crop is there in the first place. Is the primary reason to build nitrogen levels, create root growth for bio tillage or suppress early-season weeds?

Most grass varieties max out on root growth in the first two weeks in April. “As soon as a grass joints, it's usually done with root growth,” Plumer notes.

If available N is the primary goal, the trick is waiting for the legume plants to get fairly large, but terminating it before it reaches the reproduction stage. For example, Plumer says 90% of hairy vetch's nitrogen content is in the top growth. Once hairy vetch blooms, it's reached its full N potential. After hairy vetch blooms, simply walking on it will kill the plant, so control is very easy, Plumer notes.

The further the grass plants get into the reproductive stage, the longer it takes for the nitrogen to be released in the soil, since the plant has to break down, Plumer explains. For grasses, much of the nitrogen becomes available in the vegetative stage of growth. Once the plant reaches first joint, the nitrogen becomes tied up in the plant and will release as the plant breaks down over the course of a year or longer. The same is true once legumes reach the bud stage. Waiting longer only increases the amount of time it takes for the plant to release the available N.

As a rule of thumb, Plumer says annual ryegrass typically joints at 7 to 10 inches, which can be between March 15 and April 20. When spraying hairy vetch, Plumer recommends killing it in the vegetative stage for both ease of control and nitrogen release. A week after spraying vetch, it will be brittle enough that row cleaners will shatter it rather than collec it. Plumer learned this the hard way, when he had to remove 100 pounds of vetch from the row marker after each pass.

As with typical weed control, Plumer recommends using multiple modes of action when burning down cover crops. Also, he warns a complicated blend of cover crops can mean trouble when mixing up a concoction that will control them.

Most importantly, Plumer says to spray on time. “You've got to be ready to spray no matter the condition,” Plumer adds. On his research fields, he uses an ATV sprayer. “There is no reason for a farmer to wait with an ATV sprayer,” he notes.

FINANCIAL HELP FOR FARMERS READY TO TRY COVER CROPS

Check with your local EQIP and CSP for financial assistance available to help with cover crop planting.

Farmers and landowners who usually don't utilize conservation programs have signed up for programs to facilitate the use of cover crops, especially given the new interest in cover crops for no-till programs.

The USDA Natural Resources Conservation Service, and Environmental Quality Incentives Program, commonly known as EQIP, also provide assistance for cover crops and has seen tremendous growth in recent years. In 2012, that federal program provided assistance to support cover crops on 51,635 acres in Iowa, up from 4,059 acres in 2009.

The Indiana State Department of Agriculture in 2012 also prepared a cost-share program to install cover crops. So many farmers responded that in just 24 hours, the state had to inform the local office facilitating the program to quit taking applications.

Iowa experienced similar growing interest. Iowa Secretary of Agriculture Bill Northey announced that in 2012, 117 Iowa farmers took advantage of changes that were made to the Iowa financial incentives program for soil conservation, which is commonly called state cost share, to install 4,660 acres of cover crops across the state.

Through the program Iowa provided up to $25 per acre for establishment of the cover crop. In total the department's $104,253 investment was matched by farmers and landowners in 24 different Soil and Water Conservation Districts across Iowa.

Check with your local Soil and Water Conservation District or the Natural Resources Conservation Service about current programs such as EQIP and CSP or to answer any questions and concerns.

DROUGHT YEAR BRINGS ACTION ON COVER CROP GRAZING

Though it likely won't happen every year, 2013 brought extra leniency for farmers looking to graze cover crops for increased forage.

For the 2013 crop year, USDA's Risk Management Agency intends to file special provision statements to allow haying or grazing of cover crops without impacting the insurability of planted 2013 spring crops. This flexibility will help farmers plant a cover crop without risking crop insurance coverage in 2013.

KNOW YOUR RULES FOR REPORTING AND REIMBURSEMENT

USDA's FSA reminds farmers to be up-to-date on rules and reimbursement for all seeded cover crops and forage crops.

ACREAGE REPORTING REQUIREMENTS

FSA reporting requirements for all fall seeded cover crops as well as forage crops change frequently.

In 2012, producers of perennial forage crops (grass, hay, alfalfa, and pasture) were required to submit an acreage report for those crops as well as all fall seeded wheat and other fall seeded small grains. In prior years, reports for these crops were not due to FSA until later in the spring and summer.

The latest change is part of an initiative at the national level to align acreage reporting dates between FSA and the USDA's Risk Management Agency or RMA.

All acreage must be reported for a farm, including crops on non-cropland such as hayed or grazed grassland and other cover crops. It is also important to accurately report crops' intended use. Intended use is used to determine eligibility in many FSA programs and cannot be revised once reported.

FSA often receives requests for information about how farmers and ranchers protect the soil and water resources of our nation. “Producers with cover crops or other crops which protect the soil through the winter months should be recognized for their contribution to a better environment,” says Whitaker. “When they report those crops to us we have the statistics to show this important impact.”

Producers should contact their local FSA county office if they are uncertain about reporting deadlines.

NEW RULES FOR COVER CROP REIMBURSEMENT

In recent years, farmers could receive approximately $40-$60 per acre reimbursement for planting cover crops, depending on the cover crop planted.

“There's no way the payment rate would have limited anyone from putting in a cover crop,” Illinois NRCS conservation agronomist Brett Roberts notes. The rate takes burndown and seeding into account.

Roberts says most farmers limit cover crop seed costs to $20/acre. “This is sort of the tipping point on what farmers are willing to spend on cover crops,” Roberts says.

Nationally, NRCS is implementing a different method for determining payment rates for conservation practices. Previously, payment rates were determined by each state, Roberts notes. The new method being implemented is to establish payment rates for conservation practices by region. Cover crops are part of a suite of practices that will be implemented using the new regional payment rates.

UNDERSTAND CROP INSURANCE RULES RELATED TO COVER CROPS

The Risk Management Assurance Agency, part of USDA, fielded enough questions from farmers about the influence of pasturing or harvesting cover crops on crop insurance that it issued clarification of those rules. The clarification was issued by Brian Frieden, working on behalf of RMA, and based in Springfield, Ill.

The rules are clear if you want to plant certain crops that can be insured and backed by federal crop insurance in regards to cover crops, he notes. Potential crops you could plant and cover by insurance include corn, sweet corn, popcorn, hybrid seed corn, processing pumpkins, soybeans, processing beans and grain sorghum.

If you will be planting into a field with a cover crop, first you must stop haying the cover crop growing in that field by May. You must also terminate all cover crop growth at least seven days before the final planting date for the spring crop you are planting.

Note that this refers to the final planting date recognized by USDA. Some people vary on when they kill a cover crop in relation to planting on their farm. Be sure to confirm local regulations.

For those in an area where double-cropping is a recognized practice by RMA, you may be able to plant soybeans, processing beans or grain sorghum without meeting these requirements outlined for first crops. However, there will be additional rules to follow, and premiums will be higher.

The best advice is that if you are seeding cover crops and whether you intend to graze or make hay form them next spring or not, contact your insurance agent to see how your plans line up with RMA rules about cover crops and insuring the crop that follows them. As demonstrated in 2012, the last thing you will want to do is anything that would cause you to lose crop insurance on your corn and soybean acres in 2013.

Fall-seeded cover crops are increasingly popular in the Northeast. In the past, onerous crop insurance rules limited their use. But recently made changes by USDA's Risk Management Agency give producers more flexibility, says Gene Gantz, Pennsylvania-based program coordinator for the agency.

The following changes affect producers in Connecticut, Delaware, Massachusetts, Maryland, Maine, North Carolina, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Virginia, Vermont, and West Virginia, according to Gantz. It affects farms considering fall-seeded cover crops, then planting an insured crop next spring.

If you're a producer in these states, you may insure a corn, cotton, grain sorghum, or soybean crop planted on insurable acreage and into an established small grain, grass or legume. That assumes that before your new crop's emergence, you till the cover crop to terminate it or that you treat it with a herbicide labeled for that purpose.

Following a cover crop, you may insure any spring-seeded crop such as a grain, vegetable, or organic crop. Gantz adds that good farming practices must be followed in terminating the cover crop and in the

planting your insured crop. The rules won't limit growing cover crops or their use as long as the cover crop is destroyed before the new crop emerges, he adds.

You must also meet all other policy requirements for the insured crop including planting by the final planting date or the end of the late planting period, if applicable.

As always, check with the RMA for the latest information before making planting decisions.

REMAINING THOUGHTS ON COVER CROPS

Cover crops can play an important role in maintaining and improving soil productivity.

BOTTOM LINE FOR COVER CROPS: PROFIT OR LOSS

Don and Dave Robison, farmers near Greenwood, Ind., set up an extensive test plot with checks and various combinations of cover crops in a field on their farm in 2012. Despite drought, the cover crop plots yielded typically more than 100 bushels per acre, and gave them an indication of what they could expect if they had an entire field in that cover crop mixture.

For those who have been working with cover crops for a while, it's no longer just a decision of whether or not to use cover crops, it's now a decision of which mixture will work the best. Also, which varieties should they select? Who is selling quality seed adapted to this part of the country? And how should they get the seed established?

Don recently reviewed the findings of their one-time plot this summer at a conservation meeting. The most important chart for him was the net advantage plot. Every cover crop plot, based on a yield boost, returned an advantage compared to the check, even after seed cost and cost of application or seeding were subtracted. These covers were established in the fall of 2011. Plots were harvested in 2012.

The net advantage ranged from $41.78 to $286.94 for having a cover crop on the field during the winter and growing in the spring. Robison used a price of $5.75 per bushel for corn, because he doesn't expect high prices to last in the long run, and he wanted a fair comparison for the future so that he could make decisions.

THERE IS NO ONE-SIZE-FITS-ALL SYSTEM FOR COVER CROPS

For many in corn-on-corn situations, the end result of a bad weather year is a well-below-average yield. Yet, there were stories of no-till cover-crop farms that saw hearty, 200-bushel yields during the drought of 2012. What gives?

Yield disparity is the primary reason many conventional farmers are taking a second look at cover crops. However, that yield difference may not always be there. Experts warn to not jump on the cover crop bandwagon with the expectation of a 20-bushel yield boost after one year. It's a process.

According to Pro Harvest Seeds' Doug Hanson, a Danforth, Ill., native, it's a three-year process. He advises clients to set three-year goals for a

field, and then work backwards. That means identifying the cash crop and cover crop rotation for the next three years.

“If you want to be successful with cover crops, you've got to manage them like you do your cash crops,” Hanson notes.

GLOSSARY OF TERMS

Aerial
Aerial application is an economical way that farmers can apply cover crops to fields By using aerial application or high clearance (see high clearance details below), farmers can cover large acres quickly and so before harvest. This not only minimizes having to juggle another field operation during harvest – especially for growers who apply manure to fields after harvest – but also provides the cover crop more time and more heat than by waiting until after crops are harvested in September and October.

Annual Ryegrass
Annual ryegrass, also called Italian ryegrass, is a utility grass with a dense, deep penetrating root system.

Brassicas
Any plant belonging to the genus Brassica, of the mustard family, including many economically important vegetables, as cabbage, kale, broccoli, cauliflower, turnip, and mustard.

Broadcast
Cover crops can be either planted into the summer crop by broadcast seeding or planted after harvest by drilling or broadcasting.

Burndown
To kill the annual cover crop planted

Cash Crop
Crop for direct sale in a market, as distinguished from a crop for use as livestock feed or for other purposes.

Catch Crop
A crop that reaches maturity in a relatively short time, often planted as a substitute for a crop that has failed or at a time when the ground would ordinarily lie fallow, as between the plantings of two staple crops.

Cereal Rye
Rye is a grass grown extensively as a grain and as a forage crop. It is a member of the wheat tribe and is closely related to barley and wheat.

Conservation Tillage
Any tillage and planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water. Where soil erosion by wind is the primary concern, any cropping system that maintains at least 1,000 pounds per acre of flat, small grain residue equivalent on the surface throughout the critical wind erosion period is considered conservation tillage.

Conventional Tillage
Full width tillage that disturbs the entire soil surface and is performed prior to and/or during planting. Where less than 15 percent residue covers the ground after planting, or less than 500 pounds per acre of small grain residue equivalent throughout the critical wind erosion period. Generally involves plowing or intensive (numerous) tillage trips. Weed control is accomplished with crop protection products and/or row cultivation.

Cool Season Crop
A crop that grows best during the cool temperatures of spring and fall.

Corn Belt
The area of the United States where corn is a principal cash crop, including Iowa, Indiana, most of Illinois, and parts of Kansas, Missouri, Nebraska, South Dakota, Minnesota, Ohio, and Wisconsin.

Crop Residues
Crop residues absorb energy of raindrops to reduce the soil splash. Plants and close-growing crops minimize raindrop impact as well as hold the soil together, while acting as filter. They also reduce the amount of runoff as do subsurface drainage system.

Cover Crops
Cover crops are grasses, legumes, or small grains grown between regular grain production periods for the purpose of protecting and improving the soil. For water erosion control, the winter cover crops hold the soil together until spring, helping to keep nutrients in the land and reduce run off. Cover crops also protect the land from the harsh forces of the wind.

Drilled
Planted with a grain drill. Grain drills differ from row crop planters in that they do not meter individual seeds, but drop small groups of seed in a process referred to as bulk metering. Drills plant crops in closely spaced rows (typically seven to 10 inches on center) that will not be mechanically cultivated.

Erosion
Erosion is a selective process, removing the fine silt, clay, and organic matter at a much faster rate than coarser sands. This can result in poorer soil tillage and lower nutrient and water-holding capacity if nothing is done about the situation.

Flowering
This is the stage when the crop starts flowering. In corn, tassel emergence and pollen shedding takes place at this stage. Two to three days after pollen shedding, silk emergence takes place. At this stage, typically occurs 51-56 days after planting the corn seed, pollination between silks (female) and tassels (male) takes place.

Forage Crop
Annual or perennial crops grown primarily to provide feed for livestock. During harvesting operations, most of the above ground portion of the plant is removed from the field and processed for later feeding.

Grazing
Any vegetated land that is grazed or that has the potential to be grazed by animals.

Green Manure
A crop of growing plants, as clover and other nitrogen-fixing plants, plowed under to enrich the soil.

Grass
Any plant of the family Gramineae, having jointed stems, sheathing leaves, and seedlike grains.

Ground Cover
Any of a variety of low-growing or trailing plants used to cover the ground.

Ground Water
The water under the surface of the earth that is found within the pore spaces and cracks between the particles of soil, sand, gravel and bedrock.

Gully Erosion
They are formed when channel development has progressed to the point where the gully is too wide and too deep to be tilled across. These channels carry large amounts of water after rains and deposit eroded material at the foot of the gully. They disfigure landscape and make land unfit for growing crops.

Hay
The product of any of a variety of perennial crops, typically grasses or legumes, that can be used a feed for ruminant animals.

Heading
The stage in which the plant's flower (seed) head pushes its way through the flag leaf collar.

High clearance
A method of successfully seeding cover crops like annual ryegrass and annual ryegrass-crimson clover mixes into standing corn and soybean crops late in the summer. farmers and custom seeders often use high-clearance, self-propelled sprayers that they have modified to seed the cover crop down in between the rows. High clearance cover crop seeding enables farmers to cover large acres quickly and to seed cover crops when there is plenty of sun and time for the seeds to germinate and to establish. this can result in betters stands with deeper roots than by waiting until late September to drill cover crops.

Leach
The downward transport of dissolved or suspended minerals, fertilizers, pesticides and other substances by water percolating through the soil.

Legumes
Legumes are plants or crops such as soybeans, alfalfa, and clover that are high in nitrogen production and are helpful when replenishing the soil and improving its ability to prevent eventual soil erosion.

Loam
Loam is an easily crumbled soil that consists of a varying mixture of clay, silt, and sand.

Mulch
Mulch is a type of protective covering such as sawdust, compost, burlap, shredded wood or paper strips used on the ground to reduce water evaporation, control weeds and enrich the soil. It is also very important in preventing water erosion in newly formed waterways and other areas where vegetation still has not had enough time to establish itself. The mulch intercepts the erosive forces of raindrops, thus reducing erosion until the seeding produces its own protective cover.

Mulch Tillage
Full-width tillage involving one or more tillage trips which disturbs all of the soil surface and is done prior to and/or during planting. Tillage tools such as chisels, field cultivators, disks, sweeps or blades are used. Weed control is accomplished with crop protection products and/or cultivation.

Nematodes
Unsegmented worms with elongated rounded body pointed at both ends; mostly free-living but some are parasitic.

No-Tillage
Crop production system in which the soil is left undisturbed from harvest to planting. At the time of planting, a narrow strip up to 1/3 as wide as the space between planted rows (strips may involve only residue disturbance or may include soil disturbance) is engaged by a specially equipped planter. Planting or drilling is accomplished using disc openers, coulter(s), row cleaners, in-row chisels, or roto-tillers. Weed control is accomplished primarily with crop protection products. Other common terms used to describe No-till include direct seeding, slot planting, zero-till, row-till, and slot-till.

Overseed
To seed an existing stand with another type of plant.

Pasture
Land used primarily for the production of domesticated forage plants for livestock (in contrast to rangeland, where vegetation is naturally-occurring and is dominated by grasses and perhaps shrubs).

Postemergence
Refers to the timing of pest control operations. Postemergence operations are accomplished during the period subsequent to the emergence of a crop from the soil and must be completed prior to point at which crop growth stage prohibits in-field travel (unless alternative application means – aerial or irrigation-based – are used).

Preemergence
Refers to the timing of pest control operations. Preemergence operations are accomplished during the period subsequent to the planting of a crop and prior to the emergence of that crop from the soil.

Preplant
Refers to the timing of pest control operations. Preplant operations are accomplished during the period subsequent to the harvest of one season's crop and prior to the planting of the next season's crop.

Primary Tillage
The mechanical manipulation of soil that displaces and shatters soil to reduce soil strength and to bury or mix plant materials and crop chemicals in the tillage layer. Tends to leave a rough soil surface that is smoothed by secondary tillage.

Ridge Tillage
The soil is left undisturbed from harvest to planting except for strips up to 1/3 of the row width. Planting is completed on the ridge and usually involves the removal of the top of the ridge. Planting is completed with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges. Weed control is accomplished with crop protection products (frequently banded) and/or cultivation. Ridges are rebuilt during row cultivation.

Rill Erosion
The removal of soil by concentrated water running through little streamlets, or headcuts. Detachment in a rill occurs if the sediment in the flow is below the amount the load can transport and if the flow exceeds the soil's resistance to detachment. As detachment continues or flow increases, rills will become wider and deeper.

Rotation
The practice of growing different crops in succession on the same land chiefly to preserve the productive capacity of the soil

Row Crop
Agricultural crop planted, usually with mechanical planting devices, in individual rows that are spaced to permit machine traffic during the early parts of the growing season

Secondary Tillage
The mechanical manipulation of soil that follows primary tillage. Performed at shallower depths than primary tillage, secondary tillage can provide additional soil pulverization, crop chemical mixing, soil surface leveling, and firming, and weed control. In conventional tillage systems, the final secondary tillage pass is used to prepare a seedbed.

Seeded
Generic term for introducing seed into the soil-air-water matrix, typically via a mechanized process that will maximize the likelihood of subsequent seed germination and plant growth.

Soil conservation
Protection of soil against erosion or deterioration.

Soil Test
A soil test indicates the availability of nutrients present in the soil and the availability of those nutrients to crops grown there.

Sown
Planted using a broadcast seeding machine that distributes seed upon the soil surface. The seed may then be incorporated into the soil to ensure adequate seed-soil contact for germination.

Strip Tillage
The process in which only a narrow strip of land needed for the crop row is tilled.

Sustainable Agriculture
any of a number of environmentally friendly farming methods that preserve an ecological balance by avoiding depletion of natural resources.

Tillage
The mechanical manipulation of soil performed to nurture crops. Tillage can be performed to accomplish a number of tasks including: seedbed preparation, weed control, and crop chemical incorporation.

Triticale
Hybrid produced by crossing wheat, Triticum aestivum, and rye, Secale cereale.

Warm Season Crop
Crops that are harmed by frost and do not grow well until the temperatures are in the 70s

Water Erosion
Water erosion is the removal of surface material by water from the Earth's crust and transportation of the eroded materials from the point of removal.

Wind Erosion
The erosion, transportation, and deposition of topsoil by the wind, especially in dust storms.

Winter-Hardy
Able to survive the effects of cold weather.

Winter Kill
To kill by or die by exposure to cold weather.